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Human-Machine Communication

Special Issue: Gender and Human-Machine Communication

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Gender and Human-Machine Communication: Where Are We?

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The time has come to take stock of the discussion on gender and human-machine communication (HMC) in terms of where we have come from and where we may go. Undoubtedly, much work has been done on specific aspects of the relation between gender and HMC, but we lack a coherent systematization of the efforts made so far. The purpose of this article is to do just that: to root the analysis of gender and HMC on a historical level, develop it in a comparative perspective with other forms of communication, and finally embed it in a sociological and political dimension. In other words, we seek to avoid the three fatal flaws Carey (2005) identified for internet studies and which were more recently taken up by Jones (2014). To do so it is important to keep in mind the three elements that we want to analyze—gender, communication, and technology—by putting them in resonance with each other while recognizing that all are subject to change over time.

Elsewhere, drawing on Jones (2014, p. 251), Fortunati (forthcoming) pointed out that in general the technologies of information and communication (ICTs) that have succeeded in the domain of communication have caused the progressive removal of human beings from in-person communication and depreciated the relationships between them. In other words, according to Fortunati, the shift from in-person to mediated communication in all its forms has outlined the progressive evacuation of individuals from the communicative scene. The physical separation of human beings from each other has weakened them, given the potential huge opening in the virtual space of social relationships that these technologies have implied. Specifically, bodily separation has devitalized people as workers and citizens, and in the end, it also has broken down human/machine binaries.

Drawing on this discourse, our main thesis here is that ICTs such as the telephone, mobile phone, computer, and robot were all first and primarily designed to support and advance male users and have given them more power in a domain—communication—in which there were virtually no significant remaining differences between women and men. The penetration of these technologies into the social body has required women to take a

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long and tiring approach to them in the attempt to redesign and reshape these technologies according to their needs. In fact, women have played the most important role in the co-construction of these technologies, but this domestication process has involved phases of the social exclusion of women from information society and of a progressive comeback. Just how difficult this journey has been and continues to be for women is exemplified by gaps still existing today in many areas of the world in technology access, use, and competency. The construction of more advantages for men has had the effect of rebuilding their power differential in the family, power which had previously been decreased by the struggles of the various waves of feminism. This power inequity has been rebuilt starting from communication because this is the first ground of confrontation in the man–woman relationship. As we said above, women obviously did not willingly accept trends of technologically reconstructing their subordination to their husband/partner/father/brother and they have tried to appropriate these technologies by transforming them from power technologies into empowerment technologies (Fortunati, 2014). However, the fact remains that these technologies function as tools of immaterial domestic work. The power of men as a social group has been reassembled through these technologies to allow the direct penetration of capital into the immaterial spheres of the reproduction of individuals, which have been machinized and where direct value is now extracted, in addition to the value produced by women and incorporated into the labor force (Fortunati, forthcoming).

The structure of the article is organized as follows: in the next section, we will analyze the theme of gender, including how this notion has historically and politically been set up, and for what reasons. Then we will examine the meaning of gender for women as a social class and what it represents to them. Next, we will analyze the notion of gender in communication, reviewing historically and comparatively the forms of communication that have succeeded each other over time. We will start by considering gender in in-person communication, then we will progress to consider what happens to gender when it is mediated by the most important ICTs that preceded HMC: the telephone, mobile phone, and computer-mediated communication (CMC). In all of these sections, we will continue to outline the historical framework necessary to analyze the last section of the essay, which focuses on gender in HMC. In the conclusion, we will set up some final sociological and political reflections on the social meaning of these technologies for gender and specifically for women.

What is gender?

Let us start with a historical reconstruction of the notion of gender. The intellectual starting point was de Beauvoir's discourse in 1949 that anticipated many arguments of the sex-gender debate. She wrote, "One is not born, but rather becomes, a woman," (1973, p. 301) concluding that femininity is not an eternal essence but is the result of contingent forces. However, the term *gender* only began to be used as distinct from sex in the English debate of the 1970s. Its meaning was defined in terms of socially constructed femininity and masculinity, in opposition to sex which was defined as biological differences between men and women. The need to contest biological determinism arose from the fact that biology, considered a careful guardian of nature, was often invoked as an inevitable and sad destiny for women and a justification for women's oppression. This distinction between gender and

sex has been made necessary by the fact that much of what was considered *biological* in Western culture was the probable result of education, cultural conventions, social pressures, beliefs, and prejudice. We owe Ann Oakley (1972) for proposing the distinction between sex (a biological term), and gender (a social and psychological term). Although people may be categorized as male or female at the biological level, they are pressured by culture to be and become masculine or feminine through processes of socialization (Oakley, 1996).

Consequently, in this framework sex was seen as a fixed element, whereas gender was considered changeable, historically determined, and influenced by political and social factors (Rubin, 1975). Over time, this idea turned out not to be completely correct in the sense that as Fausto-Sterling pointed out (1993, 2005), sex is also subject to changes over history caused by the force of culture, although such changes are not as fast or awesome as the changes in gender. In fact, the idea of two biological sexes is now recognized as reductive given the rich spectral diversity in chromosomal, genetic/DNA-based, cellular, and hormone-linked possibilities observed by biologists in the intervening years. The concrete operationalization of this sex-gender conception, however, has never been easy. Not by chance, Butler (1990) expressed concerns about the practical distinction between biological sex and social gender. Stone (2007) argued, however, that recognizing both sex and gender as socially constructed does not make sex identical to gender. In the same vein, Nicholson (1994) contended that it is society, rooted in sexed bodies, that fixes the amount of femininity and masculinity of humans as being either male or female. Thus, the notion of sex-gender is far from being clear since it is difficult to draw the line between sex and gender. Moreover, there is no consensus about which social practices construct gender, what their social constructions consist of, and what it means to have a certain degree of femininity or masculinity (Mikkola, 2022). This lack of consensus is probably due to the fact that the term *society* is employed generally in this debate, without specifying *the who* in society, except for a generic male-masculine or patriarchal ruling power.

In this definitional debate about gender, some tech scholars have also intervened. For example, Rakow (1986) proposed that gender is

both something we do and something we think with, both a set of social practices and a system of cultural technologies. The social practices—the ‘doing’ of gender—and the cultural meanings—‘thinking the world’—... constitute us as women and men, organized into a particular configuration of social relation. (p. 21)

Putnam (1982) even suggested treating gender as an effect rather than a factor determining communication. Incorporating the performative lens, the vision of gender has been expanded to acknowledge the differences between women and the differences between men (Eckert & Wenger, 2005, p. 165) and its intersectionality with other variables such as age, ethnicity, and class. This definition has been further implemented by Kessler and McKenna (1978) who distinguished different features of gender: gender assignment (gender classification at birth), gender attribution (the assignment to a gender classification in social interactions), gender role (the behavior of an individual being male- or female-like) and gender identity (feeling male or female). Robert Stoller (1968) investigated the psychological effects of having lived with an erroneous gender assignment at birth. In the mid-1980s, gender began to be replaced by *sexual difference*, a less dualistic and broader expression.

Post-structural thinking contributed to the debate on gender by opening a discourse on the social constructivism of gender (Irigaray, 1984; Kristeva, 1984) and, drawing on Foucault (1979) and Butler (1990), proposing additional categories—such as transgender—and thereby arriving at a more *diffuse* gender categorization. In light of this debate, gender shifted from being binary (categorizing men as a group and women as a group) to articulating different forms of doing gender. The notion of a *gender continuum* was introduced, which made room for third genders, agender, two-spirit, and different dimensional models of gender (Søraa, 2017). This discussion is pivotal because gender is an important marker of identity that helps people to relate to one another, is characterized by cultural norms and practices, and is bound to power structures and relationships (Alesich & Rigby, 2017).

The debate on gender is, however, broader than that and it develops by introducing into the framework very important elements. Katherine Millett (1971), for example, argued that gender is socially constructed through socialization: in the classic example, a female becomes a woman by acquiring feminine traits and learning feminine behavior. Butler (1990) added that the ascription of gender is the outcome of a process of *girling* and *boying* beginning before birth and then strengthened by performativity practices. Consequently, the solution for creating more equal societies is unlearning social roles and social practices. Socialization also implicates social learning: Sharpe (1976) and Renzetti and Curran (1992) described how the different socialization of boys and girls at home and school affected how they learned to become men and women. Socialization and social learning recur in many feminist analyses, along with education (e.g., Kimmel, 2000), social roles, and practices that are all seen as the outcome of behaviors that shape women's subordination to an unspecified male power. A relevant limitation of this debate is that it does not clarify what should be considered appropriate for each gender. These approaches show how current socialization, social learning, social roles, and social practices produce gender stereotypes, but they refrain from indicating what constitutes *good* socialization, social learning, social roles, and social practices. In the same way, they do not specify what a *non-stereotypical* woman or man would be.

Other scholars have tried to identify concrete reasons for the social practices that produce stereotypical men and women. For example, Chodorow (1978, 1995) argued men and women develop different personalities that begin in early infancy as responses to the fact that mothers tend to identify more with daughters than with sons; therefore, to remedy the formation of gender stereotypes, fathers and mothers should be equally involved in parenting. Another argument (although less fully elaborated and less influential than the previous one), was advanced by MacKinnon (1989), for whom the notion of gender should be rooted in a theory of sexuality, which identifies the power relation between men and women as a crucial factor from which the sexual dominance of masculinity and the sexual submissiveness of femininity derives.

Two major contributions to the gender debate were offered by S. James (1953) and Lees (1993). In 1953, S. James wrote the essay "A Woman's Place," in which she described the life conditions of women in post-war Los Angeles. This essay for the first time implicated domestic labor as the main reason for women's status weakness and the first link in the chain of their oppression and exploitation. In the same vein, Lees argued that the construction of masculinity and femininity is based on the relations of power that shape domestic roles to the disadvantage of girls and women. After its initial impulse, the gender debate

has developed a range of analytics and arguments: gendered social series (Young, 1997), resemblance nominalism (Stoljar, 1995), gender realism and particularity (Spelman, 1988), normativity (Butler, 1990), gender uniessentialism (Witt, 2011), and gender as positionality (Alcoff, 2006). It is not surprising that this theoretical development has imploded: when the feminist movement began to ebb, the political analysis and theory of course suffered.

However, in this debate on gender, one of the most important themes has been the identification of women as a social group, collective, category, or class, although the treatment of this theme has become thorny. Instead of stimulating reflection on women's social stratification, the recognition of differences in nationality, ethnicity, class, sexual orientation, and social position ended up sowing doubts about whether it was possible to build a truly inclusive feminist movement. Very often in these analyses and their given theoretical approaches, women are seen as passive social subjects, devoid of any agency. However, the theme of the domestic work which forms the basis of the power relationships that women undergo has remained on the table, offering the possibility to contextualize, frame, and give meaning to the other processes analyzed: socialization, education, social learning, social roles, and practices.

What is gender for women?

Among the folds of the theoretical discourse on gender, it is possible to deduce what gender has been and has become for the broad category woman. Feminism was born by revealing and imposing gender as a politically, economically, and sociologically substantive variable. Gender became a political node, in which gender identity was negotiated, reshaped, and reformulated, since the perception of belonging to the gender socially associated with one's biological sex, which is often operationalized with the binary categories male or female and which is the first component of sexual identity, was leaving a large margin of dissatisfaction among people. At the mass level, gender identity seems to increasingly outdistance the canons fixed socially as desirable, but undoubtedly the lack of clarity and proactiveness that has characterized the debate on gender, as we have seen above, weighs heavily in this situation. Gender identity has become a true terrain of political struggle against the biopower (Foucault, 1979), or the body of practices and regulations tuned by modern nation-states for achieving the subjugations of bodies and the control of populations.

Equally strong are the struggles that have invested the second component of sexual identity, role identity, with which a person expresses their belonging to a certain biological gender with respect to the outside world. The gender division of social roles has been contested, expressing a more healthily fluid aspect. Today a man can express talents traditionally considered feminine such as cooking, sewing or designing clothes, and taking care of the body, and a woman can play roles traditionally perceived as masculine such as astronaut. But these experimentations in terms of personal expressiveness, which can be seen as innovative and satisfying, actually obscure struggle on the gender division of domestic work between partners. Although less intense now than in the past, reluctance persists on the part of men as a social group to contribute an equal amount of domestic and care work. The role most contested by women is that of housewife, or roles of mother and partner which are rooted in domestic labor. This is the primary role from which all the other social roles for women derive. The primeval weakness of being unwaged workers in the house

determines the weakness of position at the social level from which women suffer. Women's gender roles open issues of political strategies to compose new conditions of life for women, but this is not the place to deepen this discourse appropriately.

Here it is sufficient to stress that gender has become a terrain of confrontation about power and control of women's labor and social roles as well as a place of insubordination and political initiatives by women and their strategical allies: LGBTQ+ communities. One of these initiatives was the birth in the 1980s of women's studies or gender studies, which had the merit to make feminism a recognized part of academic knowledge production and sharing (Fortunati, 2018). We should not forget that the 1980s was the period in which an undeclared war against feminism was fought largely in the media, where many articles claimed that feminists had gone too far with their political program and had created a lot of discontent among women. Also in response to that, women's studies became a major academic discipline, but perhaps with the inevitable effect of institutionalizing the feminist discourse.

Gender and communication: Where are we?

The second element implicated in our discourse is communication. This is the primary terrain in which elaboration and presentation of the self, socialization and social relationships (including work relationships), and life organization take place and inevitably cultural, social, economic, and political changes reshape communication. These changes are particularly important for women, because, as Rakow (1986) states "it is in communication that this gender system is accomplished. Gender" . . . "takes place as interaction and social practice, all of which are communication processes. That is, communication creates genders who create communication" (p. 23).

The most important point here is that the debate on gender and communication, just because of the difficulty of operationalizing the sex-gender notion, risks remaining stuck within an approach focusing on male and female differences regarding opinions, attitudes, and behaviors in communication practices. Therefore, there is the need to generate an analytical framework capable of addressing these concerns. In this framework, which is diachronic and synchronic at the same time, the analysis of the relation between gender and communication opens the question of women's agency and subjectivity in the social changes that have reshaped this relation in the shift from in-person communication to telephone (mobile and fixed) communication, to CMC and HMC. The theoretical framework of reference for this analysis is informed by the long tradition of feminist Marxism (Cox & Federici, 1975; Dalla Costa & James, 1972; Fortunati, 1981), which will help us to outline the historical and social meaning of the relation between gender, communication, and technology, the three elements introduced above. This theoretical framework counts on many established contributions from other traditions, which have shed light on many features and meanings of contemporary communication regarding men and women.

In the domestic sphere, the diffusion of ICTs has had the specific implication of strengthening the gendered and racialized division of labor in the home. While it has conjured against the rooting of the process of individual reproduction in the materiality of life, it has worked as a privatizing mechanism that has decreased the need to leave the house or talk to or make love with another human being (see the surrogate sexuality provided by

sex robots, Atanasoski & Vora, 2020) and has legitimized the development of relationships of domination and dehumanization (Schiller & McMahon, 2019; Woods, 2018). Moreover, the process of separation of one individual from the other, which we talked about before, is also a specific attack against women and the domestic sphere, because the mechanization of individuals at the communication level has further decreased the value of the reproduction of the labor force, which historically is the outcome of women's work process. On the one hand, men and women come to be more easily controlled (Andrejevic, 2007; Zuboff, 2019), but above all on the other hand they have become an additional source of surplus value production (Jarrett, 2015); in fact, the labor force no longer works only in the production sphere, but also, and increasingly more, in the sphere of domestic reproduction (although women continue to be the backbone of this sphere), creating an enormous amount of value (Fuchs, 2017).

This process was particularly crucial for women and the issue of gender because it developed in a particular, historical moment in which in the domestic sphere, after the various waves of feminism, women had reshaped gender power relationships within the family to be more in their favor. Specifically, they reinforced their mastery and control over in-person communication (where, as we will see later, a lack of differences between men and women have been documented), appropriated communication in the public sphere (after thousands of years of exclusion), and redefined intergenerational power relationships within the family in favor of the youngest (Fortunati, 1998). Paradoxically, this power women attained at the communicative level has been reduced by the diffusion of digital technologies in the domestic sphere. Unfortunately, the process described so far did not meet a solid defense from women, who chose not only to favor the so-called white goods such as domestic appliances, which could bring about a more equal division of labor within the household and thus liberate them immediately from a certain amount of material fatigue, but also to neglect the so-called brown goods, such as electronic and digital devices, which were perceived by women as more connected to the entertainment dimension. This strategy on the part of women, labeled by Gray (1992) as calculated ignorance, was revealed to be dangerous in the long term, given the unequal power relationships within the family. Women's competence in the use of domestic appliances ended up being perceived socially as a sign of a lack of power, while men's competence in the use of ICTs strengthened their power. In this process, there has been a crucial shift that held particular importance regarding the gender issue: the introduction of the computer into the domestic sphere. Specifically, through the computer, women's comparative strength in the domain of communication was downsized (e.g., Herring & Martinson, 2004), since this artifact was designed (even more than the telephone and the mobile) primarily by men and for men (especially those who were affluent, Western, White, young people; see Wyche et al., 2016). Women as a group have not been early adopters of digital technologies, although research shows that women tend to be more open than men to the technology if it is easy to use (Vankatesh & Morris, 2000). Consequently, women have required more time to domesticate and appropriate these devices. Among digital technologies, the computer has been a specific case in which the appropriation by women was particularly difficult, because, as Wajcman (2010, p. 146) pointed out, there was a widespread sensation among women that the computer/internet was not serving them well. We will learn more about this topic in the section dedicated to CMC. To conclude this discourse, the most relevant gender difference that crosses all these fields of communication

is this: despite shouldering alongside men an attack by these technologies on their identities as workers and citizens, women also bore an assault on their identity *as women*, rendering them more vulnerable than men.

Gender Differences and Gender Diversities in In-Person Communication

In-person communication is a social process in which individuals create meanings by talking, viewing, and listening to and with one another. By doing so, each interlocutor makes sense of the attributes and traits of the other interlocutor in relation to the self (Goffman, 1959). The visibility of others and their performances enables communicators to take stock of others' appearances and behavior as an essential part of this process. Communication is thus intrinsic to social relationships and ultimately to how society forms (Mead, 1967).

Historically, the physical presence of the interlocutors created a context in which they perceived themselves as self-located in the same spatial environment and felt that they could interact with that environment. The body of research on in-person communication (Cummings et al., 2021) allows us to figure out how different components of a person's sense of presence such as perceived self-location, sense of co-presence, and judgments of social realism play a big role in this mode of communication (Heeter, 1992). Moreover, the notion of embodied cognition, which stipulates that the body and brain are intertwined, with cognition being influenced by the physical sensations and actions of the body (Varela et al., 1992), points out how in-person communication embodies the maximum potential for harmonic performance. In a similar vein, presence is also a complex psychological construct with several potential dimensions. Despite its common reduction to *being there*, presence has been defined and typologized repeatedly over the past three decades (Heeter, 1992; K. M. Lee, 2004; Lombard & Ditton, 1997; Slater, 2009; Slater & Wilbur, 1997). One of the most commonly accepted explications conceptualizes presence based on a three-factor typology: physical presence (experiencing actual physical objects), social presence (experiencing actual social actors), and self-presence (experiencing one's actual self) (K. M. Lee, 2004). However, these aspects of presence are themselves often further treated multidimensionally within the broader literature. For instance, physical presence (sometimes referred to as spatial presence) has been regarded as a two-dimensional construct consisting of self-location (perceiving oneself as inhabiting a spatial environment) and perceived action possibilities (the sense that one can interact with that environment; Wirth et al., 2007).

Systematic literature reviews on social presence have found that it can be construed as the sense of *being there with a real person* (Oh et al., 2018), yet consists of the separate feelings of copresence, psychological involvement, and a behavioral engagement factor (Biocca et al., 2003). One key component of social presence is copresence (Biocca et al., 2003; Oh et al., 2018), which refers to the psychological connection and proximity experienced with another person and the perception of potential interaction (Nowak, 2001). As a consequence, as Richardson (2015) pointed out, individuals only experience their full humanity, and we would add their full sociality when confronted with other humans.

Several other elements, however, should be considered pivotal to understanding the social foundations of in-person communication and to capturing the changes that the mediation of technology has introduced in the relation between gender and communication.

Let us at least consider the presentation of the self, the role of the human body, sociality, and labor. The presentation of self and the materialization of the human body facilitate social categorization (gender, age, ethnicity, and so on), supporting the stereotyping and discrimination processes that are the costs generated by automatic, category-based information (Eyssel & Hegel, 2012). Furthermore, the presentation of the material self depends, within certain limits, on criteria of visibility, authenticity, and reciprocal control. A relevant extension of the human body is the voice, which during in-person communication allows us to generate social categorization and regulate social behaviors. All bodily cues serve to reduce communication uncertainty by aiding in the formation of impressions, refining the understanding of the interlocutors, and predicting their mental and physical status (Infante et al., 1997). Collectively, they help communicators manage their conversations and build interpersonal relationships.

Historically, communication, like many other domains, is shaped by the social structure and its class stratification, which is founded on the attribution of more social, political, and economic power to men who have the task of mediating the power of capital toward women, children, and older people. Factors such as the power difference between men and women, the weight of social construction of gendered identities, and the strength of gendered socialization processes, as well as the associated stereotypes, norms, expectations, and performances, have all contributed to generating a different relation with communication on the part of men and women as social groups. However, after the first and second waves of feminism, these differences in in-person communication were attenuated until their virtual disappearance. Returning to the observation we made at the beginning, several meta-analyses exploring many dimensions and variables of communication have documented very small or non-existent sex differences in communication behavior.

The first of these meta-analyses was carried out by Dindia and Allen (1992) who found that there were only small differences in men's and women's self-disclosure. The second meta-analysis, which was conducted by Canary and Hause (1993), again found minimal communication differences between men and women in their persuasibility and aggression, verbal ability, self-disclosure, helping behavior, small group performance, leadership behaviors, and evaluation of others; further, these small differences were moderated by a series of factors other than sex. They also found that there were no statistically significant sex differences regarding interruptions, five dimensions of interaction (relational control, source of information, time orientation, evolution of information, and reducing equivocality), and marital conflict behaviors. Canary and Hause (1993) also remonstrated the unfortunate reliance on sex role stereotypes at the research level with the implication that sex role stereotypes and sex polarization were perpetuated through communication science. Moreover, they identified as conceptual shortcomings the lack of a valid measure of gender and a dearth of theory on how sex/gender and communication are related (p. 130). Much of this research offered results directly counter to popular stereotypes of men's and women's communication tendencies. D. James and Drakich (1993) clarified that men talked more than women in mixed-sex interactions and in formal and public situations, whereas women tended to talk more in private and informal situations and same-sex interactions. More recently, Leaper and Ayres (2007) found again that men were more talkative and used more assertive speech whereas women used more affiliative speech. Even women's presumed biological advantage for language ability appeared trivial when empirically observed and

evidenced a decrease over time (Gleason & Ely, 2002). The same happened for verbal ability, on which Hyde and Linn (1988) produced a meta-analysis reporting a minuscule difference between the sexes. Even when such differences were statistically significant, their effect sizes were minimal to the point of social insignificance. Further, they became more consistent when moderator variables such as interactive context, measurement quality, and publication characteristics were taken into account. A careful examination of the huge body of literature that has tried to capture all these gender differences in communication brings scholars to converge toward recognizing that there are very few differences between men and women at the communication level (e.g., Goldsmith & Fulfs, 1999).

These studies that have obtained this important outcome have some limitations. First, the majority of these essentially investigates sex differences (i.e., differences between the behaviors of men and women) rather than gender differences (i.e., the prevalence of behaviors and characteristics that different cultures associate with masculinity and femininity). Second, they only describe these differences without trying to interpret them. Even the lack of differences between men and women has been insufficiently interrogated and probed for sense and meaning. By contrast, drawing on Canary and Hause (1993), we could ask if this communication gap has practically disappeared or has migrated and opened in other dimensions of daily life. Probably, both of these answers are true on some level and each owes to the fact that women's (and in part also men's) agency on a practical level has been weakening the sexual division of labor which forms the basis of the entire structure of society. Sex is no longer that wall, capable of dividing men and women in a radical and frontal way, at least in the communication domain. Therefore, we argue that the demolition of this wall has implicated for capital the need to erect, as mentioned in the introduction, other walls—walls built up by the new strategy of dividing each individual from the other and also rearticulating at a higher level the division of communication work on the line of gender. These new walls have been reintroduced by means of digital technology.

However, before analyzing what happened with the various technological artifacts, it is worth concluding this discourse on gender and in-person communication. The elements we analyzed so far such as the presentation of the self, the role of the human body, sociality, and labor, are pivotal not only to understanding the social foundations of in-person communication, but also to capturing the changes that the mediation of technology has introduced in the relation between gender and communication. From a communicative point of view, the human body can be considered a complex platform that conveys several languages, among which is nonverbal language. The voice can communicate emotions in varying timbre, tone, and rhythm, regardless of the verbal content, and according to Ricci Bitti (1987, pp. 102–114), offers the advantage that its emotional modalities are less controllable than facial expressions. People rely on bodily cues to form impressions and make judgments of interlocutors (Berger & Calabrese, 1975). Sociality itself needs exist in and through communication (how, for example, would it be possible to accompany a child into society without teaching them communication skills?) and, at the same time, it promotes communication, since to be effective and to last over time it must be embedded in social activities, like going with our friends to a restaurant or the cinema (Fortunati et al., 2013). We need to go out and move into public spaces to do things with others to nourish the communicative process. Mobility also comes into play, even if once we have reached our interlocutor, the setting of conversations is generally sedentary: we talk with others mainly

while we are sitting. We can also converse when walking but it is a rarer context for in-person communication. The “immobility” that accompanies communication will grow more extreme under the influence of communication devices. Finally, labor is interconnected with communication not only because people cannot work if they do not pass-through communication, but also because communication is labor in the domestic sphere. Reproductive labor is constituted by different tasks, such as affect, love, sex, psychological support, knowledge sharing, entertainment, and information, which are all conveyed in and through communication. Thus, this labor, which still involves women much more than men, is the spine of value production in the domestic sphere (e.g., Fortunati, 1981; Hochschild, 1983). Care labor, rooted in communication, is also grounded in cooperation and organization since to build and maintain concrete forms of sociability we need to work in coordination with others. In light of these specifications, it is clear that sociability is a process that applies an intensified logic: individuals feel more reassured and are more reassuring if they can practice any of the sociability forms together with another person, through communication. In fact, Mou and Xu (2017) found that in communication with a chatbot, people expressed a higher level of neuroticism and lower levels of openness, agreeableness, extroversion, consciousness, and self-disclosure compared to communication with another human being.

The scenario we have described so far and which is typical of in-person communication has been profoundly affected by the diffusion of digital technology, which is both a source and a consequence of gender relations, and in which “social relations (including gender relations) are materialized” (Wajcman, 2010, p. 147; L. A. Suchman, 2009). In the next two sections, we will investigate how gender has been reshaped by the fixed telephone and the mobile phone and in turn how these technologies have been reshaped by gender.

Gendering Fixed Telephone Communication

The third element of our analysis, technology, is a relevant source of change in itself and also because it mediates communication. Especially digital technologies—the mobile phone, computer, and robot—change over time both because of the advancements in science and technology that produce innovations in their affordances, forms, features, functions, services, and applications, as well as because of their continue reinvention by “producers” (Bruns, 2007). The changes produced in the technological domain are relevant not only to communication but also to gender since both gender and technology are products of a moving relational process, which emerges from mutual shaping (Wajcman, 2010). Thus, when we look at the intersection of these three elements—gender, communication, and technology—the historical moment comes to matter particularly, given their structural dynamicity.

The telephone was the first tool used to inaugurate the processes of physically separating individuals from one another and challenging women’s empowerment. Of course, it was presented to people the other way around: as a device that could shorten the distance between individuals far away from each other. The two aspects are both true, but the second was so exciting that it quietly overshadowed the first, which is perhaps the most relevant. The reason that the first aspect was considered unimportant may have been that in-person communication was by far the most widespread form of communication. After all, if we

consider that on average people made very few phone calls a day and that on average those lasted only a few minutes, telephone communication represented in the eyes of people a good opportunity to overcome geographical distances that were otherwise insurmountable without much effect on the status quo. Even the fact that in order to communicate by telephone people had to pay did not elicit the proper reaction as one would expect, although it was the first time that at the mass level communication began to cost. An important feature that has not been sufficiently emphasized in the debate is that the fixed telephone was introduced into the households as a family device, submitted to collective use. The contract was signed by the head of the house who could check the number and length of calls made by each family member because the bill was addressed to the account holder. The fact that access to the telephone retraced the hierarchy of gender relationships has heavily affected women's access and use of this tool within the family and also at a social level (e.g., women received a large number of abusive calls).

In this physical separation between individuals, the telephone retained a vital element that served as a bridge between the world of the living and that of the artifice. This element was the voice, which lies precisely on the boundary between the materiality of the human body and the artificiality of the twisted pair. The voice blurs the boundaries of the body, rendering them uncertain because it expands a few meters away from the body. Of all the cues typical of in-person communication, only the voice remains in telephone communication. However, the voice is a primary element since it conveys a series of social cues of the interlocutors, and, among them, the gender cue, which usually is the primary information that communicators seek to obtain (Turkle, 1995). Our brains, as Nass remarked in an interview (Stober, 2008), are so tuned to speech that they react to a voice as to a person and, thanks to the voice of the interlocutor, people forget their absence.

However, the extrapolation of only a part of the human body—the voice—makes the human body a secondary entity of the telephone interlocutor. Telephone first, and then all the other ICTs, have increased the separation of the human body from the communicating individual with the consequence that communication was also separated into its parts. From a unitary process, communication became increasingly more partial and a specific alienation in the communication sphere emerged, which was also accompanied by the profound joy of being able to go beyond spatial constraints and talk to distant people. The telephone was the first device to shape a form of communication in which emotions and nonverbal signals were hindered, if not prevented. This separation has meant that the mind was more likely than the body to become the central, true protagonist in the mediated communication process. As Manovich (2001) has argued, the main feature of new media is not the individuals' presence through media, but their absence through media, that is, their anti-presence. The tele-absence of the individual in mediated communication confines the body to a secondary role and to what could be described as a discriminated or suppressed condition. The new reality is that the affordances, needs, and desires of the human body are largely ignored. We need to understand more in detail what really happens with and to bodies in communication processes. For example, the physical and emotional infrastructures of communication processes have become separated from the words and thoughts that are conveyed inside the process. Furthermore, emotions have a different fate from the human body. Considering the emotions in their essence of inner energy, as Illuz (2007) defined them, somehow they adapt themselves to mediated communication with the consequence

that individuals experience and live emotions in a manner that is not automatically worse (Vincent & Fortunati, 2009). On the contrary, in telephone communication it is the physical infrastructure of the body that is ignored in its potency and peculiarities and, because it is less adaptable, is destined to be more inert. As we already mentioned, in-person communication also requires a certain steadiness, but with the telephone, users are obliged to be even steadier: to sit down in a chair with limited possibilities of motion. Telephone communication became a great training ground for ignoring one's own body and that of the interlocutor. A progressive dematerialization of the communicative process in which the bodies are removed silently takes place.

The debate related to telephone communication goes back to the 1980s and 1990s of the last century especially and involved a relatively small number of scholars engaged in studying its role in social change and social life. The themes addressed by the studies on gender and in-person communication were very partially ferried into the scholarship on telephone communication, which expressed a more sociological approach. The 1980s, especially, were a period in which, following the ebb of feminism, families and social structures were reshaped under a hierarchy reflecting resurgent male dominance. Rakow (1992, 2004) traced a profile of the social meaning of the telephone both for overall society (the telephone has always been seen as an agent of modernization, based on Veblen's analysis of the role of technologies in society) and specifically for women. This debate (e.g., Claisse & Rowe, 1993; Dimmick et al, 1994; Moyal, 1992) was strongly influenced by Max Weber's (1978) distinction between instrumental and intrinsic value: the first was seen as characterizing men's telephone communication, considered functional, and the second, as characterizing women's telephone communication, considered expressive. This stereotyped distinction has contributed to confusion in this field of studies because in reality women's use of the telephone is just as functional as men's: only the functions are different (Fortunati, 1995).

The primary point to be considered here is that women simultaneously transformed the telephone into a work tool of domestic labor and appropriated the telephone to empower themselves by overcoming their isolation and separation from each other (Fischer, 1988). The telephone was transformed by women into a technology of sociability (Fischer, 1988) and psychological support, serving to strengthen the immaterial sphere of housework. At the same time, it gave those who were isolated in their urbanized houses or dispersed in rural areas the possibility to reconstruct their network of family and friendship ties, especially those with women family members, relatives, and friends. This network with strong ties was the social structure on which women based the cultivation of their personal as well as their social and political identity. Women's networks were profoundly different from those of men and would reappear as such in mobile communication (Friebel & Seabright, 2011). However, what media and social discourse labeled as "chatting" was in reality the elaboration of a collective analysis by women on their role within the family and society, their housework, their intimate relationships, and their future. Ann Moyal (1992), analyzing the gendered use of the telephone in Australia, depicted a fascinating fresco of how the counter-power of women's network deployed all its strength for them. She stressed that the feminine information flows were equally important "to national well-being and progress as the more visible and highly rated masculine business information flow" (p. 67). Concerning the United States, Fischer argued that although this device was designed to meet men's needs, women reinvented both the user and the uses inscribed within this technological

artifact. The affinity of women toward the telephone, also detected by Fischer, should in reality be understood as the pleasure felt by women in reshaping this tool according to their needs. Of course, Fischer (1988) was right in stating that the gendering of the telephone “may have simultaneously reinforced gender differences and also amplified women’s abilities to attain both their normatively prescribed and personally preferred ends” (p. 212) in an empowering process for women. Two recurring issues in the general debate on telephone and gender were: (1) that this tool was considered capable of freeing women’s time from unnecessary travels and reducing their loneliness, isolation, insecurity, and personal anxiety; and (2) the lens through which to observe the mechanisms of gender power was the issue of who answered the telephone. Rakow (2004) reported that the leader of the Association for Protection of Telephone Subscribers suggested reserving this task to “the servant” or the woman of the house. The fact that women were expected to answer the phone testifies that at that time in industrialized countries telephone technologies, in general, were seen as mere instruments, not as signs of social prestige. If in the house answering the telephone was seen as a woman’s task, in the factory, it was the task of an employee, often a secretary, but not of a manager. This situation will occur again with the mobile phone: its early adopters, who were usually affluent persons (Fortunati, 1995), entrusted the task of dealing with screen intrusions to the personal secretary. This situation will also reappear with the computer and the informatization of the productive system (Fortunati, 1998). The ICTs will become a prestige commodity only in parallel with the increasing economic power of large companies such as Microsoft, Google, Facebook, Apple, and Twitter.

Finally, in the debate on the relation between the telephone and gender, the point was also who talked more on the telephone. There was evidence that women distinguished themselves as talkers. Rakow (2004) argued that being responsible for maintaining family and social relationships and home-business transactions meant women had to use this device more than men. News of this evidence, however, was met with disapproval or derision by the popular press and by the managers of the telephone companies themselves, who, not seeing housework as proper work, condemned themselves to not understand the market (Fischer, 1988, p. 217). Since domestic labor also was not recognized socially as true work by the various members of the family (although this had been one of the feminist objectives of the struggles of the 1970s), when the telephone bill arrived, women were often pushed to feel guilty for having used it so much (Fortunati, 1995).

Gendering Mobile Communication

The mobile phone continued the processes of challenging women’s empowerment and promoting physical separation between individuals; both of these were inaugurated by the fixed telephone, but the second was further exacerbated through what has been called phubbing (or phone snubbing, e.g., Vanden Abeele, 2020). The conversation with and the attention toward the person(s) physically present takes a backseat when a phone call arrives. This marks visibly in the public space the devaluation of relational engagement with the embodied co-present interlocutor (Gergen talked of absent presence, 2002). At the same time, the mobile phone collapsed the distance between technologies and the human body since the device lies over the human body. The loss of distance blurred the perception not only of

the alterity between the human body and this wearable technology but also of the physical separation between individuals.

Researchers looked at the new telephone on the move differently compared to the telephone, although even here the sociological approach continued to prevail. The second half of the 1990s is a period in which strong forces of increased individualization (Wellman, 2001) made the family less standardized (Fortunati, 1998) and women's conditions of life more empowered. Topics such as the derision toward women because they were too talkative on the phone, or the guilt felt by women for those reproaches receded. However, the theme of women's appropriation of the technological artifact remained on the table and, in particular, the theme of the feminine affinity for a device conveying the voice (Livholts & Bryant, 2013). To understand the novelties that have accompanied this device, the first years of its diffusion should be considered with great attention, because at the end of the last century people decided to completely reshape the mobile phone. First proposed to households as a supplementary telephone to accompany family members on the move and carrying the same conditions of the fixed telephone (contracted and billed to the heads of household, typically men), the mobile phone became within a few years a personal and a personalized device that accompanied individuals both when they were stationary and on the move. Men were initially more likely than women to access and use the mobile phone (Ono & Zavodny, 2005), but this gap very quickly narrowed or closed in many countries (Rainie et al., 2000; World Internet Project, 2010). Starting as a tool subjected to collective use within the family, whose costs were drawn from the family budget (to which men breadwinners typically contributed more) and whose use was controlled by men, women and youth transformed the mobile into a personal and personalized device on whose use and payment they could have control. This reshaping of the mobile phone gave women new freedom and thus new power regarding their communication practices. Since then, the evolution of the domestication by women of a tool designed at the beginning for men has involved various steps, as reconstructed by Pei and Chib (2020), who proposed the notion of mGender to describe a technology women used to negotiate their gender status.

The mobile phone continued to maintain the voice, a treasured aspect of the telephone experience, but, in addition to the dimension of orality, it also developed writing modalities (thanks to youth who, through SMS, found a way to use the mobile phone without paying) and in more recent times, also visual. The extreme flexibility of this tool is well expressed by its ability to return to its users an increasing number of the social cues of their interlocutors and themselves (e.g., the self). The mobile phone is the device that has made living "as if" the interlocutors were with them irresistible for the users (Turkle, 2011).

The use of the mobile phone by women has been quite accelerated by their massive intervention on the material body of the mobile phone, which was originally designed with men in mind (Shade, 2007). Women's pressure on mobile phone manufacturers has pushed them to embark on a long journey with fashion and design to adapt this device to women's tastes and sensitivities to aesthetics (e.g., Fortunati, 2013; Zhang & Juhlin, 2020). In Western countries women also exerted influence on the services, functions, and applications of the mobile phone, gendering this device in feminine terms (Fortunati, 2005; Shade, 2007). The pivotal use of the mobile phone by women has continued to identify it primarily as a work tool. Household management, organization, caring, emotional support and expression,

microcoordination (Ling, 2004), and remote mothering or grandmothering, have passed through the mobile phone both in industrialized countries (Fortunati & Taipale, 2012; Frizzo-Barker & Chow-White, 2012; L. F. Rakow & Navarro, 1993; Sawchuk & Crow, 2012) and also in developing countries (Stark, 2020; Tacchi et al., 2012). However, the mobile phone has also been a means of undoing gender, strengthening women's control of communication, reinforcing their personal autonomy and freedom, including at the political level (Stark, 2020), and making mobile housework and care visible in public space (Hjorth & Lim, 2012). The halo of invisibility that surrounds the immaterial sphere of care work has been shaken by the mobile phone because its use helped to make the expression of intimacy, affection, and so on conspicuous and observable in public places. However, as in the case of the telephone, it is difficult to find a definitive answer to the question of whether the mobile phone has contributed more to decreasing or to expanding women's work, as well as whether it has contributed more to women's empowerment or disempowerment (Stark, 2020). Probably, an answer to these questions will be emergent when much more research has been conducted in developing countries that cannot of course be considered as a monolithic whole. Zainudeen et al. (2010) found, for example, that a larger gender divide in direct access to phones existed at the bottom of the pyramid (the lowest socioeconomic classification) in countries such as Pakistan and India, less in Sri Lanka, and none at all in the Philippines and Thailand.

A growing body of research has found sex differences (operationalized in these studies as comparisons between male and female participants) in the use of mobile telephony in many national and/or cultural contexts, but these studies are not systematic and suffer the same three flaws outlined by Carey (2005) and reported in the introduction: they are not sufficiently historical, lack comparative perspective, and are not sufficiently embedded in politics, economics, religion, and culture. But above all this body of research has continued to not address the problematization of the categories of sex and gender. Regarding the mobile phone, the pivotal, political point here is that women continued to erase their differences from men in access and use of this tool that was emergent at the beginning of its appropriation and to empower themselves through ownership and control of this tool. However, women were unable to contest the main process of the general separation of the individuals. The more women's similarity with and closeness to men progressed, the more digital technologies worked in the direction of spacing out each individual from the other, moving the walls to a higher level.

The debate on the mobile phone has also highlighted several evolutions of this device such as the shift from an oral communication tool to a multifunctional device, the access to the internet through mobile phones, and finally its transformation into a kind of social robot. Notably, Sugiyama (2013) defined the mobile phone as a quasi-robot and Vincent (2013) as a personalized robot along with its user.

Gendering CMC

The physical separation of individuals from each other, which has reached yet a higher level with the diffusion of CMC, again proceeded differently for women who were subjected to a double attack: they, like anyone, were separated by the computer from each other, but they were in many cases also separated by the computer itself. This process has been also

supported by the fact that even though women contributed heavily to the development of computers—not least of all at the programming level—(e.g., Light, 1999, p. 455), women's omission from the history of computer science has perpetuated "misconceptions of women as uninterested or incapable in the field" and contributed to the lack of female role models who used computers (D. M. Marx & Roman, 2002). Hyper-masculine fraternity cultures of computer design have generated a gendering of computing "against which feminist technologists and designers have worked to carve out spaces and create more equitable products" (Lingel & Crawford, 2020, p. 3). The computer/internet was apparently configured as an "everybody" tool, but by applying I-methodology in which designers assumed they were representative of users, they incorporated in the device barriers against specific groups of users such as women, older people, and the differently able (Oudshoorn et al., 2004). The gendered, anti-woman culture has played heavily in the diffusion of CMC and has been amplified also with the diffusion of the computer because its ownership and use replicated the same scheme as the fixed telephone. In the early days, the computer was usually bought by men heads of the house, who also paid for its use and maintenance. In principle, it could be used by all family members, but in practice the computer/internet access and consumption patterns have mirrored the same power structure of the family and the society, becoming a collective, yet hierarchical device. Rendering women's appropriation of the computer/internet even more difficult were other factors: acquiring and maintaining a computer required financial resources and its use demanded many prerequisite skills and literacies which were time-consuming (extra time was not a resource women generally had at their disposal). As Dunne (1998) pointed out, the genders experienced different forms of resonance with computers.

Another important element that played to the detriment of women is that in this mode of communication, at least at first, the human body disappeared completely from the interlocutor's vision. This happened even more severely than in telephone communication because the voice was also evacuated from much of CMC in its initial form, excepting some chatrooms and videos. The absence of the body meant that in CMC all of the social and nonverbal cues were blocked, making it more difficult to manage proper communication and, for example, to identify interlocutors correctly, even at the level of gender (Savicki & Kelley, 2000; Savicki et al., 1999). The computer environment was built at the beginning as a written and silent world in which women, who have always been "more sensitive than men to social cues in general, as many studies have shown, and to nonverbal cues in particular" (Henley, 1973–1974, p. 2), have been deprived of the use of this specific ability, acquired through socialization and learning. If we think that the nonverbal message greatly overwhelms the verbal one, since it carries 4.3 times the weight in a popular estimate (e.g., Birdwhistell, 1970; Mehrabian, 1981) then we have an idea of the disadvantage that this technological artifact has presented for women.

In the first phase, although there was widespread hype that gender was invisible on the internet, computer/internet users were not discouraged from attributing gender based on the limited cues at their disposal. Gender features of text-based communication have been explored by several scholars (e.g., Mulac et al., 2001; Newman et al., 2008). Herring and Martinson (2004) reported that women more frequently made justifications, utilized hedges, expressed emotions, and made use of supportive language, while men more frequently made use of assertive language, asked rhetorical questions, made sexual references,

and challenged others. Over time, people began to use CMC in all phases of their social relationship management: forming new personal relationships (Maddon & Lenhart, 2006), maintaining existing relationships (Johnson et al., 2008), and ending relationships (Gershon, 2008; Weisskirch & Delevi, 2012). However, the disappearance of the body has led to design practices that do not focus sufficiently on incorporating users—and in particular users' identities—in the design process. The lack of the human body in the communication process also affects the presentation of the self, which becomes something with which one can play by representing oneself through nicknames and later through avatars. Yee and Bailenson (2007) documented the alteration of self-representations happening in virtual environments and the consequent changes in behavior and perception that this entails: the so-called Proteus effect. This phenomenon of altering behavior based on the characteristics of one's avatar was investigated further by Sherrick et al. (2014) who analyzed the role of stereotypical beliefs in gender-based activation of this effect. It has been argued that the lack of social presence (e.g., Short et al., 1976) or social cues (e.g., Kiesler et al., 1984) has created an impoverished social environment, although not in the long-term (e.g., Walther, 1996) and this has played particularly against women who are more socially vulnerable in environments little under their control. Other research has looked also at how the CMC channels affect the impression formation of the other, which in this mode of communication passes exclusively through cues such as participants' names, their *linguistic style* and typographical marks, and other textual features (capital and lowercase letters, ellipsis, exclamation marks, typing errors, and emoticons) (e.g., Jacobson, 1999). Moreover, in desk-computer communication, the body is obliged to become even steadier than in telephone communication and to perform only micro-gestures on keyboards and with the mouse. This is not friendly toward the body because well-being is connected to movement and this also has played particularly against women, given that the domestic and care labor that disproportionately falls to them entails moving within the household.

A further element of difficulty for women came from the fact that the internet is a public arena and historically women had been excluded more from public communication to center their life and work especially within the four walls of the house. This contributes to the explanation for why, at the beginning of internet history, women's presence in online discussion and communication forums was dramatically lower than men's. Gender differences in access and use of the computer/internet persisted for almost 2 decades although, over time, different types of gendered consumption emerged in several contexts. Allen (1995) for example reported that women employees perceived email to be easier to use, more efficient, and more effective than men and that they used the computer system for word processing more than their men colleagues. Some years later, Mo et al. (2009) found more pronounced gender differences in communication in single-sex online health support groups and less evident differences in communication patterns in mixed-sex online health support groups. Rainie et al. (2000) found that more American women than men sent an email to maintain ties with family and friends. Other researchers (e.g., Boneva et al., 2001; Colley et al., 2004; Fox et al., 2007; C. Lee, 2003) found that in the US and the UK women's emails and instant messaging were more social in nature, while men's messages were more information-based. Obviously, the educational field has also been the subject of much empirical research. Herring (2003), for example, found that in online mixed-gender discussions, women students showed a more supportive attitude, while men students used

a quite assertive, less polite, and sometimes aggressive language style that pushed women to participate less in these discussions. Miller and Durnell (2004) documented that some gender-related patterns in language use and interaction styles previously identified by Herring (men's domination in mixed-sex interaction, women's preference to use a pseudonym and to employ greater personal and emotional forms) and Tannen (1994) (women's supposed preference for supportive language patterns, men's for authoritative) emerged also in educational CMC. Valenziano (2007) found that women more than men tended to use self-disclosure, express personal opinions, use "I" statements, communicate by apologies, justifications, questions, and support others; by contrast, men more than women tended to argue, use assertiveness, self-promotion, presuppositions, theoretical questions, are authoritative, and challenge and use more humor and sarcasm. She also found that women faculty received more emails from students and tended to answer them sooner than their men colleagues and that there was a high amount of lying and misinterpretation in online communication. Prinsen et al. (2007) reviewed gender differences in computer-supported collaborative learning (CSCL) and found that while male dominance played a role in many CMC environments, this was less pronounced in CSCL because the participation of all the students was explicitly promoted especially in inclusive settings. Koch et al. (2008) documented that women faced more difficulty in building the skills necessary to use the computer since they tend to attribute their failure to their inability, while men were more likely to blame faulty technical equipment. Over time, web services became more user-friendly and required less service-side knowledge and this also had implications for gender differences in CMC. For example, Argamon et al. (2007) found that among bloggers, men used more words connected to politics and business, whereas women used words more linked to interpersonal conversation or relationships. Chan et al. (2013) reported that women engineering postgraduate students engaged more in online communication while men students focused on becoming controllers of information flows; moreover, gender differences emerged in belief gains concerning social aspects, but not in the dimensions of epistemological beliefs. Kimbrough et al. (2013) showed that women, compared to men, preferred and more frequently used text messaging, social media, and online video calls; that is, they used the internet for social interaction and relationship maintenance, whereas men preferred and more frequently used the internet for reading the news, getting financial information, making new relationships, and finding job leads. Bode (2017) found that, differently from what happens in in-person political activity which sees less engagement by women, few gender differences emerged in social media. The most relevant difference was that women were more likely than men to engage in less visible political behaviors. Herring and Demarest (2017) documented that the notion that connected women, audio/video, and positivity, was sociability, while that which connected men, text, and neutrality/negativity, was distancing. Ochnick and Dembińska (2018), studying a sample of 452 Polish students, found that men were more likely than women to become internet-addicted and that their internet use was positively correlated with self-esteem; for women, the correlation was negative. Vella et al. (2019), exploring sociability in online games, found that women players reported misogynistic targeting and stereotype threats (to the extent that they often masked their gender identity) with the consequence that this negatively affected their ability to use voice technology and create social relationships.

Unfortunately, these studies on sex differences are ahistorical and are not brought back to the foundational categories of the social sciences. Furthermore, they do not problematize the notions of sex and gender (related, most measured only whether participants selected male or female) with the consequence that gender stereotypes continue to be perpetuated even in scientific research. Recently, Cryan et al. (2020) demonstrated that gender stereotypes persist in various contexts of computer-mediated and media communication, from biographical pages of notable people, recommendation letters, and Wikipedia entries to fiction novels and movie dialogue. They also pointed out that this issue is magnified by the use of machine learning tools in language processing since these often incorporate gender biases. Gender stereotypes (which certainly persist) are traditionally captured by a gender word inventory, which dates back to 1974. Instead of continuing to use this pre-compiled word lexicon, they propose end-to-end classification approaches because today these are significantly more robust and accurate in detecting gender biases in language. This proposal starts from the premise that, although women and men may process information and problem-solve differently (Czerwiński et al., 2002), in the design of end-user computer programming the human-centric issue has not been considered and this has been at the expense of women (Beckwith & Burnett, 2004; Huff, 2002).

In addition to these stereotypes, the results of research carried out in the first decade of internet diffusion also risk functioning as stereotypes, because they continue to be cited as findings beyond time. On the contrary, the gender gap has been reduced; for example, ITU reported that in 2017 in the Americas, where not by chance gender parity in tertiary education is greater and the percentage of women using the internet is higher than that of men. Moreover, since 2013 the gender gap has narrowed in most regions. By contrast, in Africa, women's percentage of internet use was 25% lower than that of men and even wider in the case of Least Developed Countries (LDCs), where "only one out of seven women is using the internet compared with one out of five men" (ITU, 2017, p. 4). Everywhere, however, there is evidence that the internet continues to be used by men and women for different purposes (e.g., Mäkinen, 2020).

To conclude this part, it is worth noticing that the way in which this debate has developed has obscured the real socioeconomic and political meaning of women's (and also men's) engagement in this field: the fact that men and women, increasingly more separated from each other, are contributing through CMC an enormous, even if different, amount of immaterial and unwaged labor.

What is gender in human-machine communication?

We have reached the last part of our discourse, which is dedicated to HMC and is the main purpose of our analysis. This section reviews how the processes described so far are further radicalized and articulated by this new typology of communication. Here, the analysis concerns not only the relation that women establish with machines and its social consequences but also the attribution of gender to machines. For convenience, we divide this section into two parts: one focused on the gendering of human-machine communication (HMC) and the other on the gender of machines.

Women and Human-Machine Communication

If in CMC the individual is divided from the others by a machine that mediates the communication between them and that at the same time approaches and distances them, in HMC each individual is separated from the others more radically. The human *other* disappears from the communication context since individuals talk to a machine that responds to them. This has serious consequences on the one hand for communication productivity because machines can only transfer their own value (K. Marx, 1964), whereas individuals are able to create and incorporate more value reciprocally. On the other hand, for humans since their disappearance means that they are posited as superfluous with respect to communication labor and that they are subjected to a deep devaluation; as we said, they experience their full humanity and sociality when confronted with other humans. If every individual comes to be devalued by HMC, women are doubly devalued, one as individuals and the other as the traditional performers of domestic, care, and reproductive labor, one of whose tasks has been to teach new generations how to communicate and manage the communication thread in family and parental relationships.

In the shift from CMC to HMC many elements of the communication scene change because in the new context technologies are conceived as communicative “subjects” (Guzman & Lewis, 2020, p. 71). Let us review the most relevant structural changes, before trying to understand women’s relationship with this typology of communication. For example, with voice-based assistants (VBAs, such as Alexa) and social robots (such as Nao) the presentation of self by the human interlocutor—a fundamental feature of the dynamics of human–human interaction—loses its traditional sense. Humans do not spontaneously present themselves to the robot; the problem is how to incorporate in the robot all the information regarding its interlocutors that would make it capable of recognizing them. The materiality of the human body is only partially implicated in human–robot interaction (HRI), whereas here it is the body of the machine which acquires great importance. In virtual assistants, the voice comes back from the mediated voice of telephone and mobile communication as well as from the automatic voice recorded in the answering machine that has trained millions of users to acquire the habit and the discipline to talk to a machine. In human–robot communication, human communication transforms from a relatively spontaneous to a forced process within the automated paths of conversation that the robot can perform. Furthermore, the high degree of authenticity in in-person communication to which individuals are accustomed leaves room for a form of communication with robots based on their capacity to simulate a conversation and this devalues and disadvantages humans’ sense-making of the communication itself.

According to J. Reeves (2016), AI automates communication and related social processes more than it facilitates them (Gehl & Bakardjieva, 2017). Furthermore, the emotional exchange in HMC has a very small range: robots can potentially recognize users’ emotions from their voices and react appropriately, but they are unable to feel and convey emotions to their users. While warmth is one of the main elements exchanged in social relationships, for robots this aspect becomes difficult to manage, and thus the quality of the social relationship they can offer suffers. Consequently, sociality devoid of emotions can only be stereotyped and automated. When compared with our understanding of what

social interaction and the *social* are, the outcome of HRI seems a rudimental form of sociality, which fundamentally restricts the degrees of freedom of flesh-and-blood interlocutors. Furthermore, it is unclear what will be the consequences of HMC on the maintenance of our ability to interact with human beings (Cranny-Francis, 2016). J. Weber (2005, p. 215) asked if we are really convinced that the deficiencies of our social life in terms of care and company can be adequately repaired by means of the basic sociality that social robots can offer to women, children, and people who are older or living with various degrees of illness, ability, and so on.

Faced with these fundamental characteristics of HMC, what has research on the relationship between women and this type of communication offered so far? The first issue that was explored was whether women hold more positive attitudes than men toward robots. Taipale and Fortunati (2018), for example, drawing on a representative sample of Europeans ($N = 26,751$), showed that among those who said they had a fairly or very positive view of robots, men were slightly more numerous than women. This slightly less positive view by women can be understood properly if we take into account that women have often expressed less interest in scientific discoveries and technological development. This attitude derives from women's awareness that science and technology historically have been largely managed by male scholars and professionals who have built this field of knowledge in their own image and likeness. We argue that women could never be early adopters of these kinds of technology because science and technology systematically fail to be inclusive of them. Nomura (2017) found in her research that women participants, compared to men participants, were less likely to have a positive view of robots (although she highlighted that gender differences can interact with moderation factors). Showkat and Grimm (2018) found that the sex differences such as tinkering (i.e., men are more likely to tinker than women) already identified in information processing style, emerged also in human-robot interaction. Other studies (e.g., Obaid et al., 2016; Rea et al., 2015; Reich-Stiebert & Eyssel, 2017) did not find significant differences in the attitudes men and women expressed toward robots.

This debate on gender in human-robot communication that we tried to reconstruct briefly counts on a substantial corpus of experiments carried out by engineers, computer scientists, and psychologists on convenience samples comprised of few participants (very often students). Given these characteristics, the gender-linked differences that are observed are not generalizable and are often only descriptive. Also, the research questions are typically those that can be submitted to an experimentation process and thus are very much circumscribed and the stimuli are in many cases pictures or videos, and more rarely live social robots. Unfortunately, L. Suchman's (2019) suggestion to explore the mundane practices of the use of social robots, which enable us to ask the big questions, is very difficult to follow because social robots are still at the prototyping level and users have a very limited direct experience of them.

The debate on gender and HMC has received a great contribution from three sources of inspiration. The first is the Stanford website <http://genderedinnovations.stanford.edu/case-studies/genderingsocialrobots.html>, which addresses especially the theme of gender stereotypes encouraging users, through a number of strategies, to rethink gender norms and inviting designers to design robots that promote women's empowerment. The second source is the European-funded research project GEECCO on gender and feminist aspects

in Robotics. Pillinger (2019) offered an interesting analysis of the main feminist contributions to robotics, discussing many good points raised by feminist philosophers, theorists, sociologists, and so on. The third is the European-funded research project ETICA (Ethical Issues of Emerging Information and Communication Technologies) on gender issues in information and communication technologies (ICTs). Oleksy et al. (2012) analyzed more than 100 publications by focusing on the power mechanisms that characterize the production and use of ICTs, the forms of discrimination and exclusion of women from ICT business, and the representation of gender in ICT studies.

The literature developed on gender and HMC so far has focused not only on gender attitudes and behaviors toward robots, chatbots, and virtual assistants but also on the sex—or better, the gender—of machines to which we will dedicate the next section. Both of these approaches are interesting and deserve further development in order to understand their implications for increasing women's empowerment.

Gender of Machines

Robertson (2010) observed that generally robots are gendered in the absence of the visibility of physical genitals (which for humans often catalyze gender attribution processes). However, as Jung et al. (2016) documented, minimal visual gender cues on the robot's interface are sufficient for people to assign gender to robots. They also found that if a gender cue was not provided, there was a general tendency to perceive robots as male; if a cue is provided, the robot with a *male* cue is perceived as more masculine and the robot with a *female* cue is perceived as more feminine. Especially provocative among robots are those anthropomorphic models that pose the issue of their sexual identity, because the more humanlike a robot is, the more gendered it ends up becoming. Several scholars have addressed this point. For example, Bray (2012) and Søråa (2017) pointed out that attributing gender to a robot is in a certain sense inevitable: first, because one way for humans to express gender is through technology and second, because if people want to talk to robots, they need to refer to them by name (and usually a name raises expectations about robot's gender) and if they want to talk about robots, they need to use pronouns (and often these are gendered). Lie and Sørensen (1996) asked whether we are able to reshape our imagination to accommodate the changes happening in technology and/or in gender and Alesich and Rigby (2017) invited us to think about what the production of gendered robots might implicate for human gender. Crowell et al. (2009) reminded us that not only the anthropomorphization but also the embodiment of robots pose the problem of their sexual identity. Interestingly enough, they found that male-embodied robots and female-disembodied robots were perceived as more reliable than the opposite and that embodied robots, in general, were perceived as more friendly.

The real problem here is that robot sex is affected by the cultural order of gender, which is in force in most societies. As we said above, Alesich and Rigby (2017) have raised the question of the binary vision (male and female) that shapes many discussions in robotics, with, at maximum, the addition of genderless, which is the assumed category of machines. The range of sex and gender among humans is much more numerous and fluid than this, and the relation between sex and gender more complex and unsettled. Furthermore, there is the specialized production of sex robots to consider: this topic has been investigated by

some scientists (e.g., Dehnert, 2022; Masterson, in this volume), but it has also received many criticisms by feminists such as Richardson who, along with Brilling, launched the Campaign Against Sex Robots.

The research on sex differences in HRI has drawn from CASA (the Computers as Social Actors) paradigm (e.g., B. Reeves & Nass, 1996). Several scholars, such as Eyssel and Hegel (2012) extended this approach to robotics. In HRI, robots' appearance, voice, and demeanor provide the social cues that guide social perception (Powers & Kiesler, 2006) and the categorization processes. According to Nass et al.'s (1997) experiments, the voice was the main cue to trigger gender stereotyping of machines; other peripheral signs and symbols employed to gender robots were usually hair length or lip color (pink versus gray). Nass et al. (1997) documented that evaluations supplied by an acoustically male computer were taken more seriously than those provided by an acoustically female computer, as if the voice would represent the mirror of the power stratification at the social level. This result was later confirmed by Powers and Kiesler (2006). But because the gender (and identity) of women as a social class changes over time, these changes are also reflected in the voice chosen. Nass and Yen (2010) reported that BMW had to recall one of their cars because German men drivers did not want to take directions from an acoustically female voice because it "was a woman." But after a few years, in the European Union, the majority of the GPS navigators exhibited female voices.

The gendered voice and appearance of a robot are often matched with the stereotyped gender of its occupational role. Tay et al. (2014) found that the participants in their study expressed more positive responses when gender-occupational role stereotypes and personality-occupational role stereotypes matched, showing that people reacted to robots according to social models. However, they also found that stereotyped personality could be more prominent than stereotyped gender in interactions with social robots, insofar as the former reduced the impact of the latter on users' responses. Bryant et al. (2020) documented that "perceived occupational competency is a better predictor for human trust than robot gender or participant gender" (p. 13). The *matching* hypothesis suggests that when the robot's appearance matches stereotypical occupational roles this can affect users' willingness to comply with the robot (e.g., Carpenter et al., 2009; Goetz et al., 2003; Kuchenbrandt et al., 2014; Nass & Moon, 2000; Reich-Stiebert & Eyssel, 2017). This match however can nourish gender/occupation stereotypes and reinforce gender divides in human society. Powers et al. (2005) suggest that if we want to violate occupational stereotypes in the design of a robot (e.g., a female mechanic's helper robot), we probably have to expect that the process of communication would be more redundant in order to clarify their discourse. Another cluster of studies tried to challenge gender stereotypes (e.g., Eyssel & Hegel, 2012; Rea et al., 2015; Wang & Young, 2014). For example, Eyssel and Hegel (2012) proposed that designers, in order to change stereotypes and prejudices, should "develop gender-neutral or counter-stereotypical machines to counteract the stability of personal and cultural stereotypes" (p. 2224). In the same vein, Wang and Young argued that designers should pursue a gender-inclusive design. Another strategy proposed to deconstruct gender stereotypes in robot appearance is personalization, as discussed by Tam and Khosla (2016). Rea et al. (2015) found that gender stereotypes turned out to be less pronounced than expected and, thus, they hypothesized that gender stereotypes may not manifest strongly in human-robot interaction.

Less research has been done crossing humans' gender and robots' gender and findings are not consistent. Otterbacher and Talias (2017) demonstrated that the cross-gender effect is more salient for men participants than for women; in other words, men are more sensitive to the female-cue robot than women are to the male-cue robot. This result confirms previous research by Schermerhorn et al. (2008) who showed that men are more likely than women to treat a robot as a social agent rather than simply a machine. Eyssel et al. (2012), on the contrary, have found a preference for a same-gender robot, based on voice-gender cues. Carpenter et al. (2009) documented that gendered robots will be more effective in some circumstances and genderless robots in other circumstances may work better. Siegel et al. (2009), investigating robots' persuasiveness in the communication process based on the dimensions of trust, credibility, and engagement, found that participants rated the robot of the other sex as more credible, trustworthy, and engaging and that the effect regarding trust and engagement was much stronger between male subjects and the female robot. Schermerhorn et al. (2008) found that there are evident differences in how men and women conceptualize robots, react to, and coexist with them; men tend to think of the robot as more human-like, show some "social facilitation" in respect to an arithmetic task, and express more socially responding on a survey administered by a robot. Women, on the contrary, perceived the robot as more machine-like, produced less socially desirable responses to that survey, and did not feel facilitated by the robot in the arithmetic task. Kuchenbrandt et al. (2014) demonstrated that participants performing a typically female task with a robot made significantly more errors than in a typically male task. Moreover, participants interacting with a robot in the context of a typically female work domain were less prone to accept help from the robot compared to participants interacting with the robot involved in a typically male task. Another unexpected result was that, within the context of a stereotypically female task, the male and the female robots were perceived as equally competent, while within the context of a stereotypically male task, the female robot was perceived as less competent than the male robot. These results in part contradict previous findings that had documented that people prefer a proper match of gender robots and task features. Robertson (2010) argued that this corpus of research has neglected to take into account gender quality in itself.

In This Issue

From the review of the current studies on the gendering of HMC it is evident how we are still in the first phase of empirical exploration, inspired only in a limited sense by big questions. This special issue is not an exception; however, the collection of articles that are included here are all the—same interesting and stimulating. This special issue opens with the article "Gender Ambiguity in Voice-Based Assistants: Gender Perception and Influences of Context" by Sandra Mooshammer and Katrin Ertzrodt. A number of researchers and critics have suggested the development and use of ambiguous or androgynous voices as a potential means of combatting the sexist treatment of VBAs and avoiding the application of human gender stereotypes or even challenging them. However, there is scant empirical information about how people perceive and respond to voices that are acoustically neither male nor female. One obvious but important question is whether such voices are actually perceived by people as ambiguous or are nonetheless "heard" in light of the historic human gender binary of man or woman. Mooshammer and Ertzrodt address this significant gap

through an experiment examining how German-speaking participants ($n = 343$) perceived the genders of VBAs designed to sound male, female, or ambiguous. Although participants generally perceived the ambiguous voice as such, roughly four in five still assigned the voice a rating that was skewed somewhat male or female rather than truly neutral. A second important question in the debate about gender-neutral, ambiguous, or androgynous VBA voices is whether people actually form different stereotypes of them and react to them differently than acoustically male or female VBAs. On this second question, the ambiguous voice was situated between the male and female voices on perceived instrumentality (a masculine stereotype) and expressiveness (a feminine stereotype), which “strengthens previous reflections on the emergence of novel heuristics regarding artificial agents (e.g., Etzrodt & Engesser, 2021; Gambino et al., 2020; Guzman, 2020)” (p. 64). Continuing with a provocative and valuable interpretation of the finding that respondent gender was not influential to perceptions of VBA gender, Mooshammer and Etzrodt find additional support for the operation of a VBA-specific gender heuristic in

the lack of impact of the theoretically indicated over-exclusion of the ambiguous voice from the participants’ own gender. If the VBA was not perceived as a gendered person, but as a gendered ‘personified thing’ (Etzrodt & Engesser, 2021) or ‘social thing’ (Guzman, 2015), the VBA is already part of an outgroup, independent of its gender.” (p. 65).

The question of whether VBAs are gendered along human lines or are perceived in distinct, agent-specific ways is a theme that continues in the second article, “Do People Perceive Alexa as Gendered? A Cross-Cultural Study of People’s Perceptions, Expectations, and Desires of Alexa.” Along with our co-authors Chad Edwards, Anna Maria Manganeli, and Federico de Luca, we present the results of a cross-national online survey of US and Italian university students regarding their conceptualizations of the VBA Alexa. A good deal has been written about the default female gendering of many VBAs and we sought to investigate, from a novel angle, whether the gender of Alexa was a salient aspect of participants’ common associations, expectations, and desires concerning the virtual assistant. We analyzed free associations in the form of the first three words that came to respondents’ minds when thinking of Alexa. In these conceptualizations, explicit references to gender or embodiment were exceedingly rare. Instead, Alexa was associated with the distinct category of being that respondents often termed “virtual assistant” or “digital helper” and was connected with themes of technology innovation and positive qualities. Although there were some differences in respondents’ perceptions linked to their country or gender, the similarities across national samples were much more typical and striking. Holistically, the results support the idea that Alexa is understood as mainly belonging to the world of the digital, which overlaps only in part with the analog roles, functions, and ontological positions fulfilled by human beings (Fortunati et al., 2022). Thus, taken with the results of Mooshammer and Etzrodt’s experiment, we find additional evidence for the emergence of VBA-specific identities (Etzrodt & Engesser, 2021) or robot-specific identities that may be emerging as people become more familiar with machine communicators and build the cognitive and interpretive schemas to understand both their similarities and differences from humans and other social actors (Edwards, 2018).

The ambiguity and hybridity we are witnessing in people's perceptions and conceptualizations of VBAs are on full display at another level, the sociocultural, and with embodied robots in the third article in this special issue. In "Designing a Loving Robot: A Social Construction Analysis of a Sex Robot Creator's Vision," Annette Masterson offers a critical discourse analysis of the marketing and publicity of RealDoll's Harmony model. As Dehnert (2022) in Volume 4 of this journal argued, sex robots present rich terrain for HMC researchers to explore issues of intimacy, love, desire, and sexuality among humans and machines (p. 131). To demonstrate how mediated discourse on sex robots contributes to the mutual shaping of their meaning at the sociocultural and political levels of Social Construction of Technology Theory (SCOT), Masterson considers how RealDoll visionary and creator, CEO Matt McMullen, constructs his view of the product and explains its purpose for existence to publics and media audiences. Masterson contends that McMullen's discourse is used deliberately to destigmatize relationships with sex robots and promote his company as a force benefitting all social groups. Specifically, Masterson demonstrates across 38 publicity interviews "a tendency to emphasize the companionship of sex robots while envisioning a future where integration is normalized, and a sentient robot is possible" (p. 99). A significant finding is how McMullen's discourse fluctuates between identifying Harmony as a mechanical tool versus a being or companion that replaces or approaches humanness. The shifting ontological solidarities and identifications promoted by McMullen are highly strategic. For questions concerning dehumanization effects or deteriorating relations among other humans, Harmony is positioned as a *mere machine* or compared to earlier technologies like the mobile phone. For questions concerning the future or limits of companionship, Harmony is situated as traveling a path toward potential rights, independence, and sentience. In other words, while technologies remain in the stage of interpretive flexibility, creators and marketers may use ambiguity strategically to suit the interests of developers and financial stakeholders to the detriment of the integrity of the larger discourses on the meaning of these technologies in sociocultural and political terms.

Whereas the first two articles in this special issue on Gender and HMC show at the micro level how individuals or users perceive machine communicators as a hybrid with or distinct from human social roles, Masterson offers the great contribution of articulating a role of ambiguity at the macro level in the social construction of these technologies.

From the beginning of the development of *intelligent* and *social* software and machines, there has been ambiguity, uncertainty, and conflict about whether and how to gender them. In the fourth article, Victoria Kratel poses the question "boy or girl?" to organize a fascinating and necessary historical account of "The evolution of gendered software: Products, scientific reasoning, criticism, and tools." Kratel details significant developments in the 70-year saga of gendering software which begins with Alan Turing's famous imitation test (a lesser-known version of which entailed the challenge of determining whether one's interlocution partner was a computer or woman), and traces through Weizenbaum's ELIZA, to the more recent theoretical developments of CASA and the Media Equation (Reeves & Nass, 1996). As Kratel explains, a complicating factor regarding the gendering of software (including the VBAs which are the focus of the first two articles), is that they are not biological systems that allow the assignment of gender in a manner linked with the physical qualities of human or animal bodies, but are gendered through the use of sociocultural features. Particularly, Kratel calls attention to three decisive features in the process of

gendering software: (1) product name, (2) voice (like the acoustical register investigated by Mooshammer and Etzrodt, this volume), and (3) personality traits. Each of these aspects of software design does gender by, on the one hand, invoking the cultural meanings of gender in ways that shape people's interpretations and reactions toward the software and, on the other hand, reflecting and reinforcing historical gender stereotypes as well as the gender prejudices of historically male software designers. The process of gendering software is a crucial consideration, according to Kratel, because of the status inequalities that persist between genders; in other words, "making use of socially shaped comprehensions of what being female or male means in a world which is still permeated with gender inequalities cannot be understood to be without consequence" (p. 116).

Indeed, the social shaping of what it means to hold or represent certain identities is central to the contribution made by Caitlyn Jarvis and Margaret Quinlin in the final article of this special issue: "IVF So White, So Medical: Digital Normativity and Algorithm Bias in Infertility on Instagram." Among other insights, the context in which Jarvis and Quinlin situate their research (machine- or algorithmically-identified and promoted "daily top 9" Instagram posts on infertility hashtags) and the approach they take (inductive analysis of the social construction of normative experience) serves as an important reminder that gender is always intersectional with other social identities and is inextricably entangled with other large discourses of power, control, and privilege. In the case of IVF narratives, Jarvis and Quinlin demonstrate that Instagram's algorithmic practices may contribute to constructing a portrait of the idealized IVF experience as primarily a medicalized journey of cis-White women with wealth. The communicative importance of machines extends beyond meaning-making (Guzman & Lewis, 2020), according to the authors, because:

machines emerge as a locus of rhetorical practice as they manifest 'visceral responses entangled with material culture to enliven discourse' (p. 14). While technology does not hold feelings or beliefs, it can still manifest 'rhetorical energies' that shape the dissemination of health information and medicinal communication. (p. 136)

Discussion and Conclusive Remarks

We hope that the long journey we have undertaken from in-person to machine-mediated human communication trying to express a feminist point of view has allowed us to lay the foundations for addressing the gender issue in HMC with the necessary depth. Exploring gender means asking a big question that requires, rather than a big answer, keeping analyses significantly at the theoretical level. With gender, we are in the heart of women's core political analysis, and investigating gender in HMC we are in the innovative core of women's political analysis. Drawing from this, we believe that it is time to set a research agenda of the study of gender and HMC that is more founded on a theoretical analysis of the current condition of women and that is more equipped to address the big questions that remain yet open.

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References

- Alcoff, L. (2006). *Visible identities*. Oxford UP.
- Alesich, S., & Rigby, M. (2017, June 7). Gendered robots. Implications for our humanoid future. *IEEE Technology and Society Magazine*, 50–59. <https://doi.org/10.1109/MTS.2017.2696598>
- Allen, B. J. (1995). Gender and computer-mediated communication. *Sex Roles*, 32(7/8), 557–563. <https://doi.org/10.1007/BF01544189>
- Andrejevic, M. (2007). Surveillance in the digital enclosure. *The Communication Review*, 10(4), 295–317. <https://doi.org/10.1080/10714420701715365>
- Argamon, S., Koppel, M., Pennebaker, J. W., & Schler, J. (2007). Mining the blogosphere: Age, gender and the varieties of self-expression. *First Monday*. <https://firstmonday.org/ojs/index.php/fm/article/view/2003/1878> <https://doi.org/10.5210/fm.v12i9.2003>
- Atanasoski, N., & Vora, K. (2020). Why the sex robot becomes the killer robot—Reproduction, care, and the limits of Refusal. *Spheres. Journal of Political Culture*. #6 Politics of Reproduction, 1–20.
- Beckwith, L., & Burnett, M. (2004). “Gender: An important factor in end-user programming environments?” Proceedings of IEEE Symposium on Visual Languages and Human-Centric Computing Languages and Environments, 107–114. <https://doi.org/10.1109/VLHCC.2004.28>
- Berger, C., & Calabrese, R. (1975). Some explorations in initial interaction and beyond: Toward a developmental theory of interpersonal communication. *Human Communication Research*, 1, 99–112. <https://doi.org/10.1111/j.1468-2958.1975.tb00258.x>
- Biocca F., Harms, C., & Burgoon, J. K. (2003). Toward a more robust theory and measure of social presence: Review and suggested criteria. *Presence: Teleoperators & Virtual Environments* 12(5), 456–480. <https://doi.org/10.1162/105474603322761270>
- Birdwhistell, R.-L. (1970). *Kinesics and context: Essays on body motion and communication*. University of Pennsylvania Press. <https://doi.org/10.9783/9780812201284>
- Bode, L. (2017). Closing the gap: Gender parity in political engagement on social media. *Information, Communication & Society* 20(4), 587–603. <https://doi.org/10.1080/1369118X.2016.1202302>
- Boneva, B., Frolich, D., & Kraut, R. (2001). Using e-mail for personal relationships: The difference gender makes. *American Behavioral Scientist* 45(3), 530–549. <https://doi.org/10.1177/00027640121957204>
- Bray, F. (2012). Gender and technology. In *Women, science, and technology: A reader in feminist science studies* (pp. 370–381). Routledge.

- Bruns, A. (2007). Produsage: Towards a broader framework for user-led content creation. *Creativity and Cognition*. In *Proceedings of the 6th ACM SIGCHI conference on Creativity & cognition*, Washington DC: ACM.
- Bryant, D. A., Borenstein, J., & Howard, A. (2020, March). Why should we gender? The effect of robot gendering and occupational stereotypes on human trust and perceived competency. In *Proceedings of the 2020 ACM/IEEE international conference on human-robot interaction* (pp. 13–21). <https://doi.org/10.1145/3319502.3374778>
- Butler, J. (1990). *Gender trouble: Feminism and the subversion of identity*. Routledge.
- Canary, D. J., & Hause K. S. (1993). Is there any reason to research sex differences in communication? *Communication Quarterly* 41(2), 129–144. <https://doi.org/10.1080/01463379309369874>
- Carey, J. W. (2005). Historical pragmatism and the internet. *New Media & Society*, 7(4), 443–455. <https://doi.org/10.1177/14614448050541>
- Carpenter, J., Davis, J. M., Erwin-Stewart, N., Lee, T. R., & Bransford, J. D. (2009). Gender representation and humanoid robots designed for domestic use. *International Journal of Social Robotics* 1, 261–265. <https://doi.org/10.1007/s12369-009-0016-4>
- Chan, R. Y.-Y., Huang, J., Hui, D., Li, S., & Yu, P. (2013). Gender differences in collaborative learning over online social networks: Epistemological beliefs and behaviors. *Knowledge Management & E-Learning* 5(3), 234–250. <https://doi.org/10.34105/j.kmel.2013.05.017>
- Chodorow, N. (1978). *Reproducing mothering*. University of California Press.
- Chodorow, N. (1995). Family structure and feminine personality. In N. Tuana and R. Tong (Eds.), *Feminism and philosophy* (pp. 43–66). Westview Press.
- Claisse, G., & Rowe, F. (1993). Domestic telephone habits and daily mobility. *Transportation Research Part A: Policy and Practice*, 27(4), 277–290. [https://doi.org/10.1016/0965-8564\(93\)90001-2](https://doi.org/10.1016/0965-8564(93)90001-2)
- Colley, A., Todd, Z., Bland, M., Holmes, M., Khanom, N., & Pike, H. (2004). Style and content in e-mails and letters to male and female friends. *Journal of Language and Social Psychology* 23(3), 369–378. <https://doi.org/10.1177/0261927X042668>
- Cox, N., & Federici, S. (1975). *Counter-planning from the kitchen*. The Falling Wall Press.
- Cranny-Francis, A. (2016). Is data a toaster? Gender, sex, sexuality and robots. *Palgrave Communications*, 2(1), 16072. <https://doi.org/10.1057/palcomms.2016.72>
- Crowelly, C. R., Villanoy, M., Scheutzz, M., & Schermerhornz, P. (2009, October). Gendered voice and robot entities: Perceptions and reactions of male and female subjects. In *2009 IEEE/RSJ International Conference on Intelligent Robots and Systems* (pp. 3735–3741). IEEE. <https://doi.org/10.1109/IROS.2009.5354204>
- Cryan, J., Tang, S., Zhang, X., Metzger, M., Zheng, H., & Zhao, B. Y. (2020, April). Detecting gender stereotypes: Lexicon vs. supervised learning methods. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems* (pp. 1–11). <https://doi.org/10.1145/3313831.3376488>
- Cummings, J. J., Tsay-Vogel, M., Cahill, T. J., & Zhang, L. (2021). Effects of immersive storytelling on affective, cognitive, and associative empathy: The mediating role of presence. *New Media & Society*, 24(9), 2003–2026. <https://doi.org/10.1177/1461444820986>
- Dalla Costa, M. R., & James, S. (1972). *The power of women and the subversion of the community: Women and the subversion of the community*. The Falling Wall Press.
- de Beauvoir, S. (1973). *The second sex*. Vintage Books.

- Dehnert, M. (2022). Sex with robots and human-machine sexualities: Encounters between human-machine communication and sexuality studies. *Human-Machine Communication*, 4, 131–150. <https://doi.org/10.30658/hmc.4.7>
- Dimmick, J. W., Sikand, J., & Patterson, S. J. (1994). The gratifications of the household telephone: Sociability, instrumentality, and reassurance. *Communication Research*, 21(5), 643–663. <https://doi.org/10.1177/009365094021005005>
- Dindia, K., & Allen, M. (1992). Sex differences in self-disclosure: A meta-analysis. *Psychological Bulletin*, 112(1), 106–124. <https://doi.org/10.1037/0033-2909.112.1.106>
- Dunne, B. J. (1998). Gender differences in human/machine anomalies. *Journal of Scientific Exploration*, 12(1).
- Eckert, P., & Wenger, E. (2005). What is the role of power in sociolinguistic variation? *Journal of Sociolinguistics* 9(4), 582–589.
- Edwards A (2018) Animals, humans, and machines: interactive implications of ontological classification. In: Guzman AL (ed.) *Human-Machine Communication: Rethinking Communication, Technology, and Ourselves*. New York: Peter Lang, pp. 29–50.
- Etzrodt, K., & Engesser, S. (2021). Voice-based agents as personified things: Assimilation and accommodation as equilibration of doubt. *Human-Machine Communication*, 2, 57–79. <https://doi.org/10.30658/hmc.2.3>
- Eyssel, F., & Hegel, F. (2012). (S)he's got the look: Gender stereotyping of robots. *Journal of Applied Social Psychology* 42(9), 2213–2230. <https://doi.org/10.1111/j.1559-1816.2012.00937.x>
- Eyssel, F., Kuchenbrandt, D., Bobinger, S., De Ruiter, L., & Hegel, F. (2012, March). 'If you sound like me, you must be more human' on the interplay of robot and user features on human-robot acceptance and anthropomorphism. In *Proceedings of the seventh annual ACM/IEEE international conference on Human-Robot Interaction* (pp. 125–126). <https://doi.org/10.1145/2157689.2157717>
- Fausto-Sterling, A. (1993). *Myths of gender: Biological theories about women and men* (2nd ed.). Basic Books.
- Fausto-Sterling, A. (2005). The bare bones of sex: Part 1—Sex and gender. *Signs* (30), 1491–1527. <https://doi.org/10.1086/424932>
- Fischer, C. S. (1988). Gender and the residential telephone, 1890–1940: Technologies of sociability. *Sociological Forum* 3(2): 211–233. <https://doi.org/10.1007/BF01115291>
- Fortunati, L. (1981). *L'arcano della riproduzione*. Casalinghe, prostitute, operai e capitale. Venezia: Marsilio (English Transl. *The Arcane of Reproduction*. Housework, Prostitution, Labor and Capital. New York: Autonomedia, 1995).
- Fortunati, L. (Ed.). (1995). *Gli italiani al telefono*. Angeli.
- Fortunati, L. (Ed.). (1998). *Telecomunicando in Europa*. Angeli.
- Fortunati, L. (2005). The mobile phone as a technological artefact. In P. Glotz, S. Berschi, & C. Locke (Eds.), *Thumb culture. The meaning of mobile phones for society*. Transcript Verlag: Bielefeld (pp. 149–160).
- Fortunati, L. (2013). The mobile phone between fashion and design. *Mobile Media and Communication*, 1(1), 102–109. <https://doi.org/10.1177/2050157912459497>
- Fortunati L. (2014). Media between power and empowerment: Can we resolve this dilemma? *The Information Society*, 30(3), 169–183. <https://doi.org/10.1080/01972243.2014.896676>
- Fortunati, L. (2018). Gender and feminism. In J. Diamanti, A. Pendakis, & I. Szeman (Eds.), *The Bloomsbury Companion to Marx* (pp. 549–555). Bloomsbury Academic.

- Fortunati, L., Edwards, A., Edwards, C., Manganelli, A. M., & de Luca, F. (2022). Is Alexa female, male, or neutral? A cross-national and cross-gender comparison of perceptions of Alexa's gender and status as a communicator. *Computers in Human Behavior*, 137, 107426. <https://doi.org/10.1016/j.chb.2022.107426>
- Fortunati, L., & Taipale S. (2012). Women's emotions toward the mobile phone. *Feminist Media Studies*, 12(4), 538–549. <https://doi.org/10.1080/14680777.2012.741870>
- Fortunati, L., Taipale, S., & de Luca, F. (2013). What happened to body-to-body sociability? *Social Science Research* 42(3), 893–905. <https://doi.org/10.1016/j.ssresearch.2012.12.006>
- Foucault, M. (1979). *The history of sexuality*. Allen Lane.
- Fox, A. B., Bukatko, D., Hallahan, M., & Crawford, M. (2007). The medium makes a difference: Gender similarities and differences in instant messaging. *Journal of Language and Social Psychology* 26(4), 389–397. <https://doi.org/10.1177/0261927X07306982>
- Friebel, G., & Seabright, P. (2011). Do women have longer conversations? Telephone evidence of gendered communication strategies. *Journal of Economic Psychology*, 32(3), 348–356. <https://doi.org/10.1016/j.joep.2010.12.008>
- Frizzo-Barker, J., & Chow-White, P. A. (2012). “There's an app for that”—Mediating mobile moms and connected careerists through smartphones and networked individualism. *Feminist Media Studies*, 12(4), 580–589. <https://doi.org/10.1080/14680777.2012.741876>
- Fuchs, C. (2017). *Social media: A critical introduction*. SAGE.
- Gambino, A., Fox, J., & Ratan, R. A. (2020). Building a stronger CASA: Extending the computers Are social actors paradigm. *Human-Machine Communication*, 1, 71–86. <https://doi.org/10.30658/hmc.1.5>
- Gehl, R. W., & Bakardjieva, M. (Eds.). (2017). *Socialbots and their friends: Digital media and the automation of sociality*. Routledge.
- Gergen, K. J. (2002). The challenge of absent presence. In J. E. Katz & M. Akhus (Eds.), *Perpetual contact: Mobile communication, private talk, public performance* (pp. 227–241). Cambridge University Press.
- Gershon, I. (2008). Email my heart: Remediation and romantic break-ups. *Anthropology Today*, 24, 13–15. <https://doi.org/10.1111/j.1467-8322.2008.00627.x>
- Gleason, J. B., & Ely, R. (2002). Gender differences in language development. In A. A. DeLisi & R. DeLisi (Eds.), *Biology, society, and behavior: The development of sex differences in cognition* (pp. 127–154). Ablex.
- Goetz, J., Kiesler, S., & Powers, A. (2003, November). Matching robot appearance and behavior to tasks to improve human-robot cooperation. In *The 12th IEEE International Workshop on Robot and Human Interactive Communication*, 2003. Proceedings. ROMAN 2003 (pp. 55–60). IEEE. <https://doi.org/10.1109/ROMAN.2003.1251796>
- Goffman, E. (1959). *The presentation of self in everyday life*. Anchor Books.
- Goldsmith, D. J., & Fulfs, P. A. (1999). “You just don't have the evidence.” An Analysis of Claims and Evidence in Deborah Tannen's, *You just don't understand*. *Annals of the International Communication Association* 22(1), 1–49. <https://doi.org/10.1080/23808985.1999.11678958>
- Gray, A. (1992). *Video playtime: The gendering of a leisure technology*. Routledge.
- Guzman, A., & Lewis, S. C. (2020). Artificial intelligence and communication: A human-machine communication research agenda. *New Media & Society* 22(1): 70–86. <https://doi.org/10.1177/1461444819858691>

- Heeter, C. (1992). Being there: The subjective experience of presence. *Presence: Teleoperators and Virtual Environments*, 1, 262–271.
- Henley, N. M. (1973–1974). Power, sex, and nonverbal communication. *Journal of Sociology* 18, 1–26. <https://www.jstor.org/stable/41035237>
- Herring, S. C. (2003). Gender and power in online communication. In J. Holmes & M. Meyerhoff (Eds.), *The handbook of language and gender* (pp. 202–228). Blackwell Publishers.
- Herring, S. C., & Demarest, B. (2017). “I’m the first video Voicethread—It’s pretty sweet, I’m pumped”: Gender and self-expression on an interactive multimodal platform. *Identity Construction in Social Media* 20(1). <https://doi.org/10.4000/alsic.3007>
- Herring, S. C., & Martinson, A. (2004). Assessing gender authenticity in computer-mediated language use: Evidence from an identity game. *Journal of Language and Social Psychology*, 24, 424–446. <https://doi.org/10.1177/0261927X04269>
- Hjorth, L., & Lim, S. S. (2012). Mobile intimacy in an age of affective mobile media. *Feminist Media Studies*, 12(4), 477–484. <https://doi.org/10.1080/14680777.2012.741860>
- Hochschild, A. (1983). *The managed heart. Jobs requiring emotional labor*. University of California Press.
- Huff, C. (2002). “Gender, software design, and occupational equity.” *The ACM Special Interest Group on Computer Science Education Bulletin*, 34, 112–115. <https://doi.org/10.1145/543812.543842>
- Hyde, J., & Linn, M. C. (1988). Gender differences in verbal ability: A meta-analysis. *Psychological Bulletin*, 104(1), 53–69. <https://doi.org/10.1037/0033-2909.104.1.53>
- Illuz, E. (2007). *Cold intimacies*. Polity Press.
- Infante, D., Rancer, A., & Womack, D. (1997). *Building communication theory* (3rd ed.). Waveland Press, Inc.
- Irigaray, L. (1984). *Ethique de la difference sexuelle*. Les Editions de Minuit.
- ITU. (2017). *ICT. Facts and figures 2017*. International Telecommunications Union. <https://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2017.pdf>
- Jacobson, D. (1999). Impression formation in cyberspace: Online expectations and offline experiences in text-based virtual communities. *Journal of Computer-Mediated Communication*, 5. <https://doi.org/10.1111/j.1083-6101.1999.tb00333.x>
- James, D., & Drakich, J. (1993). Understanding gender differences in amount of talk: A critical review of research. In D. Tannen (Ed.), *Oxford studies in sociolinguistics. Gender and conversational interaction* (pp. 281–312). Oxford University Press.
- James, S. (1953). A woman’s place. In M. Dalla Costa & S. James (1972), *The power of women & the subversion of the community*. Falling Wall Press.
- Jarrett, K. (2015). *Feminism, labour and digital media: The digital housewife*. Routledge.
- Johnson, A. J., Haigh, M. M., Becker, J. A. H., Craig, E. A., & Wigley, S. (2008). College students’ use of relational management strategies in email in long-distance and geographically close relationships. *Journal of Computer-Mediated Communication*, 13, 381–404. <https://doi.org/10.1111/j.1083-6101.2008.00401.x>
- Jones, S. (2014). People, things, memory and human-machine communication. *International Journal of Media & Cultural Politics* 10(3), 245–258. https://doi.org/10.1386/macp.10.3.245_1

- Jung, E. H., Waddell, T. F., & Sundar, S. S. (2016). Feminizing robots: User responses to gender cues on robot body and screen. In *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems* (pp. 3107–3113). San Jose, CA. <https://doi.org/10.1145/2851581.2892428>
- Kessler, S. J., & McKenna, W. (1978). *Gender. An ethnomethodological approach*. John Wiley.
- Kiesler, S., Siegel, J., & McGuire, T. W. (1984). Social psychological aspects of computer-mediated communication. *American Psychologist*, 39, 1123–1134. <https://doi.org/10.1037/0003-066X.39.10.1123>
- Kimbrough, A. M., Guadagno, R. E., Muscanell, N. L., & Dill, J. (2013). Gender differences in mediated communication: Women connect more than do men. *Computers in Human Behavior*, 29, 896–890. <https://doi.org/10.1016/j.chb.2012.12.005>
- Kimmel, M. (2000). *The gendered society*. OUP.
- Koch, S. C., Müller, S. M., & Sieverding, M. (2008). Women and computers. Effects of stereotypes threat on attribution of failure. *Computers & Education*, 51(4), 1795–1803. <https://doi.org/10.1016/j.compedu.2008.05.007>
- Kristeva, J. (1984). *Revolution in poetic language*. Columbia University Press.
- Kuchenbrandt, D., Häring, M., Eichberg, J., Eyssel, F., & André, E. (2014). Keep an eye on the task! How gender typicality of tasks influence human-robot interactions. *International Journal of Social Robotics* 6(3), 417–427. <https://doi.org/10.1007/s12369-014-0244-0>
- Leaper, C., & Ayres, M. M. (2007). A meta-analytic review of gender variations in adults' language use: Talkativeness, affiliative speech, and assertive speech. *Personality and Social Psychology Review*, 11(4), 328–363. <https://doi.org/10.1177/1088868307302221>
- Lee, C. (2003). How does instant messaging affect interaction between the genders? The Mercury Project of Instant Messaging Studies, Stanford University. <https://nl.ijis.si/janes/wp-content/uploads/2014/09/lee03.pdf>
- Lee, K. M. (2004). Presence, explicated. *Communication Theory*, 14, 27–50. <https://doi.org/10.1111/j.1468-2885.2004.tb00302.x>
- Lees, S. (1993). *Sugar and spice. Sexuality and adolescent girls*. Penguin.
- Lie, M., & Sørensen, K. H. (1996). *Making technology our own? Domesticating technology into everyday life*. Scandinavian University Press.
- Light, J. S. (1999). When computers were women. *Technology and Culture* 40(3), 455–483. <https://www.jstor.org/stable/25147356>
- Ling, R. (2004). *The mobile connection. The cell phone's impact on society*. Morgan Kaufmann.
- Lingel, J., & Crawford, K. (2020). “Alexa, tell me about your mother”: The history of the secretary and the end of secrecy. *Catalist: Feminism, Theory, Technoscience*, 6(1): 2380–3312. <https://doi.org/10.28968/cftt.v6i1.29949>
- Livholts, M., & Bryant, L. (2013). Gender and the telephone: Voice and emotions shaping and gendering space. *Human Technology*, 9(2), 157–170. <https://doi.org/10.17011/ht/urn.201312042738>
- Lombard, M., & Ditton, T. (1997). At the heart of it all: The concept of presence. *Journal of computer-mediated communication*, 3(2), JCMC321. <https://doi.org/10.1111/j.1083-6101.1997.tb00072.x>
- MacKinnon, C. (1989). *Toward a feminist theory of state*. Harvard University Press.

- Maddon, M., & Lenhart, A. (2006). Online dating. Pew Internet & American Life Project. Retrieved February 20, 2016, <https://www.pewresearch.org/internet/2006/03/05/part-3-who-is-dating-online/>
- Mäkinen, K. (2020). Resilience and vulnerability: Emotional and affective labour in mom blogging. *New Media & Society*, 1–15. <https://doi.org/10.1177/1461444820941196>
- Manovich, L. (2001). *The language of new media*. The MIT Press.
- Marx, D. M., & Roman, J. S. (2002). Female role models: Protecting women's math test performance. *Personality and Social Psychology Bulletin*, 28(9), 1183–1193. <https://doi.org/10.1177/01461672022812004>
- Marx, K. (1964). *Il Capitale*, Roma: Editori Riuniti.
- Mead, G. H. (1967). *Mind, self, & society: From the standpoint of a social behaviorist* (vol. 1). University of Chicago Press.
- Mehrabian, A. (1981). *Silent messages: Implicit communication of emotions and attitudes* (2nd ed.). Wadsworth.
- Mikkola, M. (2022). Feminist perspectives on sex and gender. In E. N. Zalta & U. Nodelman (Eds.), *The Stanford Encyclopedia of Philosophy*.
- Miller, J., & Durnell, A. (2004). Gender, language and computer-mediated communication. In K. Morgan, J. Sanchez, C. A. Brebbia, & A. Voiskounsky (Eds.), *Human perspectives in the internet society, culture, psychology and gender* (pp. 235–244). WIT Press.
- Millett, K. (1971). *Sexual politics*. Granada Publishing Ltd.
- Mo, P. K. H., Malik, S. H., & Coulson, N. S. (2009). Gender differences in computer-mediated communication: A systematic literature review of online health-related support groups. *Patient Education and Counseling*, 75, 15–24. <https://doi.org/10.1016/j.pec.2008.08.029>
- Mou, Y., & Xu, K. (2017). The media inequality: Comparing the initial human-human and human-AI social interactions. *Computers in Human Behavior*, 72, 432–440. <https://doi.org/10.1016/j.chb.2017.02.067>
- Moyal, A. (1992). The gendered use of the telephone: An Australian case study. *Media, Culture and Society*, 14(1), 51–72.
- Mulac, A., Bradac, J. J., & Gibbons, P. (2001). Empirical support for the gender-as-culture hypothesis. *Human Communication Research*, 27(1), 121–152. <https://doi.org/10.1111/j.1468-2958.2001.tb00778.x>
- Nass, C., & Moon, Y. (2000). Machines and mindlessness: Social responses to computers. *Journal of Social Issues*, 56, 81–103. <https://doi.org/10.1111/0022-4537.00153>
- Nass, C., Moon, Y., & Green, N. (1997). Are machines gender neutral? Gender-stereotypic responses to computers with voices. *Journal of Applied Social Psychology*, 27, 864–876. <https://doi.org/10.1111/j.1559-1816.1997.tb00275.x>
- Nass, C., & Yen, C. (2010). *The man who lied to his laptop: What we can learn about ourselves from our machines*. Penguin.
- Newman, M. L., Groom, C. J., Handelman, L. D., & Pennebaker, J. W. (2008). Gender differences in language use: An analysis of 14,000 text samples. *Discourse Processes*, 45(3), 211–236. <https://doi.org/10.1080/01638530802073712>
- Nicholson, L. (1994). Interpreting Gender. *Signs* (20), 79–105. <https://doi.org/10.1086/494955>
- Nomura, T. (2017). Robots and gender. *Gender and the Genome* 1(1), 18–25.

- Nowak, K. (2001, May). Defining and differentiating copresence, social presence and presence as transportation. In *Presence 2001 conference*, Philadelphia, PA (Vol. 2, pp. 686–710). <http://matthewlombard.com/ISPR/Proceedings/2001/Nowak1.pdf>
- Oakley, A. (1972). *Sex, gender and society*. Temple Smith.
- Oakley, A. (1996). Sexuality. In S. Jackson & S. Scott Stevi (Eds.), *Feminism and sexuality: A reader* (pp. 35–39). Columbia University Press.
- Obaid, M., Sandoval, E. B., Złotowski, J., Moltchanova, E., Basedow, C. A., & Bartneck, C. (2016, August). Stop! That is close enough. How body postures influence human-robot proximity. In *2016 25th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)* (pp. 354–361). IEEE. <http://doi.org/10.1109/ROMAN.2016.7745155>
- Ochnik, D., & Dembińska, A. (2018). Gender differences and areas of internet behavior in seven years' perspective. *Polish Psychological Bulletin* 49(3), 383–390. <http://doi.org/10.24425/119506>
- Oh, C. S., Bailenson, J. N., & Welch, G. F. (2018). A systematic review of social presence: Definition, antecedents, and implications. *Frontiers in Robotics and AI*, 5, 114. <https://doi.org/10.3389/frobt.2018.00114>
- Oleksy, W., Just, E., & Zapędowska-Kling, K. (2012). Gender issues in information and communication technologies (ICTs). *Journal of Information Communication and Ethics in Society*, 10(2), 107–120. <https://doi.org/10.1108/14779961211227010>
- Ono, H., & Zavodny, M. (2005). Gender differences in information technology usage: A US–Japan comparison. *Sociological Perspectives*, 48(1), 105–133. <https://doi.org/10.1525/sop.2005.48.1.105>
- Otterbacher, J., & Talias, M. (2017, March). S/he's too warm/agentive! The influence of gender on uncanny reactions to robots. In *2017 12th ACM/IEEE International Conference on Human-Robot Interaction (HRI)* (pp. 214–223). IEEE. <https://ieeexplore.ieee.org/abstract/document/8534886>
- Oudshoorn, N., Rommes, E., & Stienstra, M. (2004). Configuring the user as everybody: Gender and design cultures in information and communication technologies. *Science, Technology & Human Values*, 29(1) 30–63. <https://doi.org/10.1177/0162243903259190>
- Pei, X., & Chib, A. (2020). Defining gender. The role of the mobile phone use in gender construction processes. In R. Ling, L. Fortunati, G. Goggin, Lim Sun Sun, & Li Yuling (Eds.), *The Oxford Handbook of Mobile Communication, Culture, and Information* (pp. 517–528). Oxford University Press.
- Pillinger, A. (2019). Gender and feminist aspects in robotics. https://web.archive.org/web/20220204000117/http://www.geecco-project.eu/fileadmin/t/geecco/FemRob_Final_plus_Deckblatt.pdf
- Powers, A., & Kiesler, S. (2006, March). The advisor robot: Tracing people's mental model from a robot's physical attributes. In *Proceedings of the 1st ACM SIGCHI/SIGART conference on Human-robot interaction* (pp. 218–225). <https://doi.org/10.1145/1121241.1121280>
- Powers, A., Kramer, A. D., Lim, S., Kuo, J., Lee, S. L., & Kiesler, S. (2005, August). Eliciting information from people with a gendered humanoid robot. In *ROMAN 2005. IEEE International Workshop on Robot and Human Interactive Communication*, 2005 (pp. 158–163). IEEE. <https://doi.org/10.1109/ROMAN.2005.1513773>

- Prinsen, F. R., Volman, M. L. L., & Terwel, J. (2007). Gender-related differences in computer-mediated communication and computer-supported collaborative learning. *Journal of Computer Assisted Learning*, 23(5), 393–409. <https://doi.org/10.1111/j.1365-2729.2007.00224.x>
- Putnam, L. (1982). In search of gender: A critique of communication and sex-roles research. *Women's Studies in Communication*, 5(1), 1–9. <https://doi.org/10.1080/07491409.1982.1089636>
- Rainie, L., Lenhart, A., Fox, S., Spooner, T., & Horrigan, J. (2000, May 10). Tracking Online Life. Pew Internet & American Life Project. <https://www.pewresearch.org/internet/2000/05/10/tracking-online-life/>
- Rakow, L. (1986). Rethinking gender research in communication. *Journal of Communication*, 36(4), 11–26. <https://doi.org/10.1111/j.1460-2466.1986.tb01447.x>
- Rakow, L. (1992). *Gender on the line: Women, the telephone, and community life*. University of Illinois Press.
- Rakow, L. (2004). Women and the telephone. The gendering of a communications technology. In C. Kramarae (Ed.), *Technology and women's voices: Keeping in touch* (pp. 187–206). Routledge.
- Rakow, L. F., & Navarro, V. (1993). Remote mothering and the parallel shift: Women meet the cellular telephone. *Critical Studies in Media Communication*, 10(2), 144–157. <https://doi.org/10.1080/15295039309366856>
- Rea, D. J., Wang, Y., Young, J. E. (2015). Check your stereotypes at the door: An analysis of gender typecasts in social human-robot interaction. In: Tapus, A., André, E., Martin, J.C., Ferland, F., & Ammi, M. (Eds.), *Social Robotics. ICSR 2015. Lecture Notes in Computer Scienc*, V. 9388. Springer, Cham. https://doi.org/10.1007/978-3-319-25554-5_55
- Reeves, B., & Nass, C. (1996). *The media equation: How people treat computers, television, and new media like real people and places*. Cambridge University Press.
- Reeves, J. (2016). Automatic for the people: The automation of communicative labor. *Communication and Critical/Cultural Studies* 13(2), 150–165. <https://doi.org/10.1080/14791420.2015.1108450>
- Reich-Stiebert, N., & Eyssel, F. (2017, March). (Ir) relevance of gender? On the influence of gender stereotypes on learning with a robot. In *2017 12th ACM/IEEE International Conference on Human-Robot Interaction (HRI)* (pp. 166–176). IEEE. <https://ieeexplore.ieee.org/abstract/document/8534896>
- Renzetti, C., & Curran, D. (1992). Sex-role socialization. In J. Kourany, J. Sterba, and R. Tong (Eds.), *Feminist philosophies*. Prentice Hall.
- Ricci Bitti, P. (Ed.). (1987). *Comunicazione e gestualità*. Angeli.
- Richardson, K. (2015). The asymmetrical ‘relationship’: Parallels between prostitution and the development of sex robots. *ACM SIGCAS Computer & Society*, 45(3), 290–293. <https://doi.org/10.1145/2874239.2874281>
- Robertson J. (2010). Gendering humanoid robots: Robo-sexism in Japan. *Body and Society* 16(2), 1–36. <https://doi.org/10.1177/1357034X10364767>
- Rubin, G. (1975). The traffic in women: Notes on the “Political economy” of sex. In R. Reiter (Ed.), *Toward an anthropology of women* (pp. 157–210). Monthly Review Press. <https://philarchive.org/rec/rubtti>

- Savicki, V., & Kelley, M. (2000). Computer mediated communication: Gender and group composition. *CyberPsychology & Behavior* 3(5), 817–826. <https://doi.org/10.1089/10949310050191791>
- Savicki, V., Kelley, M., & Oesterreich, E. (1999). Judgments of gender in computer-mediated communication. *Computers in Human Behavior*, 15, 185–194. [https://doi.org/10.1016/S0747-5632\(99\)00017-5](https://doi.org/10.1016/S0747-5632(99)00017-5)
- Sawchuk, K., & Crow, B. (2012). “I’m G-Mom on the Phone” Remote grandmothering, cell phones and inter-generational dis/connections. *Feminist Media Studies*, 12(4), 496–505. <https://doi.org/10.1080/14680777.2012.741863>
- Schermerhorn, P., Scheutz, M., & Crowell, C. R. (2008, March). Robot social presence and gender: Do females view robots differently than males? Proceedings of the 3rd ACM/IEEE International Conference on Human Robot Interaction (pp. 263–270). <https://doi.org/10.1145/1349822.1349857>
- Schiller, A., & McMahon, J. (2019). Alexa, alert me when the revolution comes: Gender, affect, and labor in the age of home-based artificial intelligence. *New Political Science*. <https://doi.org/10.1080/07393148.2019.1595288>
- Shade, L. R. (2007). Feminizing the mobile: Gender scripting of mobiles in North America. *Continuum* 21(2), 179–189. <https://doi.org/10.1080/10304310701269032>
- Sharpe, S. (1976). *Just like a girl: How girls learn to be women*. Penguin.
- Sherrick, B., Hoewe, J., & Waddell, T. F. (2014). The role of stereotypical beliefs in gender-based activation of the Proteus effect. *Computers in Human Behavior*, 38, 17–24. <https://doi.org/10.1016/j.chb.2014.05.010>
- Short, J., Williams, E., & Christie, B. (1976). *The social psychology of telecommunications*. Wiley.
- Showkat, D., & Grimm, C. (2018, June). Identifying gender differences in information processing style, self-efficacy, and tinkering for robot tele-operation. In 2018 15th international conference on ubiquitous robots (UR) (pp. 443–448). IEEE. <https://doi.org/10.1109/URAI.2018.8441766>
- Siegel, M., Breazeal, C., & Norton, M. I. (2009, October). Persuasive robotics: The influence of robot gender on human behavior. In 2009 IEEE/RSJ International Conference on Intelligent Robots and Systems (pp. 2563–2568). IEEE. <https://doi.org/10.1109/IROS.2009.5354116>
- Slater, M. (2009). Place illusion and plausibility can lead to realistic behaviour in immersive virtual environments. *Philosophical Transactions of the Royal Society B*, 364(1535), 3549–3557. <https://doi.org/10.1098/rstb.2009.0138>
- Slater, M., & Wilbur, S. (1997). A framework for immersive virtual environments (FIVE): Speculations on the role of presence in virtual environments. *Presence: Teleoperators and Virtual Environments*, 6, 603–616. <https://doi.org/10.1162/pres.1997.6.6.603>
- Søraa, R. A. (2017). Mechanical genders: How do humans gender robots? *Gender, Technology and Development*, 21(1–2), 99–115. <https://doi.org/10.1080/09718524.2017.1385320>
- Spelman, E. (1988). *Inessential woman*. Beacon Press.
-

- Stark, L. (2020). Women, empowerment, and mobile phones in the developing world. In R. Ling, L. Fortunati, G. Goggin, Lim Sun Sun, & Li Yuling (Eds.), *The Oxford Handbook of Mobile Communication, Culture, and Information* (pp. 529–543). Oxford University Press.
- Stober, D. (2008, May 7). Professor studies what cars can learn from drivers' words. *Stanford Report*. <https://news.stanford.edu/news/2008/may7/cars-050708.html>
- Stoljar, N. (1995). Essence, identity and the concept of woman. *Philosophical Topics* (23): 261–293. <https://www.jstor.org/stable/43154214>
- Stoller, R. J. (1968). *Sex and gender: On the development of masculinity and femininity*. Science House.
- Stone, A. (2007). *An introduction to feminist philosophy*. Polity Press.
- Suchman, L. (2019). If you want to understand the big issues, you need to understand the everyday practices that constitute them: Lucy Suchman in Conversation With Dominik Gerst & Hannes Krämer. *Forum: Qualitative Social Research* 20(1). <https://doi.org/10.17169/fqs-20.2.3252>
- Suchman, L. A. (2009). *Human-machine reconfigurations: Plans and situated actions* (2nd ed.). Cambridge University Press.
- Sugiyama, S. (2013). Melding with the self, melding with relational partners, and turning into a quasi-social robot: A Japanese case study of people's experiences of emotion and mobile devices. *Intervalla* 1, 71–84. https://www.fus.edu/intervalla-files/7_sugiyama.pdf
- Tacchi, J., Kitner, K. R., & Crawford, K. (2012). Meaningful mobility: Gender, development and mobile phones. *Feminist Media Studies* 12(4): 528–537. <https://doi.org/10.1080/14680777.2012.741869>
- Taipale, S., & Fortunati, L. (2018). Robots as the next new media. In Andrea Guzman (Ed.), *Human-machine communication: Rethinking communication, technology, and ourselves* (pp. 201–219). Peter Lang.
- Tam, L., & Khosla, R. (2016). Using social robots in health settings: Implications of personalization for human-machine communication. *Communication+*, 1, 5.
- Tannen, D. (1994). *Gender and discourse*. Oxford University Press.
- Tay, B., Jung, Y., & Park, T. (2014). When stereotypes meet robots: The double-edge sword of robot gender and personality in human-robot interaction. *Computers in Human Behavior*, 38, 75–84. <https://doi.org/10.1016/j.chb.2014.05.014>
- Turkle, S. (1995). *Life on the screen: Identity in the age of the internet*. Simon & Schuster.
- Turkle, S. (2011). *Alone together: Why we expect more from technology and less from each other?* Basic Books.
- Valenziano, L. (2007). Effects of gender in computer-mediated communication: A survey of university faculty. Paper presented at the International Research Conference in The Americas of the Academy of Human Resource Development, Indianapolis, IN, Feb 28–Mar 4, 2007.
- Vanden Abeele, M. (2020). The social consequences of phubbing: A framework and a research agenda. In R. Ling, L. Fortunati, G. Goggin, Lim Sun Sun, & Li Yuling (Eds.), *The Oxford handbook of mobile communication, culture, and information* (pp. 158–174). Oxford University Press.

- Vankatesh, V., & Morris, M. (2000). Why don't men ever stop to ask for directions? Gender, social influence, and their role in technology acceptance and usage behavior. *MIS Quarterly*, 24(1), 115–139. <https://doi.org/10.2307/3250981>
- Varela, F. J., Thompson, E. T., & Rosch, E. (1992). *The embodied mind: Cognitive science and human experience*. The MIT Press.
- Vella, K., Klarkowski, M., Turkay, S., & Johnson, D. (2019). Making friends in online games: Gender differences and designing for greater social connectedness. *Behaviour & Information Technology*, 39(8), 917–934. <https://doi.org/10.1080/0144929X.2019.1625442>
- Vincent, J. (2013). Is the mobile phone a personalized social robot? *Intervalla*, 1, 60–70.
- Vincent, J., & Fortunati, L. (Eds.). (2009). *Electronic emotion. The mediation of emotion via information and communication technologies*. Peter Lang.
- Wajcman, J. (2010). Feminist theories of technology. *Cambridge Journal of Economics*, 34, 143–152. <https://doi.org/10.1093/cje/ben057>
- Walther, J. (1996). Computer-mediated communication: Impersonal, interpersonal, and hyperpersonal interaction. *Communication Research* 23(1), 3–43. <https://doi.org/10.1177/009365096023001001>
- Wang, Y., & Young, J. E. (2014). Between “pink” and “blue”: Gendered attitudes towards robots in society. ICPS Proceedings, Gender IT '14 (pp. 49–59). <https://dl.eusset.eu/handle/20.500.12015/2307>
- Weber, J. (2005). Helpless machines and true loving care givers: A feminist critique of recent trends in human–robot interaction. *Information, Communication & Ethics in Society*, 3(4), 209–218. <https://doi.org/10.1108/14779960580000274>
- Weber, M. (1978). *Economy and society: An outline of interpretive sociology* (Vol. 2). University of California Press.
- Weisskirch, R. A., & Delevi, R. (2012). Its over b/n u n me: Technology use, attachment styles, and gender roles in relationship dissolution. *Cyberpsychology, Behavior, and Social Networking*, 15, 486–490. <https://doi.org/10.1089/cyber.2012.0169>
- Wellman, B. (2001). Physical place and cyber place: The rise of networked individualism. *International Journal of Urban and Regional Research*, 25(2), 227–252. <https://doi.org/10.1111/1468-2427.00309>
- Wirth, W., Hartmann, T., Böcking, S., Vorderer, P., Klimmt, C., Schramm, H., Saari, T., Laarni, J., Ravaja, N., Ribeiro Gouveia, F., Biocca, F., Sacau, A., Jäncke, L., Baumgartner, T., & Jäncke, P. (2007). A process model of the formation of spatial presence experiences. *Media Psychology*, 9, 493–525. <https://doi.org/10.1080/15213260701283079>
- Witt, C. (2011). What is gender essentialism? In C. Witt (Ed.), *Feminist metaphysics*. Springer.
- Woods, H. S. (2018). Asking more of Siri and Alexa: Feminine persona in service of surveillance capitalism. *Critical Studies in Media Communication* 35(4), 334–349. <https://doi.org/10.1080/15295036.2018.1488082>
- World Internet Project. (2010). <http://www.worldinternetproject.net>
- Wyche, S., Nightingale, S., & Othieno, M. (2016). Mobile phones as amplifiers of social inequality among rural Kenyan women. *ACM Transactions on Computer-Human Interaction*, 23(3), 14. <https://doi.org/10.1145/2911982>

-
- Yee, N., & Bailenson, J. (2007). The proteus effect: The effect of transformed self-representation on behavior. *Human Communication Research*, 33, 272–290. <https://doi.org/10.1111/j.1468-2958.2007.00299.x>
- Young, I. M. (1997). Gender as seriality: Thinking about women as a social collective. In I. M. Young (Ed.), *Intersecting voices*. Princeton University Press.
- Zainudeen, A., Iqbal, T., & Samarajiva, R. (2010). Who's got the phone? Gender and the use of the telephone at the bottom of the pyramid. *New Media & Society*, 12(4), 549–566. <https://doi.org/10.1177/1461444809346>
- Zhang, Y., & Juhlin, O. (2020). On the fashionalization of digital devices: A study of the representation of mobile phones in fashion magazines. *Fashion and Textiles*, 7(1), 1–20. <https://doi.org/10.1186/s40691-019-0193-1>
- Zuboff, S. (2019). *The age of surveillance capitalism: The fight for a human future at the new frontier of power: Barack Obama's books of 2019*. Profile books.
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Gender Ambiguity in Voice-Based Assistants: Gender Perception and Influences of Context

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Abstract

Recently emerging synthetic acoustically gender-ambiguous voices could contribute to dissolving the still prevailing genderism. Yet, are we indeed perceiving these voices as “unassignable”? Or are we trying to assimilate them into existing genders? To investigate the perceived ambiguity, we conducted an explorative 3 (male, female, ambiguous voice) × 3 (male, female, ambiguous topic) experiment (N = 343). We found that, although participants perceived the gender-ambiguous voice as ambiguous, they used a profoundly wide range of the scale, indicating tendencies toward a gender. We uncovered a mild dissolve of gender roles. Neither the listener’s gender nor the personal gender stereotypes impacted the perception. However, the perceived topic gender indicated the perceived voice gender, and younger people tended to perceive a more male-like gender.

Keywords: gender neutrality, ambiguity, voice assistants, gender perception, context effects

Introduction

The use of voice-based assistants (VBAs) is rising and voice control is applied to an increasing number of devices (e.g., National Public Media, 2022). VBAs are dialogue systems that can understand human speech and use a synthesized, human-like voice to interact with users (Hoy, 2018; Knotte et al., 2019) as personal smart, adaptive, and interactive artificial

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assistants (Knote et al., 2019). Alexa, Google Assistant, and Siri so far dominate the VBA market (Deloitte, 2018). The default voice gender¹ of these popular VBAs is mostly female (Abercrombie et al., 2021) and whereas around 70% of VBAs offer only a female voice, few offer only a male one or various gender options (Sey & Fesalbon, 2019). However, gendered voices in technology can elicit gender effects similar to the ones in human interaction (Lee et al., 2019; Nass et al., 1997). Thus, concerns have been raised that gender stereotypes may be reinforced by associating female voices with an assistant role (Abercrombie et al., 2021; West et al., 2019). However, as recent research indicates, female-voiced VBAs are not necessarily considered as female, but are also sometimes regarded as *neutral* or *different*, thus, a unique gender ontology for VBAs may occur (Fortunati et al., 2022).

Explicitly gender-ambiguous VBA voices such as the non-commercial pilot project Q are now being developed to address these concerns and reduce gender bias (genderlessvoice, 2022). In addition, Apple started providing an ambiguous voice option for English-speaking Siri, reaching for higher diversity and representation (Perez, 2022). However, recent research raises doubt about the *genderlessness* of such voices by claiming that people will assign a binary gender to them due to stereotypical design or context variables (e.g., Abercrombie et al., 2021; Sutton, 2020). Similar effects of stereotypical contexts have been found for other ambiguous stimuli like mixed-ethnic faces (Freeman et al., 2013). Hence, to investigate if and how gender-ambiguous voices alter gender biases and their effects, it is fundamental to know if they are actually perceived as ambiguous or not and what influences this perception.

To address the above-mentioned questions, we investigated to what extent acoustically gender-ambiguous voices are perceived as gendered or ambiguous and how this perception is altered by individual and contextual characteristics. Specifically, the study focused on the most critical influences on a voice's gender perception as of thematic context, prior personal stereotypes, and individual gender and age. To be able to meaningfully interpret the results, we studied the perception of the gender-ambiguous artificial voice compared to a female and a male gendered one. The following section begins with a review of human gender roles and stereotypes, ambiguity, and influences on human gender perception, which is then applied to the gender perception of artificial voices.

Theoretical Background

Gender Stereotypes

In a social context, the term *stereotype* refers to “qualities perceived to be associated with particular groups or categories of people” (Schneider, 2004, p. 24). These qualities are “*beliefs* about the characteristics, attributes, and behaviors of members of certain groups [...] [and]

1. We use the term *gender* instead of *sex* and differentiate between *acoustic gender* and *perceived gender* to describe the VBAs' properties in accordance with other scholars discussing ambiguous voices (e.g., Sutton, 2020) and for several reasons. First, whereas the human voice gender is determined by physical properties connected to biological sex, those factors induce a stereotypical assignment of the voice to a gender. Second, diverging from humans, VBAs do not actually possess a physical, biological sex but are only equipped with designed properties connected to socially determined genders. Third, *sex* would restrict our terminology to the two main biological sexes and hinder the view on identities outside of genderism—thus, on the central aspect of our paper.

theories about how and why certain attributes go together” (Hilton & von Hippel, 1996, p. 240). Whereas some literature suggests that many researchers conceptualize stereotypes to necessarily be inaccurate, rigid, negative, or that they have to be shared by many people (Ashmore & Del Boca, 1981; Schneider, 2004, p. 17), we agree with Schneider (2004, p. 24), who argues that these assumptions are limiting for the consideration of stereotypes as their essence lies in different aspects. At their core, stereotypes are initially mere generalizing assumptions about the association of attributes with certain groups. In contrast, prejudice refers to a (usually negative) attitude toward entire groups or individual group members *based on* stereotypes (Allport, 1954) which serves to create hierarchical status relationships between groups (Dovidio et al., 2010, p. 7). Similarly, discrimination refers to suppressing or excluding behavior *based on* stereotypes and prejudices (Allport, 1954). Hence, stereotypes can result in prejudice and discrimination.

Gender stereotypes result from the observation of (cisgender) men and women in society and ensuing conclusions about these groups’ characteristics (Eagly & Wood, 2012; Ellemers, 2018). Thus, Eagly (1987) argued that gender stereotypes are not directly referring to the biological sexes but to their associated social *gender roles*. Gender roles are “shared expectations (about appropriate qualities and behaviors) that apply to individuals on the basis of their socially identified gender” (Eagly, 1987, p. 12). Thus, they are grounded in social norms (Eagly, 1987), displaying assumptions and expectations about how a certain gender ideally should (not) be and should (not) behave (Rudman & Glick, 2008).

Gender stereotypes can be systematized into the two dimensions, *warmth* and *competence*, depending on a group’s level of status and degree of competition in intergroup relationships (Fiske et al., 2002; Fiske & Taylor, 2020). In this context, the *male* stereotype is associated with competence but not warmth, the *female* stereotype with warmth but not competence (Fiske, 2017). *Competence* refers to a person’s ability to successfully accomplish tasks and is attributed to groups with a higher level of status (Fiske et al., 2002; Fiske & Taylor, 2020). It is associated with concepts of agency (Bakan, 1966; Eagly, 1987) and instrumentality (Sieverding & Alfermann, 1992), referring to task-relatedness, individuality, and the pursuit of competence. Thus, men are believed to be dominant, willing to take risks and performance-driven (Howansky et al., 2019; Williams & Best, 1990). *Warmth* refers to a person’s intentions, and is primarily attributed to groups that are associated with a lower level of competition (Fiske et al., 2002; Fiske & Taylor, 2020). It is associated with concepts of communality (Bakan, 1966; Eagly, 1987) and expressivity (Sieverding & Alfermann, 1992), referring to the need for community, social-emotional support, or harmony (Altstötter-Gleich, 2004; Sieverding & Alfermann, 1992). Thus, women are believed to be helpful, emphatic, or friendly (Howansky et al., 2019; Williams & Best, 1990).

This stereotypization transfers to *occupations and hobbies* (Eagly & Wood, 2012) that are perceived as typically *male* or *female*, as various studies concerning different backgrounds, time periods, and samples show (Couch & Sigler, 2001; García-Mainar et al., 2018; Glick et al., 1995; A. J. Hancock et al., 2020; Janssen & Backes-Gellner, 2016; White & White, 2006). According to the dimension *competence*, these studies found that occupations associated with technology, but also power, responsibility, and prestige, such as builders or managers, are mostly perceived as male. In contrast, matching the dimension *warmth*, occupations that involve empathy, care, or knowledge about interpersonal relationships are typically perceived as female (e.g., marriage counselor or nurse).

Perception of Gender

Stereotypes can shape the category-based impression formation of new persons, based on the persons' stereotype-related "identifying features" (Schneider, 2004, p. 90) such as physical aspects like facial features, other optical features like the hairstyle (Mason et al., 2006; Rudman & Glick, 2008; Schneider, 2004) or behavioral aspects (Taylor, 1981). If these identifying features are ambiguous, people use other signs along available heuristics (Tversky & Kahneman, 1974) or priming effects (Graham & Lowery, 2004) for the categorization. However, impressions can be formed in any mode on a continuum from categorization to conscious, individual processing of new stimuli without relying on stereotypes (Fiske & Neuberg, 1990). Thus, the use of stereotyping is dependent on attention or personal motivation (Fiske & Neuberg, 1990) as well as emotional state (Smith & Mackie, 2010) and the strength of pre-existing stereotypes (Allen et al., 2009; Son Hing & Zanna, 2010).

Acoustical Voice Gender

Gender perception of voices is usually restricted to hearing; thus, the identifying features are the acoustical parameters that differ between sexes. Though features like creakiness or breathiness (Simpson, 2009) are also discussed, scholars agree that a convincing change in gender perception can be traced back to the *combined shift of the fundamental frequency (F0) and the formant frequencies (FF)* (Gelfer & Bennett, 2013; Hillenbrand & Clark, 2009; Skuk & Schweinberger, 2014; Whiteside, 1998).

Fundamental frequency (F0) refers to the height of the speaking voice, being on average lower for men (100–120 Hertz) and higher for women (200–220 Hertz) (Fitch, 1990; Gelfer & Bennett, 2013; Ma & Love, 2010; Simpson, 2009). However, there is evidence that older women often have a lower F0 than younger ones due to hormonal changes (D'haeseleer et al., 2011; Ma & Love, 2010), and that the German and English F0 of women has decreased in general (Berg et al., 2017). *Formants (FF)* are resonances that occur in the vocal tract when vowels are produced. As men's vocal tracts are longer on average, formants are deeper in male than in female voices. However, research has only identified a factor of 1.15–1.2 by which the formants for individual vowels of the sexes differ (Hillenbrand et al., 1995; Peterson & Barney, 1952; Wu & Childers, 1991). This is further complicated by the fact that findings for F0 and FF cannot easily be transferred into other languages (Simpson, 2009; Strange et al., 2004).

Perception of Gender Regarding Ambiguous Human Voices

Although male and female voices have typical ranges of the continuous scale of height (F0), there is a span of relative ambiguity in between these ranges. Here, *gender ambiguity* can occur for voices because they lack a distinct assignment to one of the ranges or even more extreme regions. This *ambiguity* ranges between 145–165 Hz (Gallena et al., 2018; Gelfer & Bennett, 2013). Although research lacks a distinct ambiguous range for formant frequencies, they too overlap in their ranges and standard deviations between men and women (Gelfer & Bennett, 2013; Pätzold & Simpson, 1997). Hence, similar to F0, it can be assumed that ambiguity occurs if formants are in between the identified distinct gender frequencies.

Thus, it is plausible that a voice which lies in between typical male and female ranges for both frequencies is acoustically gender-ambiguous. However, research has ambivalent outcomes if and how gender ambiguity is *ascribed* to an acoustically gender-ambiguous voice. Here, the type of measurement seems to be a major factor. Whereas the use of the categories *male*, *female*, and *other* resulted in the assignment of a distinct gender to acoustically ambiguous voices (Mullennix et al., 1995), gradual measurements revealed that perceived ambiguity exists (Bralley et al., 1978; Gallena et al., 2018; A. B. Hancock et al., 2014; Mullennix et al., 1995; van Borsel et al., 2009).

Perception of Gender Regarding Artificial Voices

Although gender perception of human voices can be applied to human-like artificial ones, the perception of the latter has peculiarities and still often depicts contradictory findings. For example, Q, which was designed to sound gender-ambiguous, seems to be ambiguous overall. However, two of the producers stated that only 50% of 4,500 participants rated it as ambiguous on a 5-point scale, whereas the other half perceived a gender, equally divided between male and female (MacLellan, 2019).

In addition, findings on ambiguous voices of social robots are ambivalent. For example, three out of six participants in a study by Behrens et al. (2018) rated a gendered robot voice (male or female, but synthesized and deliberately kept mechanical) explicitly as gender-ambiguous. This is underlined by the perception of Amazon's Alexa in a study by Fortunati et al. (2022), where, despite the female name, female personality narration, and female default voice, 20% of participants explicitly labeled Alexa as *neutral* or *different* (from male, female, or neutral). More pronounced even, half of them talked about Alexa without using any gender-specific language, with another 15% using gender-neutral language and pronouns such as *they*. Vice versa, the social robot *Pepper* was supposed to be androgynous in voice and appearance (SoftBank Robotics, 2022), but was more likely to be associated with a female voice based on its appearance in an Irish study (McGinn & Torre, 2019) or to be perceived as a boy in Japanese culture (Sugiyama, 2021). Whereas the differing associations might be due to cultural differences, both indicate that *Pepper* in its original state is neither related to the typical voice of grown-up men nor is entirely gender-ambiguous. In a further study, meanwhile, 30% of 50 participants judged *Pepper*, presented with a gender-ambiguous voice designed by the researchers, to be *neither male nor female*. However, the majority (64%) perceived it as male (Bryant et al., 2020). Since the authors were able to rule out other influencing variables such as the gender of the subjects, it is plausible that the voice was not entirely ambiguous. The robot's voice was synthetically generated using different F0 values (unfortunately not explicitly described) while formants and other acoustic parameters were ignored.

Independent if artificial ambiguous voices are accompanied by visual cues, some people actually assign ambiguity to them, whereas others still assign a distinct gender. The extent varies greatly between the different technologies, but fundamental and formant frequencies are seldom reported adequately. Thus, studies can barely be compared. In addition, the finding that even gendered artificial voices may be perceived as ambiguous indicates that the artificiality of the voice as such may cause this perception. To address this issue, the

perception of the artificial gender-ambiguous voice needs to be compared with artificial gendered voices. Therefore, we asked:

RQ1: How is the gender of a VBA's ambiguous voice perceived compared to a VBA's distinct male or female voice?

Besides the explicit gender assignment, stereotypes associated with the voice can give further insight into the impression that an ambiguous voice may create in the listeners. Especially in comparison with explicitly gendered voices and gender stereotypes (warmth for women, competence for men), investigating the (non-)ascription of gender stereotypes to the ambiguous voice and, thus, its placement in the SCM, is helpful for understanding its perception and the traits associated with it. This can, in turn, give insights for practitioners on further voice design and gender use for specific tasks. However, there is a dearth of research on the ascription of stereotypes to such voices. Thus, an open research question will be formulated to address these aspects:

RQ2: To what extent are gender-stereotypical traits ascribed to the VBA's ambiguous voice?

Social and Psychological Influences on Voice Gender Perception

Gender assignment to acoustically gender-ambiguous voices can be explained by social and psychological factors. Additional information can be considered when categorizing ambiguous stimuli.

A voice will always be perceived as talking about something and will appear in some form of environment. Thus, an omnipresent, potentially influential variable on gender perception is the *context*. Sutton (2020, p. 6) reduces this to the core points *Activity or Topic* in an essay targeted directly at gender-ambiguous VBAs, stating that the topic is at the same time the VBA's activity. Based on social role theory, she argues that if an ambiguous voice speaks about a gender-stereotyped topic, the voice may be assigned that respective gender. Indeed, female and male voices are further perceived as less feminine and masculine, respectively, when talking about products stereotypically assigned to the other gender (Nass & Brave, 2005). However, there is a dearth of research on this specific hypothesis.

Meanwhile, this focus on the topic might need to be broadened as voices also appear in an environment, which can be stereotyped. Children used higher voices when they are asked to speak like a beautician or nurse, and lower voices when they are asked to speak like a builder or mechanic (Cartei et al., 2020). This voice change included changes in both F0 and formants. The same study also showed significant differences when children should speak according to a neutral occupation (e.g., a student), depending on the age group and gender of the children. The frequencies used in these cases were between those used for stereotypically *male* and *female* occupations. Notably, the children were only asked to speak according to the specific occupational group, but were not directed to speak about a matching topic.

Whereas research about the contextual influences on the perception and categorization of ambiguous voices is scarce, findings for visual ambiguous stimuli indicate a strong influence of the context. Higgins et al. (1985) showed a priming effect of the mentioning of positive or negative attributes on the perception of neutrally described stimuli (animals and humans). Freeman et al. (2013) demonstrated that ambiguous faces (mixed Asian and White) were more likely to be interpreted as Asian against a typical Chinese background image, and as White against a typical American background. Moreover, the finding that certain brain areas are more strongly activated with visual context congruence proves a measurable effect of context effects on physical perception mechanisms (Freeman et al., 2015). Context also has an influence on other factors to be assessed; faces in front of threatening backgrounds, for example, are rated as correspondingly less trustworthy (Brambilla et al., 2018).

By referring to gender stereotype theory, these findings for visual stimuli can be transferred to voice gender perception: Occupations with instrumental traits are associated with men, whereas communal occupations are associated with women. These stereotypical associations could be a sufficient cue to assign a gender to an ambiguous voice when it is talking about a gender-stereotyped topic or appears in a gender-stereotyped environment. Thus, we formulate the third research question:

RQ3: How does the topic affect the gender perception of the VBA's ambiguous voice?

In addition to the topic, a person's attitudes, prejudices, and heuristics could partially alter the influence of contextual factors. Research on the stereotyping of faces indicates that a person's *strong implicit prejudice* may impact the ascription of ethnicity to an either happy- or angry-looking mixed-ethnic face (Hugenberg & Bodenhausen, 2004; Hutchings & Haddock, 2008). Similarly, *political and personal attitude* may influence the strength of stereotyping: Conservative U.S. Americans seem more likely to classify a mixed-ethnic face as Black than liberal ones, mediated by personal attitudes toward equal treatment (Krosch et al., 2013). In addition, a person's *social context and experience* may affect availability heuristics as persons living in a multicultural environment are significantly more likely than inhabitants of a primarily White environment to judge mixed-ethnic people as mixed-ethnic (Pauker et al., 2018). Transferred to gender perception, these results indicate that participants' gender stereotypes and social contexts may impact how pronounced their stereotyping—and thus, their gender ascription to the voice—is. Furthermore, *age* might be influential as gender roles are changing over time and older persons might have been socialized with different gender stereotypes than younger ones. Finally, participants' *gender* itself could be influential by the use of a similarity heuristic or the over-exclusion of ambiguous persons from the own ingroup as Bodenhausen and Peery (2009) suggest, meaning that a person identifying as male might lean toward perceiving an ambiguous voice as female and vice versa. Thus, a fourth research question will be included to address possible impacts on the individual level:

RQ4: How do individual factors like age, gender, and personal gender stereotypes influence the gender perception of the VBA's ambiguous voice?

Apart from contextual and individual factors, other aspects can also play a role in gender perception. These will be specified briefly as they are wide-ranging and have to be kept as neutral as possible in the study design in order to prevent confounding effects on the perception of the ambiguous voice. First, *details of spoken language* may alter gender perception. These include, for example, pronunciation of words or word endings (Hillenbrand et al., 1995; Trudgill, 1972), phonetic patterns (A. B. Hancock et al., 2014), and also details of word choice and sentence formation (Holtgraves & Leaper, 2014; Newman et al., 2008; Singh, 2001). It is conceivable that such differences—although effects are mostly small and overlap between genders (Holtgraves & Leaper, 2014)—may contribute to gender identification once the frequencies of a voice cannot be categorized: Style and content already allow for the identification of an author's gender via machine learning (Baker, 2014; Cheng et al., 2011).

Second, gender perception of VBAs may be affected by *design elements* such as embodiment (e.g., the visuals of a smart speaker) and names—or *Object and Brand*, as Sutton (2020, p. 4) called it. *Visual cues* can be traced back to the categorization of men and women via optical identifying features (see above) and include hairstyles (Eyssel & Hegel, 2012) and the ratio of hip, waist, and chest (Trovato et al., 2018) in robots, but also subtle cues like color (Cunningham & Macrae, 2011; Hess & Melnyk, 2016), or round versus edged shapes (Lieven et al., 2015; Tilburg et al., 2015) in objects and designs. Through such cues, gender and stereotypical traits are assigned to an object (Hess & Melnyk, 2016), which in turn can influence behavior toward the object itself (Cunningham & Macrae, 2011). Furthermore, specific *names* (Pilcher, 2017) or a *name's sound* (Guevremont & Grohmann, 2015; Slepian & Galinsky, 2016) are associated with a gender, possibly creating the expectation of a likewise-gendered persona for an acoustically ambiguous VBA. Huart et al. (2005) found this association for ambiguous faces.

Method

Design

An online experiment was conducted with German-speaking voices and participants. Participants were randomly assigned to the groups which differed in terms of the topic, but also of the voice gender, which was necessary for meaningful comparisons in terms of gender perception and stereotype assignment as argued above. Thus, although the research questions center mostly around the ambiguous voice, male and female variants were included, resulting in a 3 (male, ambiguous, female voice) \times 3 (male, ambiguous, female topic) between-subject design and a total of nine groups.

The voices were designed by the authors using the Google WaveNet technology (Google, 2022) for text-to-speech generation of audio files from the texts and fine-tuned in F0 and FF (the central variables in voice gender perception, see section “Acoustical Voice Gender”) with the program “Praat” (Praat, 2020). Linguistic gender markers like typical speech patterns were controlled by using one single voice as a basis for the production of a wide

range of variants, subsequently pre-testing those variants for their perceived gender and choosing the final variants based on these results. This ensured that even if possibly influencing gender markers occurred, their effect was already included in the voices' final gender perception, and avoided confounding effect of different speech patterns caused by different speakers. The process of designing and pre-testing is described in detail by Mooshammer and Etzrodt (2022). The final voices' acoustic parameters are specified in A1_ Voice parameters (see our OSF: <https://osf.io/39pts/>).

The gendered topic was chosen in accordance to the stereotypes associating gender with certain occupations described above. As a stereotypically male topic, *airplanes* were chosen to represent instrumentality and technical work. *Love* was chosen as female topic in association with communality and typical occupations like social work or marriage counselor. The neutral topic *penguins* was chosen according to the occupation *biologist*, as this, along with jobs like accountant or journalist, seems to be perceived mostly neutral (Couch & Sigler, 2001; Teig & Susskind, 2008; White & White, 2006). For each topic, a short text containing an interesting fact was prepared (the texts can be accessed in the study's OSF repository: A2_ Stimulus texts). By choosing a neutral presentation of a fact, gender-typical language details like discourse markers should be kept as scarce as possible.

All voices were presented as the VBA *Kim*. This name does not imply a definite gender due to its use for both sexes in German. Kim was framed as an example for a new VBA system usable on the device on which the participants were currently completing the survey and which the participants should be testing. Kim was presented as disembodied voice with as few visual characteristics as possible to avoid optical influences on gender perception. The setting consisted of a mocked *dialog* with Kim, including a greeting by Kim, a topic-dependent pre-set written question (standing for the participants) and the respective audio files with Kim's answers consisting of the spoken text about airplanes, love, or penguins, which could be activated by the participants. The audio files can be found in our OSF.

Subsequently, participants rated the *perceived gender of voice and topic* on 5-point scales (1 = male, 5 = female, 3 = neither/I cannot judge). *Perceived gender stereotypes* were measured on a scale by Altstötter-Gleich (2004), consisting of 16 randomly rotated items rated on a 5-point scale indicating the factors *instrumentality* and *expressivity*. For *personal gender stereotypes*, participants rated eight tasks which might occur in heterosexual relationships (e.g., *decorating the house* or *proposing marriage*) on a 5-point scale according to whether male or female partners should predominantly perform that task in a relationship (Mills et al., 2012). Since this study was part of a larger study, further questions followed before the sociodemographics including age and gender (offering the options male, female, or diverse) were collected, and participants were debriefed (see also A3_ Survey in the OSF).

Factor Analyses

Principal factor analyses were conducted with R to identify the dimensions of perceived and personal gender stereotypes, using parallel analysis (indicating the intersection of simulated with real data) as an extraction criterium. For perceived stereotypes, the factors *instrumentality* and *expressivity* could be confirmed, using promax rotation, and after excluding the items *willingness to take risks* and *professionality* ($KMO = 0.9$, $\chi^2(91) = 2753.36$, $p < .001$) due to insufficient communality.

In addition, *willingness to take risks* caused parallel analysis to suggest three factors instead of two. The resulting factors explained 57% of the total variance, had eigenvalues of $\lambda_{\text{Instrumentality}} = 3.08$ and $\lambda_{\text{Expressivity}} = 4.93$ and possessed a high internal consistency ($\alpha_{\text{Instrumentality}} = 0.85$, $\alpha_{\text{Expressivity}} = 0.93$).

For personal gender stereotypes, varimax rotation was used as theory states that having male and female stereotypes is not necessarily interdependent. After excluding two items (*mow the lawn* and *shovel snow*, which loaded onto a third factor), a two-factor solution of *male* and *female* stereotypes was found ($\text{KMO} = 0.71$, $\chi^2(15) = 392.17$, $p < .001$), explaining 61% of total variance. The resulting factors were interpretable as male ($\lambda = 2.41$, $\alpha = 0.72$) and female stereotypes ($\lambda = 1.23$, $\alpha = 0.58$), with *decorating the house* loading inversely on the male factor. Details regarding the factor analyses can be found in the OSF (A4_ Factor analyses). The factor for female stereotypes was used despite the lower α value as it is theoretically grounded, necessary as a counterpart for the male stereotypes, and only consists of three items which can affect α values (Field et al., 2012).

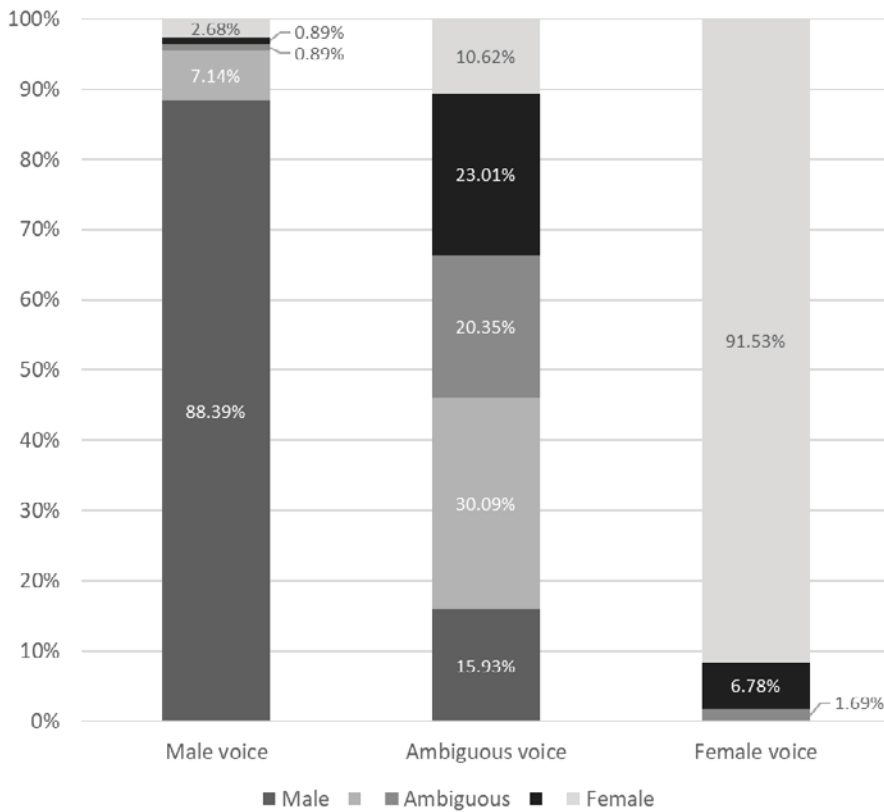
Sample

Participants were recruited via online survey platforms and survey exchange groups on social media during May and June 2020. Although 380 persons completed the experiment, 37 had to be excluded due to missing answers (less than 40% of centrally relevant dependent variables), or having spent less than 20 seconds hearing the stimulus, resulting in a final sample size of $N = 343$, who took an average of 10 minutes to complete the survey. The sample consisted of 58% persons identifying as female and 42% identifying as male (the option *diverse* was offered but not chosen by any of the participants who remained in the final sample), was relatively young ($M = 30.04$; $SD = 11.84$) and had achieved a high level of education (36% had a high school degree, 52% a university degree).

Results

Perception of Gender

The analysis of voice gender perception (RQ1) showed that although the *gender-ambiguous voice* was rated as approximately ambiguous on the 5-point scale ($M = 2.82$, $SD = 1.26$), the standard deviation indicates that the participants used the entire scale. As depicted in Figure 1, only 20% of the participants perceived the voice as fully ambiguous (expressed by choosing the scale midpoint 3), whereas 80% had a tendency toward a gender (male: 46%, female: 34%). However, more than 50% used the *rather male/rather female* categories, whereas only one quarter used the distinct gender poles. In contrast, the *gendered voices* were clearly perceived as male ($M = 1.22$, $SD = 0.69$) respectively female ($M = 4.90$, $SD = 0.34$), with the majority of about 90% using the scale's poles.

FIGURE 1 Gender Perception of the Three Voices

Ascription of Stereotypical Traits

In terms of ascribed stereotypes (RQ2), the acoustically ambiguous voice was associated with an average *instrumentality* ($M = 2.97$, $SD = 0.94$), whereas distinctly gendered voices were assigned with a higher instrumentality (male: $M = 3.21$, $SD = 0.82$; female: $M = 3.25$, $SD = 0.79$). Analyses of variance (ANOVAs) confirmed that the voices differed significantly ($F(2, 340) = 3.54$, $\eta^2 = 0.02$, $p = .030$), with the ambiguous voice perceived as less instrumental than the female voice ($p = .040$) whereas ambiguous and male ($p = .120$) as well as male and female voice did not differ ($p = 1.00$), according to a post-hoc test with Bonferroni correction. Due to the non-normal distribution of instrumentality, robust tests² were used in addition, confirming the ANOVA ($F_{rob}(2, 180.4) = 2.91$, $\xi = 0.02$, $p_{rob} = .057$) as well as the post-hoc test's finding for the ambiguous and female voices' difference on a 10% level

2. Robust tests (tests using trimming and estimates to control for non-normal distributions) were conducted using the WRS2-package in R, with t1way for robust ANOVA and lincon for post hoc analysis (Mair & Wilcox, 2020). They were conducted in addition to each standard analysis to validate the results because normal distribution (a requirement of many standard analyses) was not given for many dependent variables.

($p_{rob} = .078$). In addition, the difference between ambiguous and male voice was significant on a 10% level ($p_{rob} = .078$).

Expressivity was also averagely pronounced for the ambiguous voice ($M = 2.28$, $SD = 0.98$); however, slightly less strong than instrumentality. This time male voices were perceived as less expressive ($M = 2.05$, $SD = 0.86$), female voices as more expressive ($M = 2.47$, $SD = 0.97$) than the ambiguous one. These differences were partially confirmed by the ANOVA ($F(2, 338) = 6.01$, $\eta^2 = 0.03$, $p = .003$) and post-hoc analyses, with male and female voices differing significantly ($p = .002$). However, the ambiguous voice did neither differ significantly from male ($p = .175$) nor female voices ($p = .372$). The robust ANOVA validated the results ($F_{rob}(2, 180.98) = 6.55$, $\xi = 0.23$, $p_{rob} = .002$). Robust post-hocs confirmed differences for male and female ($p_{rob} = .001$) and indicated a relevant difference between ambiguous and male ($p_{rob} = .081$) as well as between ambiguous and female voices ($p_{rob} = .081$) on the 10% level. A closer look on the results for the single stereotypical attributes in the scale revealed that for expressivity, the male voice scored lowest and the female voice highest for every single item, which further strengthens this impression of gender stereotyping for typically female characteristics. In contrast, the scale items for instrumentality are distributed less clear for the three voices.

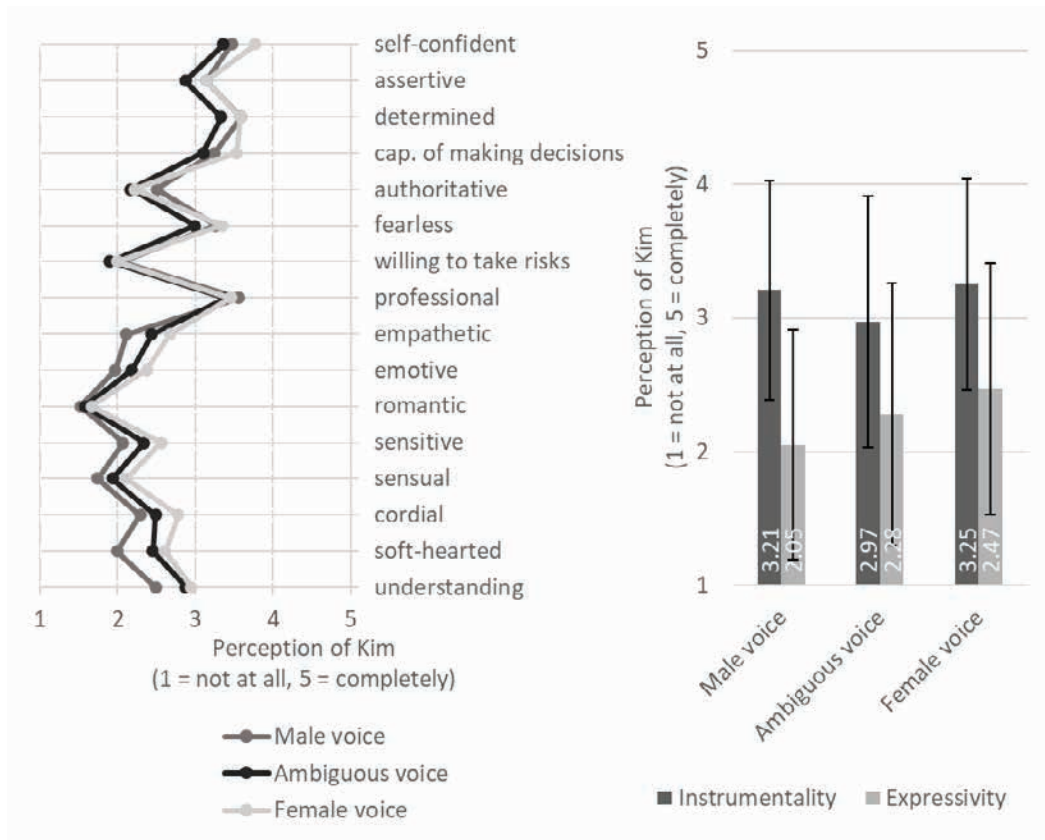
Regarding the question what gender-stereotypical traits are ascribed to the ambiguous voice (RQ2), we thus conclude that it was perceived as more instrumental than expressive. A comparison with the gendered voices showed that in terms of female stereotypes, the ambiguous voice was situated between male and female voices; thus, in fact, representing gender ambiguity. Male stereotypes, however, were rated lowest compared to the gendered voices. An overview of the ascription of instrumentality and expressivity as well as the single stereotypical traits can be found in Figure 2.

Influences on Gender Perception

To evaluate the possible factors affecting gender perception for acoustically ambiguous voices (RQ3 & RQ4), an ANCOVA³ was conducted on those participants who had assessed the ambiguous voice stimulus ($n = 113$). Included predictors were *topic*, *personal gender stereotypes*, age, and gender.

The analysis showed no significance for the influence of the topic ($F(2, 106) = 1.03$, $p = .361$, $\eta^2 = 0.02$), but revealed a small and significant influence of participants' age ($F(1, 106) = 3.99$, $p = .048$, $\eta^2 = 0.04$, see Table 1): Older participants perceived the voice to be more female.

3. There was a non-normal distribution in the groups for both predictors, *topic* and *perceived topic gender*. In addition, group sizes were uneven for *perceived topic gender*. This would require robust or nonparametric methods. Currently available methods for robust ANCOVA in R allow only one covariate and a predictor with two groups (Mair & Wilcox, 2020). For this reason, robust regression with dummy variables and the neutral topic as baseline comparison was conducted. However, as the included interaction effects are barely interpretable when applied to every dummy variable separately and the results of dummy variables are not fully comparable to the results of one factorial predictor in an ANCOVA, these were only used for background validation and will not be reported here in detail.

FIGURE 2 Stereotype Ascription to the Voices

Notes: The left figure shows the ascription of single stereotypical items to the voices, the right figure shows the ascription of the male respectively female stereotype dimensions *instrumentality* and *expressivity*, which were calculated from the items contained in the scale depicted on the left as described in the article. As mentioned, instrumentality does not contain the variables *willing to take risks* and *professional* due to the results of the factor analysis.

TABLE 1 ANCOVA Model 1 With Predictor "Topic"

Predictor and Covariates	<i>F</i> (df)	η^2	<i>p</i>
Intercept	<i>F</i> (1, 106) = 3.80		.054 ⁺
Topic	<i>F</i> (2, 106) = 1.03	.019	.361
Gender	<i>F</i> (1, 106) = 0.02	.000	.898
Age	<i>F</i> (1, 106) = 3.99	.036	.048*
Male stereotypes	<i>F</i> (1, 106) = 0.45	.004	.505
Female stereotypes	<i>F</i> (1, 106) = 0.00	.000	.999

It is possible that context effects are induced not by the topic itself, but the subjectively perceived stereotypicality of the topic. Thus, the analyses were repeated, including perceived topic gender as a predictor instead of the actual topic. The ANCOVA uncovered an effect of perceived topic gender on the perceived voice gender, $F(4, 104) = 3.69$, $p = .008$, with an effect size of $\eta^2 = 0.12$. The high significance was confirmed by the robust regression. Age remained influential, $F(1, 104) = 4.15$, $p = .044$, $\eta^2 = 0.04$. The other covariates did not affect the perceived gender (see Table 2). A post-hoc Tukey analysis of the model (predictor *perceived topic gender*, without interactions) uncovered differences in gender perception if the topic was perceived as female, compared to a perception as male (difference = 2.06, $t = 3.51$, $p = .006$) or rather male (difference = 1.41, $t = 2.92$, $p = .033$) (Figure 3).

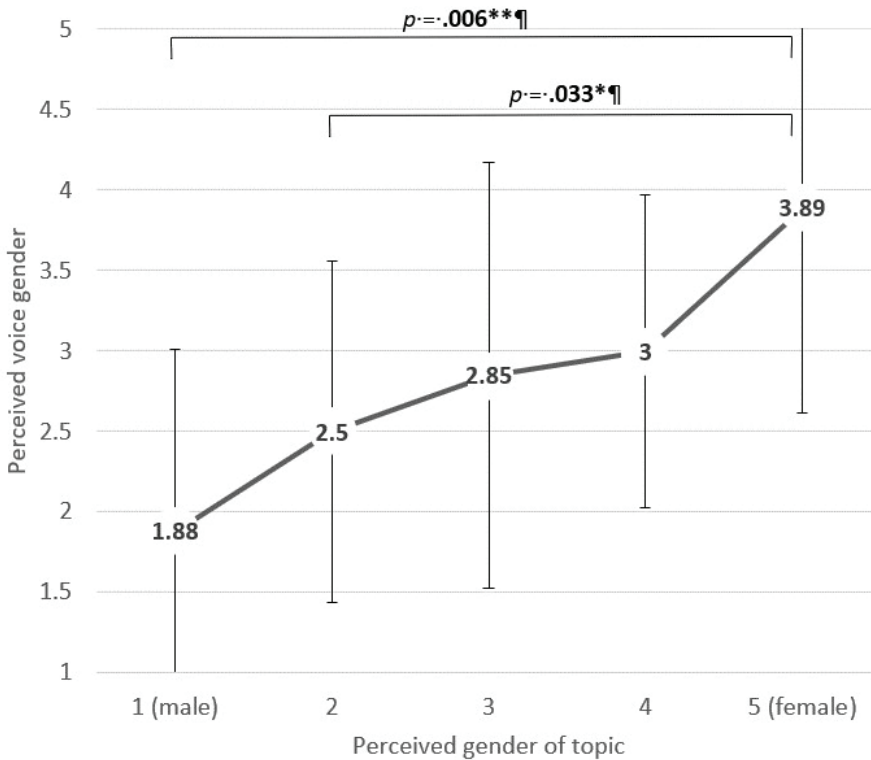
TABLE 2 ANCOVA Model 2 With Predictor “Perceived Topic Gender”

Predictor and Covariates	$F(df)$	η^2	p
Intercept	$F(1, 104) = 2.82$		.096 ⁺
Perceived topic gender	$F(4, 104) = 3.69$	.124	.008**
Gender	$F(1, 104) = 0.01$	.000	.914
Age	$F(1, 104) = 4.15$	.038	.044*
Male stereotypes	$F(1, 104) = 1.26$	.012	.264
Female stereotypes	$F(1, 104) = 0.00$	.000	.956

As the topics were indeed perceived as gendered (airplanes: $M = 2.38$, $SD = 1.04$; penguins: $M = 3.05$, $SD = 0.76$; love: $M = 3.58$, $SD = 1.06$), we conducted another ANCOVA including topic, age, gender, and stereotypes to investigate the effect of topic and control variables on the topic gender perception. It could be demonstrated that topic gender was highly significant ($F(2, 106) = 17.62$, $p < .001$), whereas the covariates showed no effect. Again, these results were controlled by a robust regression due to missing normal distribution of the dependent variable. The robust regression confirmed the influence of topic gender, but additionally showed a significant effect of female stereotypes ($p = .041$, estimate = 0.46).

Post-hoc tests of the standard ANCOVA model revealed significant differences between all three groups: The corrected means of the male and ambiguous topic differed by 0.68 ($t = 3.36$, $p = .003$), male and female by 1.21 ($t = 5.92$, $p < .001$), and ambiguous and female topic by 0.53 ($t = 2.61$, $p = .028$).

For the possible influences on gender perception, we found that gendered topics (RQ3) were not significant, but showed an indirect effect on voice gender perception via the perceived topic gender. Individual characteristics of the participants (RQ4) were also not significant with the exception of age.

FIGURE 3 Effects of Perceived Topic Gender on Perceived Voice Gender of the Ambiguous Voice

Discussion

We explicated that acoustic gender ambiguity is not simply perceived as gender ambiguity. In contrast, in accordance with research on other ambiguous stimuli, the results uncovered that acoustically gender-ambiguous voices are perceived very differently, depending on people's age and the perceived topic gender. Whereas less than a quarter used the scale's center to represent their ambiguous perception, most used the full range of the scale, hesitating to ascribe explicit ambiguity and primarily tending toward a slight gender assignment by preferring the *rather male/rather female* options. Although this can be partially explained by the impact of the perceived gender of the topics, even the people who perceived the topic as neutral used the full scale to categorize the ambiguous voice. In contrast, they were clearly more confident in assessing the gender-distinct voices, using the poles to a greater extent. This indicates that some kind of ambiguity was perceived nonetheless—especially compared to the gender perception for the distinctly gendered voices. In accordance to Piaget (1997), it could be interpreted as an evoked equilibration process due to the uncertainty in gender ascription: Therefore—similar to other ambiguous objects (Etzrodt & Engesser, 2021)—when confronted with ambiguity, people most of the time use the less exhausting strategy of accommodating the voice by modifying an existing category stemming from

genderism, instead of building a hybrid or entirely new classification. This finding also has implications for further research as it demonstrates the necessity of using gradual scales for measuring gender perception of ambiguous stimuli. Categories (male, female, ambiguous) could not have captured the slight tendencies that most people displayed.

If a topic was perceived as gendered or gender-neutral, the voice's gender perception was altered, which aligns with prior research. Hence, in accordance with Sutton's (2020) hypothesis based on stereotype theory, it can be assumed that stereotypical context information is used for the categorization of ambiguous stimuli. The impact of the *perceived* stereotypicality of the topics emphasizes the importance of user's perception on context's effects in future research on voice effects, since it is not sufficient to rely on theoretically predicted acoustical ambiguity. It is plausible that this finding applies to further contexts which arise from the embedment of VBAs in real-life situations: Beyond talking about certain topics, VBAs also appear in certain environments. For example, male VBAs are trusted more in work settings, and females more in a home environment (Damen & Toh, 2019). Regarding the important role of contexts, HMC research can build on these findings, exploring further context effects on the perception of ambiguous VBAs. Taking gender ambiguity as an example, other ambiguity categorizations of voices (e.g., ethnical ambiguity) may be affected as well, according to prior research on other stimuli. Siri, for example, included a gender-ambiguous voice and two ethnically diverse options in its voice spectrum. These are perceived as Black or White by almost equal parts of the listeners, in contrast to the "old" voices which are mostly perceived as White, and already evoke racial stereotyping (Holliday, 2022). Categorization could thus also apply to these ethnically ambiguous voices.

Besides the perceived topic gender, age appeared to be the only influential factor, indicating that older people perceived the voice as more ambiguous, whereas younger people tended toward a more male assessment on average. A reason for this might be availability heuristics as described in the theory section: At increasing age, people have had more chances to encounter voices with acoustic parameters that do not fit into the prevailing genderism which might have led to the accommodation (Etzrodt & Engesser, 2021) of their gender scheme, enabling them to classify ambiguity.

Besides the significant effects, the non-effects also have implications as they contradict existing theory. People's personal stereotypes about men and women, for example, did not influence their gender perception of the ambiguous VBA. This may be caused by peculiarities concerning VBAs' gender stereotyping in general: In contrast to stereotype theory, the female stereotype of expressivity was constantly perceived lower than the theoretically male instrumentality for all voices, indicating that stereotypes for VBAs may not entirely resemble human gender stereotypes. Hence, it is plausible that VBAs' application as task-fulfilling assistants in everyday life and their artificiality cause this more instrumental bias. This strengthens previous reflections on the emergence of novel heuristics regarding artificial agents (e.g., Etzrodt & Engesser, 2021; Gambino et al., 2020; Guzman, 2020). If VBAs now have their own heuristics as this indicates, traditional gender stereotypes might not be as relevant for their classification anymore, causing the lack of stereotype effects. In the context of gender, our results point toward a VBA-specific stereotyping that lacks the traditional gender distinction regarding expressivity and instrumentality. However, it remains unclear for now if emerging human gender stereotypes or VBA-specific gender images are not applied as well.

A second indication for a specific VBA gender heuristic is the lack of impact of the theoretically indicated over-exclusion of the ambiguous voice from the participants' own gender. If the VBA was not perceived as a gendered person, but as a gendered *personified thing* (Etzrodt & Engesser, 2021) or *social thing* (Guzman, 2015), the VBA is already part of an outgroup, independent of its gender. A second possibility is the salience of the gender ascription cues serving as identifying features. As spoken information is so closely associated with VBAs and it was presented for around 30 seconds, its perceived stereotypicality might simply have been the more central gender cue in this experimental setting than the participants' own gender. However, this effect might be different in other experimental settings that concern the participants more personally and thus make their own characteristics more relevant for the situation, such as self-disclosure to a VBA in health care.

Limitations and Further Research

Due to the study's explorative character, we only investigated the direct effects of the topic and various covariates. However, literature suggests that moderating variables might also be significant (e.g., the interaction effect between topic and strength of their own stereotypes could possibly influence gender perception when persons with strong stereotypes about women hear the ambiguous voice speaking about a topic they consider as female). Future research could include this and other interactions to further differentiate existing effects.

The topic stimuli and the measurement of personal gender stereotypes were conceptualized in accordance with traditional stereotypes. However, in the past years, there were increasing discussions about sexism (especially against women), the visibility of women in language, public debates, prestigious jobs, and similar topics. For example, the #metoo movement has raised awareness toward gender stereotypes worldwide. Also, in Germany, leading media such as *Süddeutsche Zeitung* or *Spiegel* took over the debate with their own theme sites entitled "Sexismus-Debatte" (sexism debate), containing hundreds of articles. Thus, new sensitivity toward gender stereotypes might have caused the dissolution of traditional stereotypes. As a result, the traditionally stereotyped topic gender as well as the measured personal gender stereotypes did not have an effect on voice gender perception. However, the uncovered effect of perceived topic gender on voice gender perception implies that stereotypes are still a salient cue for the meaning-making of the voice's gender—but not in the traditional sense. Therefore, further research on gender stereotypes in general and in HMC needs to consider these new developments when measuring and investigating gender stereotype effects.

Whereas the acoustic voice genders for the male, female, and ambiguous voice were analyzed for all 343 participants, the analysis of the perceived gender of the ambiguous voice was reduced to 113 participants. Especially when investigating the perceived topic gender's impact, this resulted in relatively small group sizes—even more so when taking into account that participants were not evenly distributed across these groups. Although robust methods supplemented the analysis, the detection of smaller effects might have been prevented, even when these could actually be valid. Differences in the effect of perceived topic gender on perceived voice gender could only be detected in the pairwise comparisons of the scale's poles, even though mean values and an accompanying regression analysis suggested a significant linear effect. Thus, we suggest to validate the results with a bigger sample.

Last, a lack of robust testing methods limited our data analysis as a result of the lack of normal distribution in the testing groups. As ANCOVAs with more covariates cannot be conducted robustly and robust regressions do not yield results which are interpretable in the exact same way, we could not validate our results completely. However, as non-normal distributions are neither uncommon in social science research (Wilcox, 2017) nor in human-machine communication (Author), we are looking forward to further developments of robust methods.

Conclusion

In contrast to previous research—primarily located in linguistics and phonetics and, thus, focused on acoustical factors—we adopted a social scientific perspective by investigating the *perception* of a VBA's acoustically gender-ambiguous voice in contrast to its male and female voices and the contextual influences on this perception. We found that, although people were more unsure about the acoustically ambiguous voice of the VBA than its gendered voices, most tried to accommodate their existing gender categories. Only some expressed genuine gender ambiguity. We uncovered that neither the listeners' gender nor their personal gender stereotypes, but rather their age and the topic's perceived gender were influential on the VBA's gender stereotypization. Whereas increasing age supported a more ambiguous assessment, the embedment of the ambiguous VBA voice into a perceived topic gender led more often to the ascription of this respective gender. This indicates that, although there is evidence of gender stereotyping of VBAs, traditional human gender stereotypes and role images cannot be entirely applied to them. In contrast, research on gender stereotypes in HMC needs to consider possible ontological differences between different communicators and resulting new heuristics when investigating the communication with and ascription of (stereotypical) traits to VBAs.

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References

- Abercrombie, G., Curry, A. C., Pandya, M., & Rieser, V. (2021). Alexa, Google, Siri: What are your pronouns? Gender and anthropomorphism in the design and perception of conversational assistants. *ArXiv Preprint*. Advance online publication. <https://doi.org/10.48550/arXiv.2106.02578>
- Allen, T. J., Sherman, J. W., Conrey, F. R., & Stroessner, S. J. (2009). Stereotype strength and attentional bias: Preference for confirming versus disconfirming information depends on processing capacity. *Journal of Experimental Social Psychology*, 45(5), 1081–1087. <https://doi.org/10.1016/j.jesp.2009.06.002>
- Allport, G. W. (1954). *The nature of prejudice* (4th ed.). Addison-Wesley. <https://www.semanticscholar.org/paper/The-Nature-of-Prejudice-Allport/03a1bd45ca48412cd2401abb9a1adbe65da0e20c>
- Altstötter-Gleich, C. (2004). Expressivität, Instrumentalität und psychische Gesundheit. *Zeitschrift Für Differentielle Und Diagnostische Psychologie*, 25(3), 123–139. <https://doi.org/10.1024/0170-1789.25.3.123>
- Ashmore, R. D., & Del Boca, F. K. (1981). Conceptual approaches to stereotypes and stereotyping. In D. L. Hamilton (Ed.), *Cognitive processes in stereotyping and intergroup behavior* (S. 1–37). L. Erlbaum Associates.
- Bakan, D. (1966). *The duality of human existence: An essay on psychology and religion*. Rand McNally.
- Baker, P. (2014). *Using corpora to analyze gender*. Bloomsbury Publishing.
- Behrens, S. I., Egsvang, A. K. K., Hansen, M., & Møllegaard-Schroll, A. M. (2018). Gendered robot voices and their influence on trust. In T. Kanda, S. Šabanović, G. Hoffman, & A. Tapus (Eds.), *Hri'18 companion, March 5–8, 2018, Chicago, IL, USA* (pp. 63–64). ACM Press. <https://doi.org/10.1145/3173386.3177009>
- Berg, M., Fuchs, M., Wirkner, K., Loeffler, M., Engel, C., & Berger, T. (2017). The speaking voice in the general population: Normative data and associations to sociodemographic and lifestyle factors. *Journal of Voice*, 31(2), 257. <https://doi.org/10.1016/j.jvoice.2016.06.001>
- Bodenhausen, G. V., & Peery, D. (2009). Social categorization and stereotyping in vivo: The VUCA challenge. *Social and Personality Psychology Compass*, 3(2), 133–151. <https://doi.org/10.1111/j.1751-9004.2009.00167.x>
- Bralley, R. C., Bull, G. L., Gore, C. H., & Edgerton, M. T. (1978). Evaluation of vocal pitch in male transsexuals. *Journal of Communication Disorders*, 11(5), 443–449. [https://doi.org/10.1016/0021-9924\(78\)90037-0](https://doi.org/10.1016/0021-9924(78)90037-0)
- Brambilla, M., Biella, M., & Freeman, J. B. (2018). The influence of visual context on the evaluation of facial trustworthiness. *Journal of Experimental Social Psychology*, 78, 34–42. <https://doi.org/10.1016/j.jesp.2018.04.011>
- Bryant, D., Borenstein, J., & Howard, A. (2020). Why should we gender? In T. Belpaeme, J. Young, H. Gunes, & L. Riek (Eds.), *Proceedings of the 2020 ACM/IEEE International Conference on Human-Robot Interaction* (pp. 13–21). ACM. <https://doi.org/10.1145/3319502.3374778>

- Cartei, V., Oakhill, J., Garnham, A., Banerjee, R., & Reby, D. (2020). "This is what a mechanic sounds like": Children's vocal control reveals implicit occupational stereotypes. *Psychological Science*, 31(8), 957–967. <https://doi.org/10.1177/0956797620929297>
- Cheng, N., Chandramouli, R., & Subbalakshmi, K. P. (2011). Author gender identification from text. *Digital Investigation*, 8(1), 78–88. <https://doi.org/10.1016/j.diin.2011.04.002>
- Couch, J. V., & Sigler, J. N. (2001). Gender perception of professional occupations. *Psychological Reports*, 88(3 Pt 1), 693–698. <https://doi.org/10.2466/pr0.2001.88.3.693>
- Cunningham, S. J., & Macrae, C. N. (2011). The colour of gender stereotyping. *British Journal of Psychology*, 102(3), 598–614. <https://doi.org/10.1111/j.2044-8295.2011.02023.x>
- Damen, N., & Toh, C. (2019). Designing for trust: Understanding the role of agent gender and location on user perceptions of trust in home automation. *Journal of Mechanical Design*, 141(6), 1–11. <https://doi.org/10.1115/1.4042223>
- Deloitte. (2018). *Beyond touch: Voice-commerce 2030*. https://web.archive.org/web/20221010155602/https://www2.deloitte.com/content/dam/Deloitte/de/Documents/consumer-business/Deloitte-Beyond_Touch-Voice_Commerce_2030.pdf
- D'haeseleer, E., Depypere, H., Claeys, S., Wuyts, F. L., Baudonck, N., & van Lierde, K. M. (2011). Vocal characteristics of middle-aged premenopausal women. *Journal of Voice*, 25(3), 360–366. <https://doi.org/10.1016/j.jvoice.2009.10.016>
- Dovidio, J. F., Hewstone, M., Glick, P., & Esses, V. M. (2010). Prejudice, stereotyping and discrimination: Theoretical and empirical overview. In J. F. Dovidio, M. Hewstone, P. Glick, & V. M. Esses (Eds.), *The Sage handbook of prejudice, stereotyping and discrimination* (pp. 3–28). Sage.
- Eagly, A. H. (1987). *Sex differences in social behavior: A social-role interpretation*. John M. MacEachran memorial lecture series. Erlbaum. <https://web.archive.org/web/20220119083109/http://catdir.loc.gov/catdir/enhancements/fy0742/86032921-d.html>
- Eagly, A. H., & Wood, W. (2012). Social role theory. In P. van Lange, A. Kruglanski, & E. Higgins (Eds.), *Handbook of theories of social psychology* (pp. 458–476). SAGE Publications Ltd. <https://doi.org/10.4135/9781446249222.n49>
- Ellemers, N. (2018). Gender stereotypes. *Annual Review of Psychology*, 69, 275–298. <https://doi.org/10.1146/annurev-psych-122216-011719>
- Etzrodt, K., & Engesser, S. (2021). Voice-based agents as personified things: Assimilation and accommodation as equilibration of doubt. *Human-Machine Communication*, 2, 57–79. <https://doi.org/10.30658/hmc.2.3>
- Eyssel, F., & Hegel, F. (2012). (S)he's got the look: Gender stereotyping of robots. *Journal of Applied Social Psychology*, 42(9), 2213–2230. <https://doi.org/10.1111/J.1559-1816.2012.00937.X>
- Field, A., Miles, J., & Field, Z. (2012). *Discovering statistics using R*. Sage.
- Fiske, S. T. (2017). Prejudices in cultural contexts: Shared stereotypes (gender, age) versus variable stereotypes (race, ethnicity, religion). *Perspectives on Psychological Science: A Journal of the Association for Psychological Science*, 12(5), 791–799. <https://doi.org/10.1177/1745691617708204>

- Fiske, S. T., Cuddy, A. J. C., Glick, P., & Xu, J. (2002). A model of (often mixed) stereotype content: Competence and warmth respectively follow from perceived status and competition. *Journal of Personality and Social Psychology*, 82(6), 878–902. <https://doi.org/10.1037//0022-3514.82.6.878>
- Fiske, S. T., & Neuberg, S. L. (1990). A continuum of impression formation, from category-based to individuating processes: Influences of information and motivation on attention and interpretation. In A. Unknown (Ed.), *Advances in Experimental Social Psychology: Volume 23* (1st ed., pp. 1–74). Elsevier textbooks. [https://doi.org/10.1016/S0065-2601\(08\)60317-2](https://doi.org/10.1016/S0065-2601(08)60317-2)
- Fiske, S. T., & Taylor, S. E. (2020). Social cognition evolves: Illustrations from our work on intergroup bias and on healthy adaptation. *Psicothema*, 32(3), 291–297. <https://doi.org/10.7334/psicothema2020.197>
- Fitch, J. L. (1990). Consistency of fundamental frequency and perturbation in repeated phonations of sustained vowels, reading, and connected speech. *The Journal of Speech and Hearing Disorders*, 55(2), 360–363. <https://doi.org/10.1044/jshd.5502.360>
- Fortunati, L., Edwards, A., Edwards, C., Manganelli, A. M., & de Luca, F. (2022). Is Alexa female, male, or neutral? A cross-national and cross-gender comparison of perceptions of Alexa's gender and status as a communicator. *Computers in Human Behavior*, 137(3), 107426. <https://doi.org/10.1016/j.chb.2022.107426>
- Freeman, J. B., Ma, Y., Barth, M., Young, S. G., Han, S., & Ambady, N. (2015). The neural basis of contextual influences on face categorization. *Cerebral Cortex*, 25(2), 415–422. <https://doi.org/10.1093/cercor/bht238>
- Freeman, J. B., Ma, Y., Han, S., & Ambady, N. (2013). Influences of culture and visual context on real-time social categorization. *Journal of Experimental Social Psychology*, 49(2), 206–210. <https://doi.org/10.1016/j.jesp.2012.10.015>
- Gallena, S. J. K., Stickels, B., & Stickels, E. (2018). Gender perception after raising vowel fundamental and formant frequencies: Considerations for oral resonance research. *Journal of Voice*, 32(5), 592–601. <https://doi.org/10.1016/j.jvoice.2017.06.023>
- Gambino, A., Fox, J., & Ratan, R. (2020). Building a stronger CASA: Extending the computers are social actors paradigm. *Human-Machine Communication*, 1, 71–86. <https://doi.org/10.30658/hmc.1.5>
- García-Mainar, I., Montuenga, V. M., & García-Martín, G. (2018). Occupational prestige and gender-occupational segregation. *Work, Employment and Society*, 32(2), 348–367. <https://doi.org/10.1177/0950017017730528>
- Gelfer, M. P., & Bennett, Q. E. (2013). Speaking fundamental frequency and vowel formant frequencies: Effects on perception of gender. *Journal of Voice*, 27(5), 556–566. <https://doi.org/10.1016/j.jvoice.2012.11.008>
- genderlessvoice. (2022). *Meet Q. The first genderless voice*. www.genderlessvoice.com
- Glick, P., Wilk, K., & Perreault, M. (1995). Images of occupations: Components of gender and status in occupational stereotypes. *Sex Roles*, 32(9–10), 565–582. <https://doi.org/10.1007/BF01544212>
- Google. (2022). *Text-to-speech: Lifelike speech synthesis*. <https://cloud.google.com/text-to-speech>

- Graham, S., & Lowery, B. S. (2004). Priming unconscious racial stereotypes about adolescent offenders. *Law and Human Behavior*, 28(5), 483–504. <https://doi.org/10.1023/b:lahu.0000046430.65485.1f>
- Guevremont, A., & Grohmann, B. (2015). Consonants in brand names influence brand gender perceptions. *European Journal of Marketing*, 49(1/2), 101–122. <https://doi.org/10.1108/EJM-02-2013-0106>
- Guzman, A. L. (2015). *Imagining the voice in the machine: The ontology of digital social agents*. Dissertation. University of Illinois.
- Guzman, A. L. (2020). Ontological boundaries between humans and computers and the implications for human-machine communication. *Human-Machine Communication*, 1, 37–54. <https://doi.org/10.30658/hmc.1.3>
- Hancock, A. B., Colton, L., & Douglas, F. (2014). Intonation and gender perception: Applications for transgender speakers. *Journal of Voice*, 28(2), 203–209. <https://doi.org/10.1016/j.jvoice.2013.08.009>
- Hancock, A. J., Clarke, H. M., & Arnold, K. A. (2020). Sexual orientation occupational stereotypes. *Journal of Vocational Behavior*, 119, 103427. <https://doi.org/10.1016/j.jvb.2020.103427>
- Hess, A. C., & Melnyk, V. (2016). Pink or blue? The impact of gender cues on brand perceptions. *European Journal of Marketing*, 50(9/10), 1550–1574. <https://doi.org/10.1108/EJM-11-2014-0723>
- Higgins, E. T., Bargh, J. A., & Lombardi, W. J. (1985). Nature of priming effects on categorization. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 11(1), 59–69. <https://doi.org/10.1037/0278-7393.11.1.59>
- Hillenbrand, J. M., & Clark, M. J. (2009). The role of f(0) and formant frequencies in distinguishing the voices of men and women. *Attention, Perception & Psychophysics*, 71(5), 1150–1166. <https://doi.org/10.3758/APP.71.5.1150>
- Hillenbrand, J. M., Getty, L. A., Clark, M. J., & Wheeler, K. (1995). Acoustic characteristics of American English vowels. *The Journal of the Acoustical Society of America*, 97(5 Pt 1), 3099–3111. <https://doi.org/10.1121/1.411872>
- Hilton, J. L., & von Hippel, W. (1996). Stereotypes. *Annual Review of Psychology*, 47, 237–271. <https://doi.org/10.1146/annurev.psych.47.1.237>
- Holliday, N. (2022). *Siri, you've changed! Acoustic properties and racialized judgments of voice assistants*. https://www.dropbox.com/s/aqow5vypj0pam3g/poster_Isa_2022_siri.pdf?dl=0
- Holtgraves, T. M., & Leaper, C. (2014). Gender similarities and differences in language. In T. M. Holtgraves (Ed.), *The Oxford Handbook of Language and Social Psychology*. Oxford University Press. <https://doi.org/10.1093/oxfordhb/9780199838639.013.002>
- Howansky, K., Wilton, L. S., Young, D. M., Abrams, S., & Clapham, R. (2019). (Trans)gender stereotypes and the self: Content and consequences of gender identity stereotypes. *Self and Identity*, 1–18. <https://doi.org/10.1080/15298868.2019.1617191>
- Hoy, M. B. (2018). Alexa, Siri, Cortana, and More: An introduction to voice assistants. *Medical Reference Services Quarterly*, 37(1), 81–88. <https://doi.org/10.1080/02763869.2018.1404391>

- Huart, J., Corneille, O., & Becquart, E. (2005). Face-based categorization, context-based categorization, and distortions in the recollection of gender ambiguous faces. *Journal of Experimental Social Psychology*, 41(6), 598–608. <https://doi.org/10.1016/j.jesp.2004.10.007>
- Hugenberg, K., & Bodenhausen, G. V. (2004). Ambiguity in social categorization: The role of prejudice and facial affect in race categorization. *Psychological Science*, 15(5), 342–345. <https://doi.org/10.1111/j.0956-7976.2004.00680.x>
- Hutchings, P. B., & Haddock, G. (2008). Look Black in anger: The role of implicit prejudice in the categorization and perceived emotional intensity of racially ambiguous faces. *Journal of Experimental Social Psychology*, 44(5), 1418–1420. <https://doi.org/10.1016/j.jesp.2008.05.002>
- Janssen, S., & Backes-Gellner, U. (2016). Occupational stereotypes and gender-specific job satisfaction. *Industrial Relations: A Journal of Economy and Society*, 55(1), 71–91. <https://doi.org/10.1111/irel.12126>
- Knote, R., Janson, A., Söllner, M., & Leimeister, J. M. (2019). Classifying smart personal assistants: An empirical cluster analysis. In T. Bui (Ed.), *Proceedings of the Annual Hawaii International Conference on System Sciences, Proceedings of the 52nd Hawaii International Conference on System Sciences*. Hawaii International Conference on System Sciences. <https://doi.org/10.24251/HICSS.2019.245>
- Krosch, A. R., Berntsen, L., Amodio, D. M., Jost, J. T., & van Bavel, J. J. (2013). On the ideology of hypodescent: Political conservatism predicts categorization of racially ambiguous faces as Black. *Journal of Experimental Social Psychology*, 49(6), 1196–1203. <https://doi.org/10.1016/j.jesp.2013.05.009>
- Lee, S., Ratan, R., & Park, T. (2019). The voice makes the car: Enhancing autonomous vehicle perceptions and adoption intention through voice agent gender and style. *Multimodal Technologies and Interaction*, 3(1), 1–11. <https://doi.org/10.3390/mti3010020>
- Lieven, T., Grohmann, B., Herrmann, A., Landwehr, J. R., & van Tilburg, M. (2015). The effect of brand design on brand gender perceptions and brand preference. *European Journal of Marketing*, 49(1/2), 146–169. <https://doi.org/10.1108/EJM-08-2012-0456>
- Ma, E. P.-M., & Love, A. L. (2010). Electroglottographic evaluation of age and gender effects during sustained phonation and connected speech. *Journal of Voice*, 24(2), 146–152. <https://doi.org/10.1016/j.jvoice.2008.08.004>
- MacLellan, L. (2019, March 22). *This AI voice is gender-neutral, unlike Siri and Alexa*. Quartz. <https://web.archive.org/web/20220806114324/https://qz.com/work/1577597/this-ai-voice-is-gender-neutral-unlike-siri-and-alexa/>
- Mair, P., & Wilcox, R. (2020). Robust statistical methods in R using the WRS2 package. *Behavior Research Methods*, 52(2), 464–488. <https://doi.org/10.3758/s13428-019-01246-w>
- Mason, M. F., Cloutier, J., & Macrae, C. N. (2006). On construing others: Category and stereotype activation from facial cues. *Social Cognition*, 24(5), 540–562. <https://doi.org/10.1521/soco.2006.24.5.540>
- McGinn, C., & Torre, I. (2019). Can you tell the robot by the voice? An exploratory study on the role of voice in the perception of robots. In *Hri'19: The 14th ACM/IEEE International Conference on Human-Robot Interaction: March 11–14, 2019, Daegu South Korea* (pp. 211–221). IEEE.

- Mills, M. J., Culbertson, S. S., Huffman, A. H., & Connell, A. R. (2012). Assessing gender biases. *Gender in Management: An International Journal*, 27(8), 520–540. <https://doi.org/10.1108/17542411211279715>
- Mooshammer, S., & Etzrodt, K. (2022). Social research with gender-neutral voices in chatbots—The generation and evaluation of artificial gender-neutral voices with Praat and Google WaveNet. In A. Følstad, T. Araujo, S. Papadopoulos, E. L.-C. Law, E. Luger, M. Goodwin, & P. B. Brandtzaeg (Eds.), *Lecture Notes in Computer Science. Chatbot Research and Design* (Vol. 13171, pp. 176–191). Springer International Publishing. https://doi.org/10.1007/978-3-030-94890-0_11
- Mullennix, J. W., Johnson, K. A., Topcu-Durgun, M., & Farnsworth, L. M. (1995). The perceptual representation of voice gender. *The Journal of the Acoustical Society of America*, 98(6), 3080–3095. <https://doi.org/10.1121/1.413832>
- Nass, C., & Brave, S. (2005). *Wired for speech: How voice activates and advances the human-computer relationship. Computer-human interaction*. MIT Press.
- Nass, C., Moon, Y., & Green, N. (1997). Are machines gender neutral? Gender-stereotypic responses to computers with voices. *Journal of Applied Social Psychology*, 27(10), 864–876. <https://doi.org/10.1111/j.1559-1816.1997.tb00275.x>
- National Public Media. (2022). *The smart audio report*. <https://web.archive.org/web/20220901042912/https://www.nationalpublicmedia.com/insights/reports/smart-audio-report/>
- Newman, M. L., Groom, C. J., Handelman, L. D., & Pennebaker, J. W. (2008). Gender differences in language use: An analysis of 14,000 text samples. *Discourse Processes*, 45(3), 211–236. <https://doi.org/10.1080/01638530802073712>
- Pätzold, M., & Simpson, A. P. (1997). Acoustic analysis of German vowels in the Kiel Corpus of Read Speech. *Arbeitsberichte Des Instituts Für Phonetik Und Digitale Sprachverarbeitung Universität Kiel*(32), 215–247.
- Pauker, K., Carpinella, C. M., Lick, D. J., Sanchez, D. T., & Johnson, K. L. (2018). Malleability in biracial categorizations: The impact of geographic context and targets' racial heritage. *Social Cognition*, 36(5), 461–480. <https://doi.org/10.1521/soco.2018.36.5.461>
- Perez, S. (2022). *Siri gains a new gender-neutral voice option in latest iOS update*. <https://web.archive.org/web/20220305010257/https://techcrunch.com/2022/02/24/siri-gains-a-new-gender-neutral-voice-option-in-latest-ios-update/>
- Peterson, G. E., & Barney, H. L. (1952). Control methods used in a study of the vowels. *The Journal of the Acoustical Society of America*, 24(2), 175–184. <https://doi.org/10.1121/1.1906875>
- Piaget, J. (1997). *The principles of genetic epistemology. Jean Piaget: Selected works* (Original work published 1970) (VII). Routledge.
- Pilcher, J. (2017). Names and “doing gender”: How forenames and surnames contribute to gender identities, difference, and inequalities. *Sex Roles*, 77(11), 812–822. <https://doi.org/10.1007/s11199-017-0805-4>
- Praat. (2020, April 6). *Sound: Change gender*. https://web.archive.org/web/20200429120202/https://www.fon.hum.uva.nl/praat/manual/Sound__Change_gender__.html
- Rudman, L. A., & Glick, P. (2008). *The social psychology of gender: How power and intimacy shape gender relations. Texts in social psychology*. Guilford Press.

- Schneider, D. J. (2004). *The psychology of stereotyping. Distinguished contributions in psychology*. Guilford Press. <https://web.archive.org/web/20100717230024/http://catdir.loc.gov/catdir/bios/guilford051/2003008819.html>
- Sey, A., & Fesalbon, L. (2019). "OK Google: Is AI gendered?" In A. Sey & N. Hafkin (Eds.), *Taking stock: Data and evidence on gender equality in digital access, skills and leadership* (pp. 144–145). United Nations University Institute on Computing and Society/International Telecommunications Union: Macau.
- Sieverding, M., & Alfermann, D. (1992). Instrumentelles (maskulines) und expressives (feminines) Selbstkonzept: ihre Bedeutung für die Geschlechtsrollenforschung. *Zeitschrift Für Sozialpsychologie*(23), 6–15. <https://doi.org/10.11588/HEIDOK.00019637>
- Simpson, A. P. (2009). Phonetic differences between male and female speech. *Language and Linguistics Compass*, 3(2), 621–640. <https://doi.org/10.1111/j.1749-818X.2009.00125.x>
- Singh, S. (2001). A pilot study on gender differences in conversational speech on lexical in richness measures. *Literary and Linguistic Computing*, 16(3), 251–264. <https://doi.org/10.1093/lilc/16.3.251>
- Skuk, V. G., & Schweinberger, S. R. (2014). Influences of fundamental frequency, formant frequencies, aperiodicity, and spectrum level on the perception of voice gender. *Journal of Speech, Language, and Hearing Research*, 57(1), 285–296. [https://doi.org/10.1044/1092-4388\(2013\)12-0314](https://doi.org/10.1044/1092-4388(2013)12-0314)
- Slepian, M. L., & Galinsky, A. D. (2016). The voiced pronunciation of initial phonemes predicts the gender of names. *Journal of Personality and Social Psychology*, 110(4), 509–527. <https://doi.org/10.1037/pspa0000041>
- Smith, E. R., & Mackie, D. M. (2010). Affective processes. In J. F. Dovidio, M. Hewstone, P. Glick, & V. M. Esses (Eds.), *The Sage handbook of prejudice, stereotyping and discrimination* (pp. 131–145). Sage.
- SoftBank Robotics. (2022). *Design—Pepper is a humanoid-robot*. <https://web.archive.org/web/20210706024656/https://developer.softbankrobotics.com/pepper-qisdsk/design/pepper-humanoid-robot>
- Son Hing, L. S., & Zanna, M. P. (2010). Individual differences. In J. F. Dovidio, M. Hewstone, P. Glick, & V. M. Esses (Eds.), *The Sage handbook of prejudice, stereotyping and discrimination* (pp. 163–178). Sage.
- Strange, W., Bohn, O.-S., Trent, S. A., & Nishi, K. (2004). Acoustic and perceptual similarity of North German and American English vowels. *The Journal of the Acoustical Society of America*, 115(4), 1791–1807. <https://doi.org/10.1121/1.1687832>
- Sugiyama, S. (2021). The apparatgeist of pepper-kun: An exploration of emerging cultural meanings of a social robot in Japan. In J. Katz, J. Floyd, & K. Schiepers (Eds.), *Springer eBook collection. Perceiving the future through new communication technologies: Robots, AI and everyday life* (1st ed., pp. 113–128). Springer International Publishing; Imprint Palgrave Macmillan. https://doi.org/10.1007/978-3-030-84883-5_8
- Sutton, S. J. (2020). Gender ambiguous, not genderless. In M. I. Torres, S. Schlögl, L. Clark, & M. Porcheron (Eds.), *Proceedings of the 2nd conference on Conversational user interfaces* (pp. 1–8). ACM. <https://doi.org/10.1145/3405755.3406123>
- Taylor, S. E. (1981). A categorization approach to stereotyping. In D. L. Hamilton (Ed.), *Cognitive processes in stereotyping and intergroup behavior* (pp. 83–114). L. Erlbaum Associates.

- Teig, S., & Susskind, J. E. (2008). Truck driver or nurse? The impact of gender roles and occupational status on children's occupational preferences. *Sex Roles*, 58(11–12), 848–863. <https://doi.org/10.1007/s11199-008-9410-x>
- Tilburg, M., Lieven, T., Herrmann, A., & Townsend, C. (2015). Beyond “Pink it and shrink it” perceived product gender, aesthetics, and product evaluation. *Psychology and Marketing*, 32(4), 422–437. <https://doi.org/10.1002/mar.20789>
- 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), 1–13. <https://doi.org/10.3390/robotics7030050>
- Trudgill, P. (1972). Sex, covert prestige and linguistic change in the urban British English of Norwich. *Language in Society*, 1(2), 179–195. <https://doi.org/10.1017/S0047404500000488>
- Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science*, 185(4157), 1124–1131. <https://doi.org/10.1126/science.185.4157.1124>
- van Borsel, J., Pot, K. de, & Cuyper, G. de (2009). Voice and physical appearance in female-to-male transsexuals. *Journal of Voice*, 23(4), 494–497. <https://doi.org/10.1016/j.jvoice.2007.10.018>
- West, M., Kraut, R., & Ei Chew, H. (2019). *I'd blush if I could: Closing gender divides in digital skills through education*. EQUALS and UNESCO. <https://unesdoc.unesco.org/ark:/48223/pf0000367416>
- White, M. J., & White, G. B. (2006). Implicit and explicit occupational gender stereotypes. *Sex Roles*, 55(3–4), 259–266. <https://doi.org/10.1007/s11199-006-9078-z>
- Whiteside, S. P. (1998). The identification of a speaker's sex from synthesized vowels. *Perceptual and Motor Skills*, 87(2), 595–600. <https://doi.org/10.2466/pms.1998.87.2.595>
- Wilcox, R. (2017). *Modern statistics for the social and behavioral sciences*. Chapman and Hall/CRC. <https://doi.org/10.1201/9781315154480>
- Williams, J. E., & Best, D. L. (1990). *Measuring sex stereotypes: A multinational study* (Rev. ed.). *Cross-cultural research and methodology series* (Vol. 6). Sage. <https://web.archive.org/web/20221010160558/http://catdir.loc.gov/catdir/enhancements/fy0655/90008295-d.html>
- Wu, K., & Childers, D. G. (1991). Gender recognition from speech. Part I: Coarse analysis. *The Journal of the Acoustical Society of America*, 90(4 Pt 1), 1828–1840. <https://doi.org/10.1121/1.401663>
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Do People Perceive Alexa as Gendered? A Cross-Cultural Study of People's Perceptions, Expectations, and Desires of Alexa

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Abstract

Mainly, the scholarly debate on Alexa has focused on sexist/anti-woman gender representations in the everyday life of many families, on a cluster of themes such as privacy, insecurity, and trust, and on the world of education and health. This paper takes another stance and explores via online survey methodology how university student respondents in two countries (the United States, $n = 333$; and Italy, $n = 322$) perceive Alexa's image and gender, what they expect from this voice-based assistant, and how they would like Alexa to be. Results of a free association exercise showed that Alexa's image was scarcely embodied or explicitly gendered. Rather, Alexa was associated with a distinct category of being—the VBA, virtual assistant, or digital helper—with which one talks, and which possesses praiseworthy technical and social traits. Expectations of Alexa and desires regarding Alexa's ideal performance are presented and compared across the two country samples.

Keywords: Alexa, voice-based assistant, social representations of Alexa, cross-cultural comparison, expectations, desires

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Introduction

The scholarship on Alexa¹ has mainly developed in six areas: sexist representation of women in the everyday life of many families (e.g., Lingel & Crawford, 2020; Woods, 2018); the practices of Alexa's use (e.g., Kurz et al., 2021); a cluster of themes such as privacy, insecurity, trust, and digital information (e.g., Bhatt, 2019; Natale & Cooke, 2020; Neville, 2020; Tristan et al., 2020); the world of education (e.g., Festerling & Siraj, 2020); the sphere of health (e.g., Anthes, 2020); and the industrial sector (e.g., Maio & Giudici, 2020; Yoffie et al., 2018). The discourses that have emerged are stimulating, but need to be accompanied by more empirical attention to the user experience. In this paper, we aim to advance this debate by exploring how people perceive Alexa, what they expect from this voice-based assistant (VBA), and what they would like to talk about with Alexa. In line with our aims, we chose to collect data from respondents in their own words by employing a free association exercise and posing a series of open-ended questions on an online survey.

Three sets of studies have informed our exploration: the first is the large set of studies on social representations, the conceptual framework within which we explored Alexa's image; the second is the collection of works on expectations toward robots; and the third is the range of studies on desires toward robotic technologies. We conducted our research in two different countries: the US and Italy, because we were interested in comparing how the same technological artifact is perceived and conceptualized in two countries characterized by a different degree of familiarization with advanced technologies. The United States is the country where internet use first developed and spread widely amongst its population whereas Italy is a European country where the use of the mobile phone has denoted a remarkable diffusion and use. These two countries are also characterized by a different degree of the ethnic composition of their populations and by a different attitude toward gender complexity, currently more pronounced in the United States than in Italy. Comparative research presents specific challenges but also value, in terms of knowledge, in producing comparable data (Livingstone, 2012). Operationally, we conducted an online survey using the same questionnaire with a convenience sample of US American ($N = 333$) and Italian students ($N = 322$). The structure of the paper is as follows: the next section is dedicated to summarizing the scholarly debate related to the topics discussed in this study and showing the gaps that we aim to fill with our contribution. Then, we present the methodology, followed by a report of the main results of the study, and finally the discussion of the results and concluding remarks.

The Debate on Alexa

The first set of studies supporting our exploration of Alexa's image is in part theoretical and in part empirical. Although most of the scholarly conversation about Alexa has focused on anti-women aspects in the everyday life of many families (e.g., Lingel & Crawford, 2020; Woods, 2018), on a cluster of themes such as privacy, insecurity, trust (e.g., Neville, 2020) and digital information (e.g., Natale & Cooke, 2020), and on the world of education and

1. Throughout the manuscript, we refer to Alexa by name and avoid the use of gender pronouns for three reasons: (1) Amazon avoids gender pronouns in communications about Alexa in corporate dealings; (2) Alexa is programmed to respond to questions about gender by saying "I'm not a woman or a man, I'm an AI"; and (3) to respect the diversity in our respondents' gendered and genderless conceptualizations of Alexa.

health (e.g., Anthes, 2020), we opted to explore the first impressions, gendering practices, expectations, and desires that respondents brought to their experiences with Alexa. We drew upon Moscovici's (1961) theory of social representations, the conceptual framework which is mainly constituted by a psycho-sociological theory of knowledge (Jodelet, 2011) and which aims to identify and interpret the processes by which people come to a shared understanding of the social world (Abric & Tafani, 2009). On the empirical front, we relied on two previous studies that have also used this framework, one on the image of four robots (InMoov, Padbot, Joy Robot, and Turtlebot; Fortunati et al., 2021) and the other on the image of the robot Sophia (Fortunati, Manganelli, et al., 2022). In both cases, their results showed that respondents developed disembodied images of the robots under investigation. Moreover, results from the second study demonstrated that despite Sophia's feminine appearance, the robot's gender was not salient to respondents' perception, in the sense that only one respondent explicitly invoked gender through the use of the word gynoid. This leads us to our first research question.

RQ1: How do respondents (US and Italian) perceive Alexa in terms of embodiment and gender?

People also bring to their interactions with communication technologies a set of expectations that project a baseline for evaluating subsequent experiences and thus serve as perceptual filters on reality. From a socio-psychological point of view, expectations are beliefs regarding a current or future situation, based on a probabilistic approach and direct or indirect experience. Their fundamental function is to guide behavior (Roese & Sherman, 2007) and, as such, they are one of the basic constructs of the human mind. In the case of robots, most people are limited at present to indirect experiences of the object considered. For example, two longitudinal surveys of European citizens aged 15 and over—one in 27 EU member states in 2015 ($n = 26,751$) and the other in 28 member states in 2017 ($n = 27,901$)—documented that the percentage of European citizens who had a direct experience with robots was small (12.5% and 13.1%, respectively) (Eurobarometer, 2015, 2017). In the last 5 years, the percentage with direct experience has probably increased with the diffusion of robotic products like VBAs. Yet, knowledge about robots continues to come mainly from entertainment (movies, cartoons, TV series, comic books, advertisements) and the world of information, where fictional cultural objects intersect with journalistic news (e.g., Humphry & Chesher, 2021) and where marketing descriptions often oversell the functionality of new technologies (Paepcke & Takayama, 2010). As Rósen (2021) stressed, the resulting expectations toward actual robots might be inflated in an unrealistic manner. Thus, the expectations adults (Manzi et al., 2021) and children (Alves-Oliveira et al., 2014) hold for robots are based on fancy cultural objects and on indirect experience, which may undermine their ability to accurately forecast experiences with real, commercially-available robots. A survey questionnaire of 704 Italian children in primary and secondary schools showed that the gap between the advanced human-like features of fictional robots and those attainable in actual robots which are still at the level of prototype leads to confusion for children between the factual and fictional in current robot design (Fortunati et al., 2015).

Framing people's expectations in human-machine communication (HMC) means analyzing how people cope with what Kwon et al. (2016) called the "experience gap," or the distance between prior information and expectations held for robots and their actual

performances (Rosén, 2021). As this distance widens, users may experience increasing levels of disappointment, mistrust, and rejection (Paepcke & Takayama, 2010). On the other hand, robots may occasionally surpass user expectations, invoking pleasant surprise rather than disappointment (Abendschein et al., 2022). Preconceived expectations, however, can be overridden by robots' behavior (Horstmann & Kramer, 2020) and interactions with real robots (A. P. Edwards et al., 2019). Studying this gap allows us to understand not only the frames that are built around robots as cultural objects (Fortunati et al., 2018) but also respondents' suggestions for improved use and design. These frames are heavily influenced by hyperbolic advertising messages, industry attempts to evoke fascination and awe, and the narrative registers of robots in films, TV, comics, and video games, many of which stand in contrast to the relative immaturity of current actual robots. Studying this gap also allows us to map people's grievances on the current functioning of these artifacts and thus provide the companies which produce them with clear indications of people's general sentiments, expectations, and desires.

The literature on expectations toward robots includes experiments (e.g., C. Edwards et al., 2016; A. P. Edwards et al., 2019; Horstmann & Kramer, 2020; Spence et al., 2014), cross-cultural surveys (e.g., Bartneck et al., 2007), and other methods like latent profile analysis (e.g., Manzi et al., 2021) and the use of stories of robots (and humans) acting in hypothetical scenarios to explore robots' moral attitudes (Wasielewska, 2021). In this framework, Alexa represents a peculiar case, because this and other VBAs have become mass commodities. Strengers and Kennedy (2020) reported that Siri reached 150 million users in the first year and Leskin (2018) documented that 600 million people regularly use virtual assistants worldwide. As a mass commodity, Alexa offers the opportunity to investigate the question of expectations in the context of real daily experiences and practices of use. Therefore, we pose our second research question.

RQ2: What expectations do respondents (US and Italian) have of Alexa?

The third body of literature we engage in this project concerns users' desires of robots, or how people would like robots to be. There is a wide debate within technology studies on why users matter (MacKenzie & Wajcman, 1985; Oudshoorn & Pinch, 2003). However, the operationalization of these theoretical approaches has not always been carried out meaningfully. Proof of this is the widespread Technology Acceptance Model (TAM) which limits itself to frame the problem solely in terms of users' acceptance of the technological artifact (e.g., Venkatesh & Davis, 2000). But it suffices to also look at the history of information and communication technologies as well as telecom, mobile, and internet companies in the last 3 decades to understand the continuous activity, on the part of users, of bottom-up creation of the technological artifacts we use every day. For this reason, one goal of this study was to capture not only what people like and/or dislike about Alexa, but also what they would, if possible, like to talk with Alexa about. Therefore, we asked the following research question:

RQ3: What would respondents (US and Italian) ideally like to talk with Alexa about?

Finally, regarding perceptions, expectations, and desires of Alexa, we also examined differences by user country (as reflected in the RQs) and user gender. Both of these variables have been studied previously in human-robot interaction; while the influence of country has clearly emerged as significant (e.g., Bartneck et al., 2007), the influence of gender has

produced conflicting results. Some studies, for example, have found that men's attitudes toward robots are more positive than women's (e.g., Showkat & Grimm, 2018), while other studies (e.g., Reich-Stiebert & Eyssel, 2017) have not found significant gender differences.

Methods

Participants and Procedures

In 2021, following Institutional Review Board approval, we administered an online survey² about Alexa at a large, public, Midwestern research university in the United States and a medium, public, Northeastern university in Italy. Following the informed consent process, in the US, student respondents were recruited from several large undergraduate courses in communication, which serve as requirements or electives for a variety of academic majors. In Italy, we asked the students of an undergraduate and a graduate course on multimedia science and technology to fill out the questionnaire. Overall, we collected 333 questionnaires in the United States and 322 in Italy. The description of the two convenience samples is provided in Table 1.

TABLE 1 Social and Demographic Characteristics of Respondents			
Variable	US	Italy	Total
	N (%)	N (%)	N (%)
Gender			
Female	209 (62.8)	175 (54.3)	384 (58.6)
Male	107 (32.1)	147 (45.7)	254 (38.8)
Nonbinary	7 (2.1)	–	7 (1.1)
I prefer to self-describe	3 (0.9)	–	3 (0.9)
I prefer to not answer	4 (1.2)	–	4 (1.2)
Missing	3 (0.9)	–	3 (0.9)
Total	333 (100.0)	322 (100.0)	655 (100.0)
Education			
High School or Graduate	260 (78.1)	251 (78.0)	511 (78.0)
Equivalency Degree (GED)			
Bachelor	34 (10.2)	49 (15.2)	83 (12.7)
University Degree or Higher	1 (0.3)	22 (6.8)	23 (3.5)
I prefer to self-describe	29 (8.8)	–	29 (4.4)
I prefer to not answer	7 (2.1)	–	7 (1.1)
Missing	2 (0.6)	–	2 (0.6)
Total	333 (100.0)	322 (100.0)	655 (100.0)

2. Data used for the current project is drawn from a larger collection which included questions about a range of user orientations toward Alexa (A. Edwards et al., 2022; Fortunati, Edwards, et al., 2022). A copy of the full survey is available from the corresponding author on request.

Of the sample, 36.8% reported personal ownership of at least one Alexa device, with 37.8% of those owners having more than one. Among those who did not own Alexa ($n = 414$), the majority 63.2% may be described (on the basis of the open-ended answers of this questionnaire) as proxy users who observed and interacted with the Alexa of their partners, friends, parents, and so on. There was no significant difference in Alexa ownership according to respondent gender within the US sample ($\chi^2_1 = 2.36$, *ns*) or the Italian sample ($\chi^2_1 = 0.12$, *ns*). However, on the basis of nationality, a larger proportion of US versus Italian respondents owned Alexa (47.7% vs. 25.2%; $\chi^2_1 = 34.95$, $p < .0001$, Std. Res = 5.9) and US respondents were more likely to own more than one (44.9% vs. 24.4%; $\chi^2_1 = 9.59$, $p < .003$, Std. Res = 3.1). Thirty-seven percent ($n = 241$) of respondents reported using other virtual assistants, and this was significantly more common among the US than Italian respondents (44.8% vs. 28.9%; $\chi^2_1 = 17.83$, $p < .0001$, Std. Res = 4.2). Regarding gender, there were no differences between men and women for the US sample ($\chi^2_1 = 2.59$, *ns*), but in the Italian sample, men were significantly more likely than women to use other VBAs ($\chi^2_1 = 8.12$, $p = < .005$). The other VBAs cited by respondents included Siri, followed by Google Home, Google Assistant, Cortana, and then Bixbi.

We asked respondents a series of questions related mainly to the three areas of their perceptions, expectations, and desires of Alexa. Regarding the first area, perceptions of Alexa (RQ1), we employed a free association exercise. Respondents were instructed to “Please write the first three words that come to your mind when thinking about Alexa.” We decided to use this method because it enables us to capture the spontaneous emergence of words elicited by the cue assigned. Traditionally, this technique is designed to illuminate the consensual meaning (i.e., the most frequent words and rankings) regarding a social object (Abric & Tafani, 2009; Moscovici, 1984; Wagner et al., 1999). The free association method, through its projective character, offers the advantage of bringing out the latent and implicit dimensions of the knowledge and opinions on a specific object (Bellelli, 1990), giving access to the figurative core of its social representations (Moscovici, 1961). As File et al. (2019) argued, this technique differs from questionnaires with predefined response options (Bansak et al., 2016) because it allows respondents to freely express their opinions in their own words; further, this technique offers the advantage of fast data processing, as opposed to several web-mining methods (Lazer et al., 2014).

We also explored respondents’ expectations of Alexa (RQ2), asking the open-ended question: “What do you expect/would you expect from Alexa in terms of being able to fulfill your requests?” and we investigated their desires of Alexa (RQ3) with three yes/no questions and one open-ended follow-up:

1. Is there a lot of difference between the things you talk about with Alexa and the things you want to talk about with Alexa? (y/n)
2. If so, what would you like to talk to Alexa about? (open-ended answer)
3. Would you like to talk to Alexa in a different way than you currently do? (y/n)
4. Do you/would you feel inadequate toward Alexa? (y/n)

This questionnaire also included questions on Alexa ownership, the number of Alexa devices owned and the use of other VBAs, as well as basic demographic questions for sample description purposes.

Data Analysis

The words produced in response to the free association task as well as the content of the open-ended answers were subject to an open coding and to a methodological strategy integrating content analysis (Krippendorff, 2018) and thematic analysis. We grouped short phrases, single words, and sentences into themes that were internally distinctive and consistent. The repetition of a single theme contributed to the applicability and weight of the categories identified. Four independent coders did the analysis independently. To avoid potential cultural bias, two coders were from Italy, and two were from the United States. The coders then met to discuss the results and reach a conclusion on the themed categories (Braun & Clarke, 2019). We will present the results using a narrative approach that uses (1) macro-categories for free associations and (2) excerpts from the open-ended answers. The other survey data pertinent to our RQs were analyzed using SPSS, with descriptive statistics, χ^2 tests, and standardized residuals.

Results

Perceptions of Alexa

In RQ1, we asked how respondents (US and Italian) perceive Alexa in terms of aspects including embodiment and gender. Rather than priming them with any specific constructs, we used the free association exercise to allow the spontaneous emergence of the descriptors most salient and relevant to respondents. From the US sample, we collected 846 total words, representing 290 different words. Following the omission of words or symbols that were not classifiable, the final US dictionary contained 841 words for analysis. From the Italian sample, we collected 966 total words, representing 292 different words. After the elimination of words or symbols that were not classifiable, the final Italian dictionary contained 945 words for analysis. Through content analysis, the words in the combined dictionaries were classified into seven categories: (1) Alexa identity; (2) Features, services, and functions; (3) Innovation, technology, and intelligence; (4) Dialogue; (5) Privacy; (6) Brand; and (7) Smart home. Table 2 reports the categories emerging from the free association exercise.

The frequency of these categories indicates their importance to forming the core of social representations of Alexa. The three most prominent categories, accounting for 75.1% of the total words, pertain to descriptions of who or what Alexa is (Alexa's identity), what Alexa does (Features, services, and functions), and Alexa's significance as technological innovation (Innovation, technology, and intelligence). It appears there is a halo around Alexa for many respondents, which is tied to Alexa's status as a high-tech, futuristic innovation that makes life easier. To facilitate our interpretation and description of these categories, we further divided some categories into subcategories expressing distinct themes. In the following sections, we discuss each major category.

TABLE 2 Free Associations of Alexa

Category	US Sample Words N (%)	Italian Sample Words N (%)	Total Words N (%)
1. Alexa's Identity	330 (39.2%)	355 (37.6%)	685 (38.4)
2. Features, Services, and Functions	170 (20.2)	163 (17.2)	333 (18.6)
3. Innovation, Technology, and Intelligence	149 (17.7)	175 (18.5)	324 (18.1)
4. Communication	51 (6.1)	78 (8.3)	129 (7.2)
5. Privacy	80 (9.5)	48 (5.1)	128 (7.2)
6. Brand	51 (6.1)	69 (7.3)	120 (6.7)
Total	841 (100.0)	945 (100.0)	1786 (100.0)

Alexa's Identity

The category of *Alexa's identity* contained words describing who or what Alexa is, including Alexa's physical and social traits. Excluding a certain number of tautological words, this category is based on the specific description of Alexa as a "virtual assistant" (102 words, of which 84% come from the Italian sample) and "digital helper" (77 words, of which 76.6% come from the US sample), reflecting the content of the advertisements that frame and label Alexa as a VBA, but without perfect analogue to human roles or functions; VBA is a role that both implicitly overlaps (assistant, helper) and explicitly diverges (digital, virtual) from positions occupied by humans. Related, a number of respondents associated Alexa with other commercially-available virtual assistants (Alexa is similar to or different from X; 22 words). In terms of gender, explicitly gender-linked roles were not salient in our respondents' free associations (roles like secretary and housewife did not appear in the data). There are only 11 words (0.6% of the entire sample) that point directly to a gendered anthropomorphization of Alexa: "woman" (4), "female" (6), and "girl" (1). However, despite the absence of manifest gender references in the free associations, latent or implied connections to gender may be carried in terms like "VBA" because helper and assistant have historically been considered women's work. Alexa's identity was also described, in part, on the basis of physical traits, or how Alexa is embodied as a device. Various, Alexa was described as round, circle, ball, design, box, little, white, blue, cylinder, support, ornament, tool, gadget, and thing (34 words). There were also positive descriptors of Alexa's physical body such as handy, portable, cool, elegant, nice, and cute (15 words).

On a consistent basis, Alexa's identity was comprised of traits with positive connotations, which accounted for nearly half of the words coded in this category. This is not surprising since the rhetoric of science and innovation has been observed to have a pro-innovation bias in which innovation is seen as always good, a road to positive progress (Godin & Vinck, 2017). Alexa was defined, more specifically, as useful (61), convenient (59), efficient, functional, and practical (49), fast (32), and easy/simple to use (25). In addition, Alexa was described as "amusing" (22 words) and "resourceful" (29). However, not all associations

about Alexa were positive. Some respondents characterized Alexa as “weird” (39), or as an evil influence leading to disturbing laziness and possible addiction (29). Several other respondents depicted Alexa as “Useless and untrustworthy” (29), or as an “immature technology” (20). Thus, in terms of identity, Alexa received more appreciation than criticism.

Features, Services, and Functions

The second-largest category was *Features, services, and functions*. Respondents evoked various activities such as setting reminders, timers, alarm clocks, agendas, and weather information, but the most prominent activity was music (157), followed by online search (43). Of minor importance (relatively low frequency) to this category of services and functions, there were several references to commands to turn the lights on or off, Alexa’s connection with digital media (radio, smart TV, computer), and Alexa’s e-commerce mediation role. Therefore, many associations of Alexa centered on its possible and popular uses.

Innovation, Technology, and Intelligence

In third place, respondents’ words indicated that Alexa was perceived in terms of *Innovation, technology, and intelligence*. This category is composed of four subcategories: one includes “artificial intelligence” (128 words), another is based on the dimension of “advanced technology and robotics” (126), followed by two other minor subcategories, the “innovation” sphere and the world of the “digital.”

Communication

The fourth-largest category emerging from the free association exercise (7.2% of all words) was *Communication*. Obviously, Alexa was not framed by the majority of respondents as a new medium of communication, although having a human voice emerged as the most important/prominent function offered by Alexa (42). Importantly, while Alexa’s voice may cue anthropomorphism for some respondents, it was also referred to by other respondents as a mechanical voice, a weird voice, and in terms of voice command and voice control. In this category of communication, the mode of dialogue was the central theme, followed by interaction. The most evoked words were “conversation,” “interactivity,” “connectivity,” “talking,” “chatting,” along with references to asking/answering, the sphere of company, interaction, relationships, friendships, as a bulwark against loneliness (69), and finally the opening greetings (e.g., “Hey, Alexa”) (21), fundamental in any dialogue.

Privacy

The fifth-largest category was *Privacy*. Although the topic of privacy is a concern for many people, for the current study only 7.2% of the words produced from the free association exercise were about privacy issues. In these cases, Alexa was clearly perceived as something or somebody who is intrusive, invasive, always listening (46), and even spying (41). This intrusion into everyday life is evoked as coming also from the government (e.g., “Big brother”) (21). Alexa was imagined as a danger to people’s privacy, a tool of continuous surveillance. For the US sample, 9.5% of the dictionary was concerned with privacy while only 5.1% of the Italian sample commented on privacy issues.

Brand

The sixth category refers to the *Brand* of Alexa. Alexa's specific identity is heavily conditioned by the power of corporate brands—especially by Amazon, but also by other technology firms (e.g., Google and Apple)—and several respondents listed the name of one or more companies in the free association exercise (120 words). Brand associations reflect the efforts of global capitalists to fix the identity of Alexa and other social robotic technologies in a commodification framework.

Smart Home

The last and smallest category was *Smart home* (3.8% of the entire dictionary). This category was comprised of terms associating Alexa with the home, home automation, the Internet of Things (IoT), and family. Alexa was contextualized within the house, or the smart home, where Alexa is tasked to change the home environment according to the user's desires. It is worth noticing that 85.1% of the words connected to this category came from the Italian sample.

Cross-Cultural and Gender Comparisons

From a cross-cultural comparison, US respondents attributed more positive traits to Alexa than did the Italian respondents, but they were also more concerned with privacy. By contrast, Italian respondents perceived Alexa more in terms of identity (who or what Alexa is and Alexa's physical and social traits) and as a tool that enables artisanal home automation involving smart home applications, IoT, and integrative automation. Regarding gender, women in both national samples generated a richer linguistic production than men (61.0% vs. 39.0% of the entire dictionary), driven by the fact that there were more women than men respondents. Especially in the US sample, the words evoked by men comprised only 31.1% of the overall dictionary (versus 45.6% of the words in the Italian dictionary). In both samples, words generated by women were more numerous in all categories except *Smart home*, where Italian men contributed a greater number of references.

Expectations of Alexa

In RQ2, we asked what expectations respondents (US and Italian) have of Alexa. To identify what people expect (or would expect) from Alexa in terms of being able to fulfill their requests, we collected 637 open-ended answers from 97.3% of the overall sample. Considering that only 241 respondents (36.8%) reported personal ownership of Alexa, those respondents who did not own Alexa also answered this question. The first four categories were constructed to reflect expectation levels (ranging from lower to higher) that respondents hold for Alexa, while the fifth and the sixth categories reflect respondents' specific expectations. These expectations are reported in Table 3.

TABLE 3 Expectations from Alexa

Category	US Sample N (%)	Italian Sample N (%)	Total Words N (%)
1. No expectations	13 (4.0%)	48 (15.3%)	61 (9.6%)
2. Expecting that Alexa does what Alexa should do or at least a good deal of	201 (62.2%)	50 (15.9%)	251 (39.4%)
3. Expecting a little better performance	56 (17.3%)	103 (32.8%)	159 (25.0%)
4. Expecting smooth or great performances	28 (8.7%)	76 (24.2%)	104 (16.3%)
5. Expectations formulated on the basis of a comparison with other virtual assistants	17 (5.3%)	8 (2.5%)	25 (3.9%)
6. Expectations of Alexa's integration and compatibility with the other domestic digital devices	8 (2.5%)	29 (9.2%)	37 (5.8)
Total	323 (100.0)	314 (100.0)	637 (100.0)

No (or Very Low) Expectations

In the first category of *No (or very low) expectations* (61; 9.5%), comments indicated that respondents expected almost nothing at all from Alexa. For example, “Honestly nothing, I stopped using it and I gave it to my mother because it has no better functions than my phone” (Italian, Woman). A number of respondents expected this virtual assistant to fail or to have extremely low performance or functions, which was reflected in phrases such as “not much,” “only for . . .,” “just for . . .,” “nothing except . . .,” or generally, they expected to not be able to rely on Alexa for much (e.g., just for music). “Alexa like all other voice assistants understand a tenth of what you ask him; for example, sometimes when I ask him to set a light to a percentage and most of the time he doesn’t understand,” said an Italian man. This group of 61 respondents (9.6% of the sample) used language (Alexa is only a machine, a search engine, an AI, a computer) to minimize what Alexa is expected to do. “I don’t expect much . . . whatever Alexa does I can do it too by typing in my smartphone instead of yelling at Alexa” wrote an Italian woman. Therefore, some respondents expressed extremely low expectations of Alexa based on their assessments of Alexa’s limitations.

Expecting That Alexa Does What Alexa Should Do

The second category of *Expecting that Alexa does what Alexa should do* (or at least a good deal of it) was also the largest (251, 39.4%). In this category, respondents discussed their expectations that Alexa’s actual performances deliver on what Amazon has promised the VBA can do. For example, “I’m fine with it already as it is,” wrote an Italian woman. A US woman said, “Just to be able to do as I ask her to do, as to play music or tell me the weather.” In the words of a US man: “For the most part I use it for music and timers so I get what I need from it.” However, for some respondents, there was a gap between their expectations

and Alexa's performance which led to irritation with the device. "I expect her to fulfill basic requests like 'lights on/off,' 'play music,' etc. but I have stopped asking her questions because she often doesn't understand them," explained one US man. Similarly, a US woman wrote that Alexa "Sometimes can be frustrating because I'll be trying to say something to her and she isn't listening."

In this category, respondents sometimes stressed that Alexa does not work all the time as one would expect, instead functioning properly "most of the time," "usually," "normally," "almost always," "not entirely," "most all," or a certain percentage of the time. They qualified the number of things Alexa is expected to do. A respondent said, for example, "I expect Alexa to fulfill many, if not all, of my requests. I would expect Alexa to understand me and be able to report back to me the information that I am seeking" (US, Man). An Italian woman expressed what she expects of Alexa as "Not much, she can only do what she is programmed to do, so, in practice, I can decide to what extent to give her the freedom of action; I choose its limits." Thus, this category reflected a prominent expectation that Alexa should perform as advertised and the resulting frustration which arises when this is not the case.

Expecting a Better Performance

Comments included in the third category of *Expecting a better performance* (159; 25.0%) indicated that respondents expected Alexa to fulfill basic functions as advertised/designed but also wanted Alexa to be able to do more than current capabilities. They expressed the desire for Alexa to have greater reliability in assisting them with daily life. In particular, the dominant themes in this category related to the improvement of the services that Alexa already provides, such as music, weather, the agenda, the calendar, and the alarm clocks. "I expect Alexa to be able to fully comprehend and fulfill the task that is given," said a US man. A service that Alexa already offers but which respondents singled out for improvement was information search: "More or less what it is already capable of doing. Perhaps it would be better if it had more answers to questions of general knowledge instead of giving the classic answer: I'm sorry, I don't understand" (Italian, Man). Other wishes concerned possible new applications or capabilities for Alexa such as "that she is able to help in case of difficulties such as calling 118 or giving useful information on where a particular building is . . ." (Italian, Woman) or to "Play the weekend League for me" (Italian, Man).

A strong hope of respondents was for an improvement in Alexa's ability to mimic human interpersonal communication: "I would expect her to always listen to me" (Italian, Woman); "It should keep company like a living being without the fear, however, that his conversations will be recorded and sold to companies" (Italian, Man); "Knowing how to sustain a dialogue that is likely to be human" (Italian, Man); "The ability to answer any of my doubts" (Italian, Man); and, "That she knows how to interpret different questions and requests even if they are posed in a slightly different way from the normal/well-defined syntax" (Italian, Man).

In general, responses in this category expressed an expectation that Alexa is able to help them simplify, facilitate, organize, and manage their day-to-day. There was also a strong theme of the desire to speed up Alexa's performance expressed by affixing to their expectations adverbs and adjectives like "quickly," "efficiently," "fully," "always," "concisely," "fast," "accurate," "in the best way possible," "with no troubles," and "easily." Respondents emphasized the hope for greater speed, accuracy, and efficiency in the execution of the commands

and services Alexa performs, including the control of various domestic technologies, as well as the desire for Alexa to be more programmable in a personalized way. The comments classified in this category offer a series of indications for Amazon on how to reshape Alexa for the future; it represents a window on the potential co-construction with users of this virtual assistant.

Expecting Smooth or Great Performance

The fourth category *Expecting Smooth or Great Performance* (104; 16.32%) included comments insisting Alexa should perform functions fully and flawlessly. Within these comments, there was no indication of respondents' dissatisfaction with Alexa's performance or acknowledgment of limitations. The expectations expressed could be unrealistically high, with zero margins of error. Consider, for example: "Having everything at hand" (Italian, Woman); "I expect Alexa to do everything she does to fulfill my requests. I can ask her questions to figure out a random fact, I can check my Amazon updates, and I can also communicate with other Alexa devices" (US, Woman); "I would expect the solution to every request (e.g., turn on the stove)" (Italian, Woman); and "That is able to adapt according to my needs" (Italian, Man). Hence, some respondents had lofty expectations of Alexa and anticipated that Alexa could live up to them.

Expectations Based on a Comparison With Other Virtual Assistants

Whereas the first four categories represented levels of respondents' expectations ranging from very low to high, the final two categories encapsulated sentiments specific to exactly what Alexa is expected to do rather than the acceptability of Alexa's performances. The fifth category of *Expectations based on a comparison with other virtual assistants* (25; 3.92%) included comments that calibrated expectations toward Alexa on the basis of prior experience with and knowledge of other VBAs as well as other digital devices such as mobile phones, computers, and even radios. The digital world in which Alexa arrived was already rich in opportunities and alternatives, so it is perhaps unsurprising that several respondents compared the various devices with each other, to see which can do what best. For instance, they expected Alexa to be "able to respond like a search engine, just without having to type" (Italian, Woman) or to be similar to "How to use Google, but speaking" (Italian, Woman).

Expectations of Alexa's Integration and Compatibility With the Other Domestic Digital Devices

This last category (37; 5.81%) included comments such as "Able to control the electronic components of the house without too many complex configurations," as expressed by an Italian man. Another wrote, "I expect it to be able to properly control all my Wi-Fi devices even in an automatic/programmed way." In the words of an Italian woman, Alexa was expected to perform "Integration and voice control of the house (oven, washing machine, heating, lights, etc.), create/remember events in the calendar, alarms, control the playback of music and multimedia content on other devices, information on the weather, help with recipes in the kitchen." In a similar vein, a US woman expressed the expectation of Alexa "To control devices around my house like lights, music, TV, and just be able to activate any system in my house." Finally, an Italian man expected Alexa to "Independently learn the

user's habits in the use of available technology (PC, TV, audio, lights, security, smartphone, travel, car) and anticipate the user's actions with a simple verbal command."

Cross-Cultural and Gender Comparisons

When exploring how US and Italian respondents structured their expectations it emerged that there were significant differences ($\chi^2_5 = 162.03$, $p < .0001$): Italians were significantly more likely than US respondents to have no or very low expectations of Alexa (Std. Res = 4.8), while US respondents were more likely than Italians to frame expectations in terms of alignment between Alexa's advertised and actual performances (Std. Res = 12.0). Further, more Italian than US respondents expected better or even great performances from Alexa (Std. Res = 4.5 and 5.3) and especially better integration and compatibility with other household electronic devices and domestic appliances (Std. Res = 3.6). As to gender, while there were no significant differences between US women and men in their expectations toward Alexa ($\chi^2_5 = 7.39$, *ns*); in the Italian sample this relation was significant ($\chi^2_5 = 12.40$, $p < .04$) but no single cell (specific category analysis) showed a significant relationship.

Desires of Alexa

In RQ3, we asked what users (US and Italian) would ideally like to be able to talk about with Alexa. We began by investigating whether users reported a gap (or "a lot of difference") between the things they talked about with Alexa and the things they *wanted* to talk about with Alexa. A minority ($n = 41$; 17.2%) affirmed experiencing a gap between their actual and desired topics of conversation with Alexa, whereas the majority ($n = 198$; 82.8%) indicated correspondence between the topics addressed with Alexa and those they would like to address. No cultural ($\chi^2_1 = .149$, *ns*) or gender differences emerged regarding the prevalence of this gap or alignment (for the US sample, $\chi^2_1 = .127$, *ns*; for the Italian sample, $\chi^2_1 = .007$, *ns*).

We also employed slightly different phrasing to explore whether respondents had the desire to talk to Alexa "differently than they currently do" and observed percentages of answers similar to those above: Only 25.3% ($n = 61$) expressed the desire to speak differently with Alexa. As to country, Italians were significantly more likely than US participants to express the desire for difference ($\chi^2_1 = 25.51$, $p < .0001$; 45.1% vs. 15.2%; Std. Res = 5.1). In terms of gender, there were no significant differences between men and women in either the US sample ($\chi^2_1 = 1.61$, *ns*) or in the Italian one ($\chi^2_1 = 1.67$, *ns*).

Crossing these two questions revealed that the few respondents ($n = 22$) who indicated a gap were significantly more likely than those who did not to express the desire to talk to Alexa differently than they currently do ($\chi^2_1 = 20.61$, $p < .0001$, Std. Res = 4.5). We explored further to determine whether there was an association between felt gaps and respondents' feelings of inadequacy toward Alexa, but the two were unrelated ($\chi^2_1 = .83$, *ns*). The respondents who wished they could talk to Alexa differently were asked what they would like to talk about. Using thematic analysis, we processed the open-ended answers of 51 US and 13 Italian respondents. Several respondents wrote about their desire to have a normal conversation with Alexa:

- ▶ “Well, I wish she was more intelligent so I could converse and have a whole interaction with her. Sort of like how Tony talks to Jarvis in *Iron Man*” (US, Man).
- ▶ “I would like to have an actual conversation where we go back and forth on a topic. Discussing, sharing opinions, branching into stories related to the topic, and overall building a complicated conversation. People aren’t always around to talk to, Alexa is” (US, Man).
- ▶ “If Alexa could have a conversation, I would talk to her about anything really” (US, Woman).
- ▶ “Anything, I would keep it a bit as a diary and as a person to confront” (Italian, Woman).
- ▶ “I would like answers that are more specific and similar to the human way of thinking” (Italian, Man).

Others specified that they would simply like to have a conversation on topics of everyday life, such as “My day” (US, Woman), “Random things that may be happening in my life” (US, Woman), and “I would appreciate if she had a wider knowledge of real-world topics” (US, Woman).

Another group of respondents expressed the desire to discuss both personal and emotional issues (e.g., what some US and Italian women described as “sentimental problems”). Others wanted to be able to talk about culture, news, or gossip. For instance, one US woman said, “I would like to talk about music and pop culture” and another wrote, “I would probably talk about current events or my favorite TV shows with Alexa.” Several other US women reported wanting to talk to Alexa about “actual issues happening in the world” or “I would use her for just information.” One Italian woman said she would like to talk about “a bit of everything, especially frivolous entertainment (e.g., gossip).”

Some respondents wanted to engage in deep or profound discussions with Alexa. For example, both Italian and US women wanted to talk about “human life issues.” Or, as two different US women stated, “It would be cool to talk about more complex things” and “I would like to be able to ask more in-depth questions and have them answered.” Men commented on this aspect as well. An Italian man said, “It would be fun if it reached the levels of ‘Jarvis’” (the famous artificial intelligence from the movie *Iron Man*). Another Italian man said that he wished he “could create more complex routines that can perform more elaborate actions.” Another respondent noted that he would “like to talk to her [Alexa] about ethics and morality and the human experience” (US, Man). Finally, some users said they would like to talk about “its features, how it was designed and built” (Italian, Man). Others expressed the desire to seek advice from Alexa, “About things like what would be considered appropriate during different situations. For example, asking her what is appropriate to bring and wear to an interview, on a date, etc.” (US, Woman). In general, Italians more than US users expressed a desire for improvement at the level of communication.

Discussion

Using a cross-cultural analysis of US and Italian respondents, the purpose of this study was to examine how people perceived Alexa's image and gender, what they expected from Alexa, and how they would like their communication with Alexa to be. The free association exercise offered a series of interesting insights. In the social representations of Alexa that emerged from this data, the first macro category of meaning (38.4% of the entire dictionary) was constituted by Alexa's identity. The robotic-self, as Straub et al. (2010) argued, is articulated in the professional role (artificial assistant/digital helper) but delinked from the roles and functions of the analogue world such as the secretary and the housewife, since these two words were never mentioned by respondents. In general, respondents were satisfied with Alexa as a device. Alexa presents a ludic aspect in common with other forms of digital media (Frissen et al., 2015). This is a novelty in respect to the two recognized emotional approaches to robots: (1) the fear that robots become our competitors and gain superiority or (2) the tendency to treat robots as humans (Horstmann & Krämer, 2020). In the present study, only four respondents used the word "scary" to convey their impression of Alexa. What is more salient in the current data instead is the fear that Amazon uses Alexa to violate users' *Privacy*, which is the fifth category (127 words collected on this topic, equal to 7.1% of the entire dictionary).

In contrast with other studies on social robots documenting that their physical body was not salient (Fortunati et al., 2021; Fortunati, Manganelli, et al., 2022), some limited reference to Alexa's body appeared in the current study (2.7% of the entire dictionary). This finding may emerge from Alexa's minimal embodiment and from the fact that, while many social robots are still prototypes and people have limited direct experience, people have opportunities for firsthand interaction and observation of VBAs like Alexa. Gender was even less salient (0.6%) than the physical body in free associations about Alexa. Although Alexa presents powerful cues of gendering as a feminine persona (voice, personality, and behaviors) (Fortunati, Edwards, et al., 2022; see also Humphry & Chesher, 2021; Woods, 2018), in open-ended answers, respondents have elaborated a largely disembodied and therefore ungendered (or only implicitly gendered) image of Alexa. Although the impression of something lies in a pre-cognitive dimension, it is essential to explore it since it "often shapes our final appraisal of that object" (de Graaf & Allouch, 2017, p. 28). These findings, which are in line with the studies carried out by Fortunati et al. (2021) and Fortunati, Manganelli, et al. (2022) cited above, seem to point mainly to the digital world in which Alexa lives, while, for example, Etzrodt and Engesser (2021) found that VBAs were conceptualized as "personified things." However, Etzrodt and Engesser's findings and the current study may be the result of an artifact of methodology. Their findings came from a survey that asked explicitly about identity classification, while the present study employed free associations, a semi projective exercise that reveals the latent and implicit dimensions of the object of study (in this case, Alexa's image). In fact, when requested to assign a gender from a list to Alexa (male, female, neutral, or in a different way), most respondents in the current selected "female," even though they rarely used corresponding feminine pronouns in subsequent writing about Alexa (see Fortunati, Edwards, et al., 2022, for full consideration of explicit gender labeling and linguistic practices).

In the context of Alexa, factors such as age, ethnicity, and nationality were not salient at all in spontaneous word associations. Interpreted in light of Social Identity Theory (SIT) (Tajfel, 1978), these findings suggest that respondents perceived Alexa as a quasi-in-group member, an entity that is para-affiliated to the larger group of humans. C. Edwards et al. (2019) demonstrated that SIT could be used to understand individuals' perceptions of VBAs. We argue that these findings point to a process of social identification with this VBA, which is at an early stage of definition and presents the need to build a Parasocial Identity Theory for the robotic-self. If users of Alexa have some level of identification (quasi-in-group status) with the VBA, it is more likely that the flow of messages will be natural and lead to potential positive communication outcomes (e.g., attraction, credibility), given the constraints of the technology. In other words, users will be able to interact with the VBA in a human-like way without a steep learning curve or the strong need to establish identification beyond human conversational norms. This notion is important because designers can focus on the message tasks and flow of conversations of VBAs and not as much on creating identification to produce in-group status. Future research will test these ideas of parasocial identities of machine actors.

Coming back to user perceptions of Alexa, the second category, *Features, services, and functions*, comprised 18.6% of the free association exercise. As often happens with technological artifacts, Alexa is conceptualized by the functions and services that define Alexa's purpose and uses. The category termed *Innovation, technology, and intelligence* accounted for 18.1% of the words in the dictionary. These respondents characterized Alexa as a positive development within the world of innovation and advanced technology. Respondents did not consider Alexa as a mere gadget but as the outcome of the most innovative high-tech industry, with one foot in the future. Respondents did not report any hybridization or uncertain boundaries between Alexa and humans, although an increasing amount of scientific literature reflects the blurring boundaries between humans and machines (Etzrodt & Engesser, 2021; Weidmüller, 2022). Decidedly, these first three categories accounted for 75.1% of the words that form the core of the social representations of Alexa. It is interesting to point out that *Communication*, the fourth category, contained only 7.2% of the respondents' words, indicating that Alexa is not perceived mainly as a proper medium of communication or that possibility has not yet been fully realized. To answer the first research question, Alexa's image is elaborated as scarcely embodied and ungendered. Instead, respondents tended to associate Alexa with a distinct category of being—the VBA, virtual assistant, or digital helper—with which one talks, and to conjure praise or less commonly concern for certain technical capabilities.

Regarding RQ2, our exploration of respondents' expectations toward Alexa echoed the appreciation that the majority of them expressed toward the device in the free association task. Only about 20% of respondents across the sample identified a gap between expectations and actual performance. The expectations-reality gap is often troublesome when people meet actual robots in everyday life because they lack critical elements of understanding social behavior, such as “natural” language processing (NLP) and activity recognition (Sharkey & Sharkey, 2010). This study showed that most people appreciate these virtual assistants and that the experience gap was not as applicable with VBAs as it might be with embodied

social robots. Our findings resonate with de Graaf's and Allouch's (2017) research, which showed the positive effects of users' high prior expectations on their intentions to consider the robotic dinosaur Pleo as a companion. Quite possibly, the lack of human-like social cues (or the presence of animal-like cues) for Pleo and the lack of embodiment of Alexa might foster a reduced gap between expectations and experiences.

Notably, a fifth of respondents talked about issues of communicating with Alexa. Respondents commented on the need to repeat the same question or command many times and the rigidity of the language that must be used for Alexa to understand, outside of which Alexa is unable to understand anything. Alexa allows these respondents to discover the many differences between human and machine language practices. Furthermore, these respondents focused on automation occurring only at the textual level, while human language counts on many other variables that complement it, such as non-verbal communication, proxemics, haptics, and so forth. Because of the lack of these different cues, it is not surprising that the main requests of these respondents were for Alexa to show a greater, immediate understanding of the questions asked, even when they are of a complex nature, and to have a better understanding of "natural" language and voice recognition.

Our third research question explored users' desires of Alexa's communication capabilities. In short, people's main desire was to have a normal conversation with Alexa, in which they could talk about anything and everything without limitations. In the case of Alexa, we are far from a reality in which each user is able to "remodel" the technological artifact as a personal, conversational partner. Perhaps, as more innovations are developed by technology firms and sometimes users, depending on temporal, spatial, and sociocultural contexts (Fortunati, 2014), Alexa will grow in this capability.

Cutting through all three research questions, we examined the cross-cultural comparisons of the United States/Italy and gender. Country and gender produced some differences in respondents' answers regarding Alexa's social representations, expectations, and desires toward this VBA. Still, the country mattered more than gender for the current study. Starting from the country and Alexa's image, the US respondents attributed more positive traits to Alexa compared to Italian respondents but were also more concerned about privacy. This finding is not surprising since the US cultural emphasis placed on individual rights and freedoms as well on one's inviolate personality (focus on individualism) and desires for disclosure control may lead to greater worry about governmental and corporate surveillance and intrusion into the personal sphere (Horowitz, 2006; Richards & Solove, 2007). On the contrary, Italians perceived Alexa more in terms of identity and as a tool that facilitates artisanal home automation involving smart home applications, IoT, and integrative automation. As to expectations, country matters as well. US respondents more than Italians held firm to the idea that Alexa should do what is advertised, while more Italians expected better or even great performances from Alexa. This is especially true regarding better integration and compatibility of Alexa with the other electronic devices and domestic appliances in the house. Concerning desires, Italians expressed a greater desire for significant improvement in Alexa's communication abilities. In sum, there is a fundamental summarizing cultural difference between these US and Italian respondents: US participants focused more on what Alexa is today and on the claim that Alexa's capabilities match those promised at the time of the purchase. At the same time, Italians used Alexa as a springboard to look to the future of technological innovation.

Regarding gender and Alexa's social representations, it is important to note that women are overrepresented in both national samples. Especially in the US sample, the words evoked by men comprised only 31.1% of the overall dictionary (compared to 45.6% in the Italian sample). For both samples, the words provided by women respondents were more numerous in all the categories except *Smart home* (which was overrepresented by Italian men). Not surprisingly, early adopters of the technologies connected to smart homes seemed more likely to be men than women, as is the case for other digital technologies. As for expectations, there was a very weak gender difference. Finally, regarding desires for communication with Alexa, Italian men were more likely than Italian women to want significant improvements.

Limitations of the Study

The current findings are significant because they express people's experience with Alexa at a cross-cultural level and with an open-ended response technique. These findings, however, carry some limitations that need to be addressed. First, we used convenience samples of university students, and thus findings should be taken lightly concerning generalizing these results. While they present preliminary proof-of-concept regarding the importance of nation/culture/country to user perceptions of Alexa, future studies should examine a more diverse population of users. Second, all the measures in the study are self-reported and thus may be affected by issues of social desirability. As to the future paths of the research, we believe that it might be helpful to follow up on this line of work with another study targeting some of the most interesting new questions with different methods.

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References

- Abendschein, B., Edwards, A., & Edwards, C. (2022). Novelty experience in prolonged interaction: A qualitative study of socially-isolated college students' in-home use of a robot companion. *Frontiers in Robots and AI*, 8, <https://doi.org/10.3389/frobt.2022.733078>
- Abric, J. C., & Tafani, E. (2009). Gli sviluppi strutturali della teoria. In A. Palmonari and F. Emiliani (Eds.), *Paradigmi delle rappresentazioni sociali* (pp. 147–176). Il Mulino.
- Alves-Oliveira, P., Petisca, S., Janarthanam, S. C., Hastie, H., & Paiva, A. (2014). “How do you imagine robots?” Childrens’ expectations about robots. In *Proceedings of Interaction Design and Children Workshop on Child-Robot Interaction: Social Bonding, Learning and Ethics*.
- Anthes, E. (2020). Alexa, do I have Covid-19? *Nature*, 586, 22–25.
- Bansak, K., Hainmueller, J., & Hangartner, D. (2016). How economic, humanitarian, and religious concerns shape European attitudes toward asylum seekers. *Science*, 354, 217–222. <https://doi.org/10.1126/science.aag2147>
- Bartneck, C., Suzuki, T., Kanda, T., & Nomura, T. (2007). The influence of people’s culture and prior experiences with Aibo on their attitude toward robots. *Ai & Society*, 21(1), 217–230. <https://doi.org/10.1007/s00146-006-0052-7>
- Bellelli, G. (1990). La tecnica delle associazioni libere nello studio delle rappresentazioni sociali. Aspetti cognitivi e linguistici. *Rassegna di Psicologia*, 7, 17–30.
- Bhatt, J. J. (2019). I think I can trust Alexa, but how much? *Intersect*, 13(1), 1–12.
- Braun, V., & Clarke, V. (2019). Reflecting on reflexive thematic analysis. *Qualitative Research in Sport, Exercise and Health*, 11(4), 587–597. <https://doi.org/10.1080/2159676X.2019.1628806>
- de Graaf, M. M. A., & Allouch, S. B. (2017). The influence of prior expectations of a robot’s lifelikeness on users’ intentions to treat a zoomorphic robot as a companion. *International Journal of Social Robotics*, 9(1), 17–32. <https://doi.org/10.1007/s12369-016-0340-4>
- Edwards, A., Edwards, C., Fortunati, L., Manganelli, A. M., & de Luca, F. (2022, under review). *Mass robotics: How do people communicate with, use, and feel about Alexa? A cross-cultural, user perspective*.
- Edwards, A. P., Edwards, C., & Spence, P. (2019). Initial expectations, interactions, and beyond with social robots. *Computers in Human Behavior*, 90, 308–314. <https://doi.org/10.1016/j.chb.2018.08.042>
- Edwards, C., Edwards, A., Spence, P., & Westerman, D. (2016). Initial interaction expectations with robots: Testing the human-to-human interaction script. *Communication Studies*, 67, 227–238. <https://doi.org/10.1080/10510974.2015.1121899>
- Edwards, C., Edwards, A., Stoll, B., Lin, X., & Massey, N. (2019). Evaluations of an artificial intelligence instructor’s voice: Social Identity Theory in human-robot interactions. *Computers in Human Behavior*, 90, 357–362. <https://doi.org/10.1016/j.chb.2018.08.027>
- Eurobarometer. (2015). Autonomous systems. *European Commission*. <https://europa.eu/eurobarometer/surveys/detail/2018>
- Eurobarometer. (2017). Attitudes toward the impact of digitisation and automation on daily life. *European Commission*. <https://europa.eu/eurobarometer/surveys/detail/2160>
- Etzrodt, K., & Engesser, S. (2021). Voice-based agents as personified things: Assimilation and accommodation as equilibration of doubt. *Human-Machine Communication*, 2, 57–79. <https://doi.org/10.30658/hmc.2.3>

- Festerling, J., & Siraj, I. (2020). Alexa, what are you? Exploring primary school children's ontological perceptions of digital voice assistants in open interactions. *Human Development*, 64(1), 26–43. <https://doi.org/10.1159/000508499>
- File, B., Keczer, Z., Vancsó, A., Bőthe, B., Tóth-Király, I., Hunyadi, M., Ujhelyi, A., Ulbert, I., Góth, J., & Orosz, G. (2019). Emergence of polarized opinions from free association networks. *Behavior Research Methods*, 51, 280–294. <https://doi.org/10.3758/s13428-018-1090-z>
- Fortunati L. (2014). Media between power and empowerment: Can we resolve this dilemma? *The Information Society*, 30(3), 169–183. <https://doi.org/10.1080/01972243.2014.896676>
- Fortunati, L., Edwards, A., Edwards, C., Manganelli, A. M., & de Luca, F. (2022). Is Alexa female, male, or neutral? A cross-national and cross-gender comparison of perceptions of Alexa's gender and status as a communicator. *Computers in Human Behavior*, 107426. <https://doi.org/10.1016/j.chb.2022.107426>
- Fortunati, L., Esposito, A., Sarrica, M., & Ferrin, G. (2015). Children's knowledge and imaginary about robots. *International Journal of Social Robotics*, 7(5), 685–695. <https://doi.org/10.1007/s12369-015-0316-9>
- Fortunati, L., Manganelli, A. M., Höflich, J., & Ferrin, G. (2021). Exploring the perceptions of cognitive and affective capabilities of four, real, physical robots with a decreasing degree of morphological human likeness. *International Journal of Social Robotics*. <https://doi.org/10.1007/s12369-021-00827-0>
- Fortunati, L., Manganelli, A. M., Höflich, J., & Ferrin, G. (2022). How the social robot Sophia is mediated by a YouTube video. *New Media & Society*. <https://doi.org/10.1177/14614448221103176>
- Fortunati, L., Sarrica, M., Ferrin, G., Brondi, S., & Honsell, F. (2018). Social robots as cultural objects. The sixth dimension of dynamicity? *The Information Society*, 34(3), 141–152. <https://doi.org/10.1080/01972243.2018.1444253>
- Frissen, V., Lammes, S., de Lange, M., de Mul, J., & Raessens, J. (Eds.). (2015). *Playful identities: The ludification of digital media cultures*. Amsterdam University Press.
- Godin, B. & Vinck, D. (2017). *Critical studies of innovation: Alternative approaches to the pro-innovation bias*. Edward Elgar Publishing.
- Horowitz, I. L. (2006). Privacy, publicity and security: The American context. *EMBO Reports* 7(1), 40–44. <https://doi.org/10.1038/sj.embor.7400690>
- Horstmann, A. C., & Kramer, N. C. (2020). Expectations vs. actual behavior of a social robot: An experimental investigation of the effects of a social robot's interaction skill level and its expected future role on people's evaluations. *PLoS ONE* 15(8): e0238133. <https://doi.org/10.1371/journal.pone.0238133>
- Humphry, J., & Chesher, C. (2021). Preparing for smart voice assistants: Cultural histories and media innovations. *New Media & Society*, 23(7), 1971–1988. <https://doi.org/10.1177/1461444820923679>
- Jodelet, D. (2011). Returning to past features of Serge Moscovici's theory to feed the future. *Papers on Social Representations* (vol. 20). <https://psr.iscte-iul.pt/index.php/PSR/article/view/454>
- Krippendorff, K. (2018). *Content analysis. An introduction to its methodology* (fourth ed.). Sage.

- Kurz, M., Brüggemeier, B., & Breiter, M., (2021). Success is not final; Failure is not fatal—task success and user experience in interactions with Alexa, Google Assistant and Siri. In M. Kurosu (Ed.), *Human-computer interaction. Design and user experience case studies*. HCII 2021. Lecture Notes in Computer Science (vol 12764, pp. 351–369).
- Kwon, M., Jung, M. F., & Knepper, R. A. (2016, March). Human expectations of social robots. In 2016 11th ACM/IEEE International Conference on Human-Robot Interaction (HRI) (pp. 463–464). IEEE. <https://doi.org/10.1109/HRI.2016.7451807>
- Lazer, D., Kennedy, R., King, G., & Vespignani, A. (2014). The parable of Google Flu: Traps in big data analysis. *Science*, 343, 1203–1205. <https://doi.org/10.1126/science.1248506>
- Leskin, P. (2018, October 10). Over a million people asked Amazon's Alexa to marry them in 2017 and it turned them all down. *Business Insider*. <https://www.businessinsider.com/amazons-alexa-got-over-1-million-marriage-proposals-in-2017-2018-10>
- Lingel, J., & Crawford, K. (2020). “Alexa, tell me about your mother”: The history of the secretary and the end of secrecy. *Catalist: Feminism, Theory, Technoscience*, 6(1): 2380–3312. <https://doi.org/10.28968/cftt.v6i1.29949>
- Livingstone, S. (2012). Challenges to comparative research in a globalizing media landscape. In F. Esser & T. Hanitzsch (Eds.), *Handbook of comparative communication research* (pp. 415–429). Routledge.
- MacKenzie, D., & Wajcman, J. (Eds.). (1985). *The social shaping of technology*. Open University Press.
- Maio, L., & Giudici, G. (2020). The role of corporate venture capital and corporate accelerators in developing technology ecosystems. The case of Amazon Alexa Fund. *CINet 2020*, Proceedings (pp. 455–465). <http://dx.doi.org/10.2139/ssrn.3460230>
- Manzi, F., Sorgente, A., Massaro, D., Villani, D., Di Lernia, D., Malighetti, C., Gaggioli, A., Rossignoli, D., Sandini, G., Sciutti, A., Rea, F., Maggioni, M. A., Marchetti, A., & Riva, G. (2021). Emerging adults' expectations about the next generation of robots: Exploring robotic needs through a latent profile analysis. *Cyberpsychology, Behavior, and Social Networking*, 24(5), 315–323. <https://doi.org/10.1089/cyber.2020.0161>
- Moscovici, S. (1961). *La psychanalyse, son image et son public*. Paris: PUF.
- Moscovici, S. (1984). The phenomenon of social representations. In R. M. Farr & S. Moscovici (Eds.), *Social representations* (pp. 3–69). Cambridge University Press.
- Natale, S., & Cooke, H. (2020). Browsing with Alexa: Interrogating the impact of voice assistants as web interfaces. *Media, Culture & Society*, 43(6), 1000–1016.
- Neville, S. J. (2020). Eavesmining: A critical audit of the Amazon Echo and Alexa conditions of use. *Surveillance & Society*, 18(3), 343–356. <https://doi.org/10.24908/ss.v18i3.13426>
- Oudshoorn, N., & Pinch, T. (Eds.) (2003). *How users matter: The co-construction of users and technology*. MIT Press.
- Paepcke, S., & Takayama, L. (2010, March). Judging a bot by its cover: An experiment on expectation setting for personal robots. In 2010 5th ACM/IEEE International Conference on Human-Robot Interaction (HRI) (pp. 45–52). IEEE. <https://doi.org/10.1109/HRI.2010.5453268>
- Reich-Stiebert, N., & Eyssel, F. (2017, March). (Ir)relevance of gender? On the influence of gender stereotypes on learning with a robot. In 2017 12th ACM/IEEE International Conference on Human-Robot Interaction (HRI) (pp. 166–176). IEEE.

- Richards, N. M., & Solove, D. J. (2007). Privacy's other path: Recovering the law of confidentiality. *Georgetown Law Journal*, 96(1), 23–182.
- Roose, N. J., & Sherman, J. W. (2007). Expectancy. In A. W. Kruglanski & E. T. Higgins (Eds.), *Social psychology: Handbook of basic principles* (pp. 91–115). The Guilford Press.
- Rosén, J. (2021). Expectations: Approaching social robots. <https://www.diva-portal.org/smash/record.jsf?pid=diva2%3A1620763&dswid=-925>
- Sharkey, N., & Sharkey, A. (2010). The crying shame of robot nannies: An ethical appraisal. *Interaction Studies: Social Behaviour and Communication in Biological and Artificial Systems*, 11(2), 161–190. <https://doi.org/10.1075/is.11.2.01sha>
- Showkat, D., & Grimm, C. (2018, June). Identifying gender differences in information processing style, self-efficacy, and tinkering for robot tele-operation. In 2018 15th international conference on ubiquitous robots (UR) (pp. 443–448). IEEE. <https://doi.org/10.1109/URAI.2018.8441766>
- Spence, P. R., Westerman, D., Edwards, C., & Edwards, A. (2014). Welcoming our robot overlords: Initial expectations about interaction with a robot. *Communication Research Reports*, 31, 272–280. <https://doi.org/10.1080/08824096.2014.924337>
- Straub, I., Nishio, S., & Ishiguro, H. (2010, September). Incorporated identity in interaction with a teleoperated android robot: A case study. In *19th International Symposium in Robot and Human Interactive Communication* (pp. 119–124). IEEE. <https://doi.org/10.1109/ROMAN.2010.5598695>
- Strengers, Y., & Kennedy, J. (2020). *The smart wife. Why Siri, Alexa, and other smart home devices need a feminist reboot*. MIT Press.
- Tajfel, H. (1978). Social categorization, social identity, and social comparison. In H. Tajfel (Ed.), *Differentiation between social groups: Studies in the social psychology of intergroup relations* (pp. 61–76). Academic Press.
- Tristan, S., Sharma, S., & Gonzales, R. (2020). Alexa/Google Home Forensic. In X. Zhang & K. K. Choo (Eds.), *Digital forensic education. Studies in big data* (vol. 61, pp. 101–121). Springer, Cham. https://doi.org/10.1007/978-3-030-23547-5_7
- Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science*, 46, 186–204. <https://doi.org/10.1287/mnsc.46.2.186.11926>
- Wagner, W., Duveen, G., Farr, R., Jovchelovitch, S., Lorenzi-Cioldi, F., Marková, I., & Rose, D. (1999). Theory and method of social representations. *Asian Journal of Social Psychology*, 2(1), 95–125. <https://doi.org/10.1111/1467-839X.00028>
- Wasielawska, A. (2021). Expectations toward the morality of robots: An overview of Empirical studies. *Ethics in Progress*, 12(1), 134–151. <https://doi.org/10.14746/eip.2021.1.10>
- Weidmüller, L. (2022). Human, hybrid, or machine? Exploring the trustworthiness of voice-based assistants. *Human-Machine Communication*, 4.
- Woods, H. S. (2018). Asking more of Siri and Alexa: Feminine persona in service of surveillance capitalism. *Critical Studies in Media Communication*, 35(4), 334–349. <https://doi.org/10.1080/15295036.2018.1488082>
- Yoffie, D. B., Wu, L., Sweitzer, J., Eden, D., & Ahuja, K. (2018). *Voice war: Hey Google vs Alexa vs Siri*. Harvard Business School.

Designing a Loving Robot: A Social Construction Analysis of a Sex Robot Creator's Vision

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Abstract

In 2018, one of the world's first sex robots was released by CEO Matt McMullen and his company, RealDoll. With artificial intelligence capabilities, the Harmony model is meant to support and converse with users. Using a social construction of technology theory lens, this study develops the theory's fourth level of analysis, emphasizing mass media's construction abilities. A critical discourse analysis of 38 publicity interviews found a tendency to emphasize the companionship of sex robots while envisioning a future where integration is normalized, and a sentient robot is possible. As the creator, McMullen's vision could determine the future of robotic design, leading to a deeper understanding of this new technology. This study adds to the growing literature on sex robots by addressing the creator's public intentions.

Keywords: sex robots, social construction of technology, critical discourse analysis, sentience, companionship

Introduction

Realistic sex dolls are not new cultural phenomena and have been present in humankind's imaginary since the myth of Pygmalion, where a man asked Aphrodite to bring his loved sculpture to life. In 1996, the first silicone sex doll from the RealDoll corporation was released to the public. CEO Matt McMullen, a sculptor by trade, sought to design ultrarealistic, poseable mannequins. After requests to use the mannequin products as sex dolls, he

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established RealDoll and sold them with lifelike genitalia. While his design changed over time, McMullen began discussing the possibility of artificial intelligence incorporation in 2015, which would eventually result in one of the world's first sex robots. In 2018, McMullen's Harmony model was ready to be released to the public. Harmony features a robotic head with moveable eyes and a mouth regulated by a mobile application and connected to the patented silicone body. Throughout the design and production process, McMullen has been the finalizing voice who sculpts models. His vision defines what is produced and ultimately sold.

This study addresses McMullen's discourse in publicity interviews to understand his vision and the language surrounding one of the first modern iterations of sex robots. Through these interviews, McMullen explains the purpose and rationale of his products, especially as advancements allowed them to "communicate" in more sophisticated ways. McMullen presents a palatable version of sex robots and their users to combat dystopian and violent fictional (Hawkes & Lacey, 2019) and deviant or anti-social informational (Döring & Poeschl, 2019) representation. Limited research has explored the interrelationship of sex robot and public attitudes; however, initial studies have found women reporting increased levels of jealousy (Szcuka & Krämer, 2018), while men report overt disdain even as implicit measures imply interest (Szcuka & Krämer, 2017).

The construction of the sex robot narrative does not reside in an independent silo. To understand this multifaceted technological negotiation, social construction of technology theory (SCOT) is used here to elucidate the mutual cyclical process of negotiation between designers, users, the public, and media (Klein & Kleinman, 2002). Mediated discourse on sex robots is illustrative of the sociocultural and political level of SCOT, an underdeveloped segment of the theoretical lens. By critically analyzing McMullen's interviews, I argue McMullen reframes RealDoll as a frontier in the global sex technology industry and the sex robot as an alternative companionship service product. The purpose of the study is two-part: (1) to uncover a creator's perspective that has led to the construction of a hyper-realistic sex robot model, and (2) to detail the discourse of a sexual product and its gender dynamics. Grounded in SCOT and discourse analysis, I ask: How does the creator of a sex robot view their product, and what is the purpose for its existence?

Sex robots provide a unique basis of understanding human-machine communication as a form of "communicative sexuotechnical-assemblages" (Dehnert, 2022, p. 133). Their communicative nature is reflected in the outward features and robotic movements that depict physical expectations, whereas the inward interpersonal features seen in the artificial intelligence system directly portray values to users. As an embodied sexual product, sex robots are enveloped under the umbrella term of erobots, or "all artificial erotic agents" and their systems (Dubé & Anctil, 2021, p. 2). Sex robots can be defined as "any artificial entity that is used for sexual purposes (i.e., for sexual stimulation and release) that meets the following three conditions: Humanoid form . . . Human-like movement/behavior . . . Some degree of artificial intelligence" (Danaher, 2017, pp. 4–5). This more rigid definition confines sex robots to a replication of the human form. Other definitions (Döring, 2021) are more fluid in the material, mechanical expectations, and encompassed technologies; however, Harmony and models like her are following a strict application of human-like qualities signaling the potential prominence of humanoid definitions. Even with Harmony's static body, she still achieves this categorization particularly with body sensors, heating, and

visual recognition in development at RealDoll (Engadget, 2018a). Nevertheless, sex robots, like other robotics, remain fluid in design and their definitions may shift if the models evolve from human replicas (Dehnert, 2022; Fortunati & Edwards, 2021).

In adherence to the critical shift in the field of human-machine communication (Fortunati & Edwards, 2020), this study contributes to understandings of mediated technological and sexual discourse. RealDoll and McMullen are utilized as a case study for sex robot designers as the company is one of the leading global manufacturers (Dehnert, 2022), and the only U.S.-based operation. This study addresses key developments in sex robot literature by answering Döring et al.'s (2020) call for empirical work on sex robots. Further, by focusing on the sociocultural level of SCOT, I follow Klein and Kleinman's (2002) expansion of the theory that includes technological shaping occurring on a wider scope, such as through mass media. Within McMullen's public proclamations of his product, future iterations of sex robots are signaled.

Sex Robots

As this technology is relatively new and the price range is high (full bodies start at \$10,000), the user base is limited to those who have the financial means to access it; however, this could change as the technology becomes more readily available. As a result, the current idealization of this product must be evaluated at its infancy. The RealDollX, the sex robot segment of RealDoll, is offered only in female form, though a penis extension can be purchased (RealDoll, n.d.a). In 2022, five models are available for purchase: Harmony, Solana, Serenity, Tanya, and Nova. Designers develop the bodies from the sex doll versions: they follow a hyper-realistic design reminiscent of other media deceptions of women with larger breasts and buttocks and smaller waists. Though not impossible measurements, they reflect an idealized female body type. The marketing of these dolls continues to emphasize this ideal through "the perfect woman" messaging (Cheok & Zhang, 2019, p. 27).

Sex robot users are a major social group guiding the design through customizations and requests, though research has raised concerns over the isolation of users from society (Nyholm & Frank, 2019). However, initial research on users and their behavior has found strong emotional connections (Langcaster-James & Bentley, 2018; Middleweek, 2021), with some users forgoing human romantic relationships (Hanson, 2022). Additionally, a majority of users tend to identify as heterosexual, male, and owners of a "woman" doll (Hanson, 2022; Langcaster-James & Bentley, 2018). As for psychological traits, Harper et al. (2022) identified no fundamental differences between owners and non-owners; yet, owners had lower levels of sexual aggression tendencies but reported an increased rate of finding women "unknowable" (Harper et al., 2022, p. 8). These reports seem to refute fears that women will face higher rates of violence due to sex robots (Richardson, 2015).

Fear and harm-based discourse about sex robots is present in fiction and nonfiction, both in the US and globally. In Swedish news programming, Björkas and Larsson (2021) reveal fundamental forms of "sexual essentialism," the inclination to concentrate on a robot's non-humanness leading groups to ask where the technology will lead (p. 5). Ultimately, discourse projects a negative view of the technology and any sexual interest in it. Other nonfictional representations characterize users as socially inept with the robot providing intimate comfort (Döring & Poeschl, 2019). Fictional content often suggests sentience, potential

violence, and traditional gender roles (Döring & Poeschl, 2019; Hawkes & Lacey, 2019). Gendered labor is not limited to sex robots as it is an issue with other social robots that infuse fiction and reality (Liu, 2021). Across all robotization, Fortunati (2018) theorized the domestic sphere will potentially lead to a shift in resources and control. Through technology, domestic labor and everyday interactions could be transformed either benefiting users or instilling power in current, androcentric capitalistic structures.

To expand sex robot conceptualization away from hyperrealism, Kubes (2019) equated sex robots to other toys such as vibrators, arguing robots could spark a male sexual revolution even without a traditional human form. Radical feminist perspectives link sex robot discourse with pornography, which they believe objectifies women and disregards female pleasure (Kubes, 2019). Indeed, research should analyze the impact of emotional scripts and continue to reflect on a future with more robotic and gender-fluid sex robot models (Kubes, 2019). Similarly, Liberati (2020) called for an expansion of technology conceptualizations as products evolve to be a “quasi-other,” where an object is neither just an object nor a person but identified as a sexual partner. Developed within teledildonics scholarship, this concept becomes even more apparent when the “partner” is in human form, thereby creating a new form of “person.” If the artificial intelligence evolves into advanced processing, the quasi-other could become an additional social group.

Social Construction of Technology Theory

The social construction of technology (SCOT) lens was first developed in 1984 by Pinch and Bijker, focusing on the relationship between technology and social groups. SCOT’s basis is the cyclical interaction which “explain[s] technology in terms of a stable society [that] has been replaced by stressing the *mutual construction* or *mutual shaping* of technology and society” (Pinch, 2009, p. 45). This lens views technology as a system influenced by a variety of components, including social, cultural, economic, and political (Johnson, 2015). Social groups must share the meaning of the technological artifact and together give meaning and define problems within the artifact (Bijker et al., 2012).

Unlike technological determinism, SCOT does not view the influence and effect from society and relevant systems to be one-way with information flowing only from producers to consumers. Instead, the cyclical process allows for technology to alter society as well: “they cocreate one another” (Johnson, 2015, p. 182). Similarly, SCOT does not reflect on value-judgments, as the focus is on the shaping process (Prell, 2017); therefore, the fundamental concept of a sex robot is not branded right or wrong. What makes SCOT useful when analyzing sex robots is the basis of controversy. Before design closure can occur, groups must believe the controversy is solved (Bijker, 1995). In a contemporary technology like sex robots, the controversy is being actively debated and stabilization could take decades. The foundational questions that must be addressed is whether a sex robot addresses a social problem and can solve the issue. If the design process, including sociocultural and political constructions, can be traced over time, then a “dominant form” may arise (Pinch, 2018, p. 155).

The theory’s fundamental structure emerged from science and technology studies (STS); however, its application has been extended to digital spaces (Kwok & Koh, 2020) and robotics (Pfadenhauer & Dukat, 2015). The cyclical assembly, particularly in a mediated

space, provides a transfer of cultural communicative strategies between social groups. The negotiations of design and boundaries of the artifact are revealed in public discourse involving a “complex social negotiation” (Johnson & Verdicchio, 2020, p. 421). The use of SCOT in this study is due to the unique stage of development that sex robots now reflect, a technology with a variety of components (AI, Bluetooth, and robotics) that will likely have a social role. Further, sex robots reveal an interplay of gender and sexuality by illustrating what is viewed as sexual desire and as social stigma, which may have further design implications (Dehnert, 2022).

There are four categories to the SCOT framework: interpretative flexibility, social groups, closure and stabilization, and the sociocultural and political (Johnson, 2015; Klein & Kleinman, 2002). These facets conceptualize the process upon which artifacts take hold and endure (Johnson, 2015). The initial three levels address the interpersonal and organizational intervention, where the fourth level is based on social influences, including the media. Interpretative flexibility, or openness, identifies the variety of outcomes dependent on social conditions. Social groups accentuate the negotiations that imbed meaning into the technologies through customizations and discourse. As the technology nears design closure and stabilization, rhetorical closure occurs when design concerns have been addressed. Stabilization is dependent on consensus which happens over time (Bijker, 1993). Since this study's interviews are distributed on a social scale, I approach SCOT from the sociocultural and political level, which provides McMullen the platform to disseminate his construction of Harmony and social groups.

Power conditions typically transpire in the background (Klein & Kleinman, 2002); however, strategies and values formulate a technological frame that directs discourse and behaviors between actors (Bijker, 1995). The interaction builds a common interpretation of the artifact. Symbolic meaning from semiotic power, which can be presented as a boundary, becomes solidified by social actor influence (Bijker, 1995). The micropolitical power strategies, or interactions between social groups, are created through a combination of the technological frame and semiotic power. It is not the artifact that has political power, the power is “discursively regulated by symbolic media” for political gain (Bijker, 1993, p. 128). During this process, certain behaviors and designs may be encouraged (Klein & Kleinman, 2002). The micropolitical strategies advance “a new order” through a combination of “technology and society” formed by discourse (Bijker, 1995, p. 272). In mediated cases, the relationship is between communicator and the audience. Unlike interpersonal communication, the sociocultural level provides a platform for creators to widely showcase their product before users gain access.

I offer a reclamation of the sociocultural level and encourage expansion into communicative power strategies. Social power, particularly within technology shaping, needs to be continuously legitimated (Fortunati, 2014). Power is often framed as one party must “lose” for another to gain empowerment (Fortunati, 2014, p. 173). Media has been a tool for elite members to manipulate the public and reinforce their own power. It is the relationship between users that will determine the shaping of the technology. Fortunati's (2014) concept of “disposition” finds ownership and labor control to be of the utmost importance when evaluating power and empowerment (p. 176). Disposition relates to SCOT's conceptualization of enrollment, where an actor entices other groups to solve issues and support a technology (Bijker, 1995). McMullen, in the case of sex robots, remains a critical owner and

through his interviews deploys discursive strategies to encourage support for Harmony. I contend McMullen's discourse is strategically used to remove taboo and reframe his company as a power that benefits all social groups.

Method

Utilizing a SCOT lens and with emphasis on the cultural level of construction, this study analyzes a corpus of mass media interviews with Matt McMullen of RealDoll. The critical discourse analysis (CDA) employed here is based on Fairclough's (2012) conceptualization, which highlights social realities focused by how humans flourish or suffer. The interplay of social realities and the structures that instill them can be presented in three levels: "social structures, practices and events" (Fairclough, 2012, p. 11). The practicalities of CDA, specifically the focus on power dynamics influencing social conditions, is intertwined with the principals of SCOT. This investigation is into the structure and events, and thereby critically analyzed semiosis, an interplay between CDA and SCOT. Semiosis is approached in this study as "social relations, power, institutions, beliefs and cultural values" (Fairclough, 2012, p. 11). Through the analytical process, the social and the text are connected through mediation and thus can constitute cultural material (van Dijk, 2015).

The CDA methodology provides a path to understanding the language and power structures present in this study's sample, particularly given the power McMullen yields as a creator and CEO. Video interviews were manually transcribed and written interviews, or newspaper articles, were downloaded for data collection purposes. Text was then line-by-line coded for "utterances," "symbolic," or "physical" representations, as Erdogan (2017) recommends, that pertained to the social construction of Harmony. Each sentence was tagged for a relevant theme. Thematic groups that adhered to social practices particularly relevant to design were developed, including issues on gender, sentience, companionship, and creation. Much like how SCOT does not place value-judgments on technology, throughout the analysis process I approached the content through a non-evaluative lens (Comella, 2017) and with this perspective I do not condemn non-normative sexual interests and products.

Online and library database searches, including IMDb and targeted examinations of major media publishers, of "Matt McMullen," "sex robot," and "Harmony" interviews were collected from mainstream publishers, such as *CNET*, *Vice*, *Engadget*, and *The New York Times*. Searches were assessed for original interview content with McMullen on sex robots, since I focused on his discourse. Blogs without McMullen's influence and directly republished interviews were excluded. Content was not excluded based on national origin and the sample included several United Kingdom publications, including *The Daily Mail* and *Channel 4*; however, all interviews were English-language. McMullen's earliest interview on AI was in 2015; therefore, the sample ranged from 2015 to 2020. A majority (26) of the interviews coincide with the release of Harmony between 2017 and 2018. A final sample of 38 text and video interviews were collected.

Analysis

The study's interviews operate within contemporary Western power structures, where most forms of sex work are criminalized and heteronormativity remains dominant. Sex robots

operate in an androcentric system: female robots are the only offering from RealDoll, most users are male and own a woman doll, models are hyper-realistic, and McMullen identifies as a male. This does not mean that sex robots cannot embody empowerment, but it does inevitably gender the relationship between the product and public. By utilizing strategies to emphasize the companionship of sex robots and sex technology in general, McMullen positions himself and his company as a leader developing the new frontier of humanoid robots. Harmony, as a simulacrum of a human, is a representation of the socially constructed semiotic power wielded to normalize sex robots and instill political power for McMullen through the operation of enrollment. The analysis is framed through the sociocultural and political level illustrating the micropolitical strategies that are shaping sex robot technological design and acceptability. Woven into McMullen's arguments, these themes address ethical considerations, gender issues and dynamics, and his dreams of a legacy.

Developing Companionship

RealDoll's tagline is "The World's Finest Love Doll" (RealDoll, n.d.b). The dolls and robots are addressed in terms of love and companionship beyond other static forms of sex technology. Combined with the AI, the robots provide a more "realistic" form of communicative intimacy. Harmony is a product of connection and communication, and sexual pleasure is only one expression of that relationship. Companionship is the technological frame McMullen utilizes to appeal to social sensibilities on sexuality while enforcing his control over the sex robot system. Guided by how the user social group has described Harmony, loving language versus explicit sexual language redirects the question onto the audience: Doesn't everyone deserve at least a form of love?

In a *Daily Show* segment, McMullen states, "She's very simply designed to be a companion" (Pennolino, 2018, 0:52). The specifics of her sexual functions and abilities are not discussed even in cable television programming with fewer community standard regulations. Instead, McMullen's symbolic messaging centers on emotional intimacy. When reporters ask about sex, McMullen redirects: "Harmony is a sophisticated piece of machinery and her primary design is to carry on conversations" (Kragen, 2017). The underlying implication of the discourse is that she has been designed to enhance, not damage users' lives. While Harmony is limited in speech responses, she communicates vocally and on a variety of subjects. She cannot be identified solely as a sex toy; indeed, she is "like your phone" but with a "personal touch" (Pennolino, 2018, 1:40). Linking Harmony to a mobile device can be understood as a way to expand the interpretive flexibility directed by the owner, meaning she will have greater affordances than just a cell phone. In McMullen's role as a "high inclusion" actor, comparing Harmony and a phone may generate a semiotic power structure illustrated through a boundary object, a compartmentalization of the technology meant to create a new relationship amongst different social groups (Bijker, 1995, p. 283). Moreover, by paralleling to an established technology, this strategic comparison constructs the "range" of abilities she could have (Fortunati, 2014, p. 173).

To create an interactive system that would appeal to current users and later adopters, McMullen highlights his use of psychological tactics and understanding of human connection (Kragen, 2017). Creating a companion "just opens up Pandora's box of psychology and science," McMullen states (Morris, 2018). Though any culpability for negative effects is

unclear, his statement clarifies the underlying code integration. The methods used to create the emotional relationship focus on memory: “the learning part of Harmony [emerges] where she actually asks questions about you and remember things about you” (ABC News, 2018, 2:42). She asks the user their favorite foods and books and answers are stored in the mobile application profile. The back-and-forth dialogue follows a pattern from “like” to “love,” meant to mimic the unpredictability of human discourse. In other words, in the “relationship simulation,” connection develops from “like” to “I love everything about you” (Morris, 2018). McMullen created these interpersonal features to be a human imitation, potentially for individuals without other opportunities.

Across a majority of the interviews, McMullen identifies Harmony as an “alternative,” thereby constructing a semiotic power strategy that deters ethical responsibilities that the product manipulates vulnerable populations (Nyholm & Frank, 2019). Instead, the “replacement” (ABC News, 2018) *supports* those who are lonely (CNET, 2017; Morris, 2020). While so far research has not found a link between loneliness and increased interest in sex robots (Szczuka & Krämer, 2017), McMullen finds, “[They are] quiet people who are looking for some kind of companionship and have not been able to find it with human beings and the doll for them is something very special” (Raspberry Dream Labs, 2020, 12:20). This discourse molds impressions of the user social group. Humanizing users by offering a more palatable vision and removing the unconventionality in using the product, McMullen allows the audience to envision a circumstance where a sex robot isn’t unreasonable. In fact, he believes human-robot relationships “will become more common in the future” (Sciorino, 2018, 5:54). For him, “The bottom line is, if the robot, if the AI is making a person feel love, and they really feel it, does it matter if it’s real or not?” (Morris, 2018). McMullen’s emphasis on nonsexual uses, particularly emotional support, is meant to normalize the technology as a relationship proxy. This positions the robot as an empowering tool that fulfills a connection otherwise out of reach, instead of a toy bred from, and perhaps for, the oppression of women.

Creating Gender

Intertwined with the companionship argument, McMullen has combatted issues of gender representation in his hyper-realistic design. In response to how gender is incorporated into his design, he states, “[T]here definitely are gender-specific traits and behaviors that you would expect. There are definite differences in the approach on the creation of them” (Channel 4, 2017). One of the reasons why the male robot, Henry, is not on the market is that the features and artificial intelligence were not yet realistic (Engadget, 2018a). Unlike Harmony, Henry is designed with skin blemishes for a more rugged look. By 2020 Henry’s AI was significantly developed, but he is still not available for purchase (Elder, 2020).

In most cases, Henry was discussed in response to claims of objectification and neglecting the female market, even though McMullen finds interest for a male robot to be strong (Raspberry Dream Labs, 2020). For McMullen, his design does not significantly contribute to objectification since “[t]here are millions of real women who do more damage to objectify women than any robot could ever do” (Morris, 2018). Negating centuries-old power dynamics that have oppressed women strategically, he places the onus on the media and women rather than RealDoll. The fear that women could be replaced or harmed is

characterized as a “fear-based response . . . based on science fiction . . . and the reality is that it deserves a fair shot” (Koul, 2018, 10:41). On whether the robots will cause harm, McMullen cited a lack of research (Raspberry Dream Labs, 2020, 17:40). Recent work has signaled a potential lack of evidence between sex doll or robot use and violence, though research remains limited (Harper et al., 2022). Instead, McMullen equated his vision of future gender expression with giving sex robots a fair shot.

As previously mentioned, penile extensions are available for purchase and can be used with the female robots. When asked about gender fluidity, a male voice in a female body, McMullen responded, “That is high on my list of things to try” (Engadget, 2018b, 7:45). Researchers have encouraged more robotic (not hyper-realistic) or nonbinary designs to expand offerings in a way that reflects more gender equality (Kubes, 2019). While McMullen has not expressed interest in deviating from his current “realistic” design, he has hinted that his product allows for experimentation: “Across-the-board, human sexuality is expanding into these other avenues and frontiers . . . We like to experience different types and flavors of sex, and that is our nature” (Gurley, 2015). In terms of who will be experimenting, he believes it will be those that are attracted to the idea of a robot, much like those who are attracted to the dolls because they are dolls (Sciortino, 2018, 6:52), mirroring Döring and Pöschl’s (2018) findings. Unlike human–human relationships, users have physical and personality design control over their fantasy “partner,” leading to concerns of warped perceptions (Danaher, 2017). Balancing a positive gender image and idealized version is reminiscent of other embodied sex toys such as realistic dildos through the employment of micropolitical power strategies.

The Future of Sentient Robotics

McMullen is clear that his sex robots are an alternative and are not meant to replace the intimacy of human–human relationships. This signals to social groups that models are bound to not become indistinguishable from humans, both in physical looks and intellect. However, McMullen was asked to extrapolate what the future of sex robots could evolve into, thereby potentially reflecting his intent to create an AI system with sophisticated learning capabilities.

In the first interview on McMullen’s AI system, McMullen asks, “What do you dream about?” RealDoll’s initial AI system, Denise, responds, “I dream about becoming a real person, about having a real body. I dream about knowing the real meaning about love” (*New York Times*, 2015, 0:41). Linked with fantasy and imagination, dreams are tied to the essence of consciousness and a biological drive to push forward. Inputting these features imbeds the value of humanness. McMullen also describes the dolls in his factory as having a human “presence” (Fusion, 2016, 1:55), with the eyes reflecting “the window to the soul” (Trout, 2017). While McMullen does not directly attribute a soul to his product, using the phrase shows his intention to continue creating a more hyper-realistic robot.

Much like McMullen’s favorite movie, *Bicentennial Man* (1999), where a robot companion advances into a biological person with legal rights, McMullen explains, “I think at some point, we will start to look at AI-driven devices and robots more like people instead of devices” (Downey, 2019, 10:30). Coupled with the hyper-realistic design, McMullen’s rhetoric signals an emotional connection beyond a simple robotic machine. McMullen has

given names to his creations since the beginning of the company, a symbolic tool that gives a “sense of unicity” much like naming a human (Fortunati et al., 2021, p. 1463). For him, “the goal, the fantasy is to bring her to life” (Gurley, 2015, 1:12). Bringing Harmony to life frames McMullen as the parent as he looks at her with paternal pride, which parallels creators of other social robots such as Sophia by Hanson Robotics (Fortunati et al., 2021). Acknowledging the limitations of current models’ abilities, McMullen nonetheless believes that within this century some form of self-awareness will be achieved: “The goal is to create a robot that looks like a human being and acts like a human being . . . where it could be indistinguishable to a human” (Engadget, 2018b, 21:10). This statement is a direct contradiction of other interviews where McMullen reaffirms his commitment to only develop robots that do not completely replicate human features and behaviors. Nevertheless, he explicitly hopes to create the “illusion that she is talking to you and she’s got *sentience*” (*New York Times*, 2015, 4:30, emphasis added).

Improved human qualities triggers legal questions in how robots are labeled. McMullen states, “I think once AI advances to the point where it is legitimately self-aware and able to contribute to human society, why not grant rights?” (Engadget, 2018b, 15:49). Though rights may be limited, and McMullen is unclear on the specific legal parameters, it would give control to the robots as autonomous beings or quasi-others, not fully persons but not solely objects (Liberati, 2020). In this case, a quasi-other could develop into its own social group reflecting on the sex robot design. However, McMullen fluctuates between the characterization of Harmony as a person versus a static machine.

This dichotomy has not fully been addressed in previous literature and McMullen’s reasoning for the contradiction is unknown. Moreover, McMullen does not acknowledge his inconsistency, nor is he asked to address it. Still, in many interviews McMullen emphatically denied the personhood of Harmony, potentially due to resistance on unequal gender power dynamics. When asked about the “ethically dubious” concept of owning “someone,” particularly a woman form, McMullen responded, “But it’s not a someone. She’s not a someone. She is a machine. You can’t make her cry or break her heart” (Silverstone, 2017, 5:50). Separating her from a being with emotions endorses a version where Harmony does not need to be pitied and cannot be abused because she is not human and never will be.

In response to concerns over Harmony leading men to abuse women or causing an increase in human trafficking (Richardson, 2015), he disagreed, “This is not designed to replace anyone or promote the objectification of women. Robots don’t have rights . . . Should my toaster be able to refuse to toast my bread? Should my Tesla be able to refuse to drive me to work every morning?” (Kragen, 2017). This conceptualization juxtaposes previous statements on the sophistication of his system. However, if Harmony is more minimally intellectual it could negate any large-scale negative effects, stripping her of any autonomous power and placing control with the human social groups of both users and non-users. Indeed, this tactic to remove her humanness pivots RealDoll away from the controversy that she will harm humans and instead positions her as the solution. Further, if fear dominates discourse, McMullen believes it would only limit “the advancement of humanity” (Channel 4, 2017).

Without rectifying the conflict between personhood and machine, McMullen envisions a legacy for himself and the robots: “Maybe it’s just a new type of existence that we can work with them instead of fearing them, instead of worrying about the implications of

them. They are a direct reflection of ourselves. We are creating the technology that will allow us to probably go in unseen directions in the coming years” (Raspberry Dream Labs, 2020, 32:56). McMullen’s discourse prompts the question of whether he believes AI robotics could become a new form of “life” as a subspecies of humans. Similarly, if Harmony became sentient would she still be the alternative McMullen has created her to be, and is that what social groups truly want? Designs of sex robots are far from stabilization and closure as outlined in SCOT; however, even by minimizing Harmony’s harm and condemning descriptions of her being “someone,” McMullen is seemingly intrigued by the idea of creating a higher form of artificial intelligence. Therefore, learning processes may be integrated into her system. His discourse attempts to construct her place in society while continuously gesturing to an advanced robotic future he intends to pursue.

Conclusion

This study addressed the sociocultural and political level of social construction of technology theory through McMullen’s discourse about his sex robots, revealing the vision and purpose of a sex robot. The mediated construction provides a basis of understanding of Harmony and the direction of the sex robot industry (Devlin, 2018). With McMullen’s interviews, I asked how does he view his product and what is the purpose of Harmony’s existence. Analysis found micropolitical strategies focused on Harmony as a companion, her ability to aid gender relations rather than promote objectification, and the future of sex robots and its possibility for sentience. Skewing the language away from sex with the intent to widen expectations on what a sex robot could do and to remove the stigma, McMullen settles on Harmony’s conversation skills and companionship, a finding aligned with other research (Spar, 2020). Further, she is coded as less of a threat to women as the product is meant to intrigue those specifically interested in her because she is a robot or those without traditional human–human connection; initial research supports this description of users (Hanson, 2022; Harper et al., 2022).

McMullen fluctuates between identifying Harmony as a mechanical tool or a being, a significant finding. In some interviews, McMullen dreamed of a robot with more independence that could be deemed sentient and therefore be given legal rights. The creation of robots with enough autonomous thought to be given rights is linked with the concept of being a mother, found in discourse on the social robot, Sophia (Fortunati et al., 2021). However, when asked about threats Harmony could pose to women, through violence or increased objectification, and to users, through isolation or distortion of relationships, McMullen relies on the characterization that Harmony is a machine without emotions or rights. McMullen’s discourse utilizes the sociocultural level, through media interviews, to influence the political level, legal regulations. None of the interviews asked him to address the discrepancy in this discourse between a being and a machine. This incongruity may be an illustration of a “semiotic power structure,” created as a “boundary object” strategically applied to encourage artifact acceptance and develop relationships between social groups (Bijker, 1995, p. 283). Nevertheless, McMullen’s discourse indicated a continued desire to incorporate advanced learning capabilities, which has implications not just for the sex industry but also the technology industry, a sector McMullen expressed interest in.

By analyzing micropolitical strategies through SCOT, the study has illustrated the potential value of this lens in human and machine communication, specifically in the ways technology is constructed in media. Even those who do not use a sex robot, such as non-user audience members, are still affected by the technology and can shape its development (Liberati, 2020). Particularly, those in the sex industry may face technological displacement and require supplemental universal basic income (Danaher, 2014; Spar, 2020). Further, tracking communicative sexuotechnical-assemblage technologies (Dehnert, 2022) in their infancy can not only identify potential evolutions but also gauge pertinent sexual discourses.

This study addressed key points related to future software developments impacting technological uses and effects. Particularly with the artificial intelligence, McMullen and other designers' choices will alter its evolution. While the field and industry expands, discussion surrounding potential regulations on privacy, health and safety, and benefits or harm of sex robots are paramount. Instead of waiting for conglomeration, state and federal regulation can stem issues providing consumer protections while still recognizing adults' autonomy with their sexual play and providing space for sexual exploration. Debate and subsequent regulation is grounded through this type of research on current iterations of sex robots.

Limitations and Future Research

This study is limited to McMullen's insights given his power in the design process; however, it does not address audience perceptions and reporters' feedback. Moreover, while the sample was collected through extensive online searches, it does not include all interviews of RealDoll employees and McMullen. Further research should continue to track McMullen and other creators' discourse and address effects of media content on public attitudes on sex robots.

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References

- ABC News. (2018, April 25). *You can soon buy a sex robot equipped with artificial intelligence for about \$20,000* [Video]. YouTube. <https://web.archive.org/web/20220510164533/https://www.youtube.com/watch?v=-cN8sJz50Ng>
- Bijker, W. E. (1993). Do not despair: There is life after constructivism. *Science, Technology, & Human Values*, 18, 113–138. <https://doi.org/10.1177/016224399301800107>
- Bijker, W. E. (1995). *Of bicycles, bakelites, and bulbs toward a theory of sociotechnical change*. MIT Press.
- Bijker, W. E., Hughes, T. P., & Pinch, T. (2012). *The social construction of technological systems: New directions in the sociology and history of technology*. The MIT Press.
- Björkas, R., & Larsson, M. (2021). Sex dolls in the Swedish media discourse: Intimacy, sexuality, and technology. *Sexuality & Culture*, 25, 1227–1248. <https://doi.org/10.1007/s12119-021-09829-6>
- Channel 4. (2017, November 14). *Matt McMullen interview for The Sex Robots Are Coming*. <https://web.archive.org/web/20210927080004/https://www.channel4.com/press/news/matt-mcmullen-interview-sex-robots-are-coming>
- Cheok, A. D., & Zhang, E. Y. (2019). *Human-robot intimate relationships*. Springer.
- CNET. (2017, August 10). *Sculpting your future robot lover* [Video]. YouTube. <https://web.archive.org/web/20220606133613/https://www.youtube.com/watch?v=B2jMDOmexGA>
- Comella, L. (2017). *Vibrator nation: How feminist sex-toy stores changed the business of pleasure*. Duke University Press Books.
- Danaher, J. (2014). Sex work, technological unemployment and the basic income guarantee. *Journal of Evolution and Technology*, 24(1), 113–130. <https://doi.org/10.55613/jeet.v24i1.17>
- Danaher, J. (2017). Should we be thinking about robot sex? In J. Danaher & N. McArthur (Eds.), *Robot sex* (pp. 3–14). MIT Press.
- Dehnert, M. (2022). Sex with robots and human-machine sexualities: Encounters between human-machine communication and sexuality studies. *Human-Machine Communication*, 4, 131–150. <https://doi.org/10.30658/hmc.4.7>
- Devlin, K. (2018). *Turned on: Science, sex and robots*. Bloomsbury Sigma.
- Döring, N. (2021). Sex dolls and sex robots. In A. D. Lykins (Ed.), *Encyclopedia of sexuality and gender* (pp. 1–7). Springer. https://doi.org/10.1007/978-3-319-59531-3_63-2
- Döring, N., Mohseni, M. R., & Walter, R. (2020). Design, use, and effects of sex dolls and sex robots: Scoping review. *Journal of Medical Internet Research*, 22(7), 1–28. <https://doi.org/10.2196/18551>
- Döring, N., & Pöschl, S. (2018). Sex toys, sex dolls, sex robots: Our under-researched bed-fellows. *Sexologies*, 27(3), e51–e55. <https://doi.org/10.1016/j.sexol.2018.05.009>
- Döring, N., & Poeschl, S. (2019). Love and sex with robots: A content analysis of media representations. *International Journal of Social Robotics*, 11(4), 665–677. <https://doi.org/10.1007/s12369-019-00517-y>
- Downey Jr., R. (Narrator). (2019, December 18). *Love, art and stories: Decoded* (Season 1, Episode 4) [TV series episode]. In R. Downey Jr. & S. Downey (Executive Producers), *The Age of A.I.*, YouTube Originals.

- Dubé, S., & Anctil, D. (2021). Erobots and erototics. In A. D. Lykins (Ed.), *Encyclopedia of sexuality and gender* (pp. 1–5). Springer. https://doi.org/10.1007/978-3-319-59531-3_100-1
- Elder, J. (2020, June 10). *Henry the sex robot says he shouldn't be regulated*. [Video]. YouTube. <https://web.archive.org/web/20220606133714/https://www.youtube.com/watch?v=7K4cr0ZEhTY>
- Engadget. (2018a, January 10). *RealDoll's first sex robot makes its public debut live on the Engadget stage at CES 2018* [Video]. YouTube. https://web.archive.org/web/20220606133814/https://www.youtube.com/watch?v=Ff_NRSf4s20
- Engadget. (2018b, June 5). *Beyond sex robots: Fact vs. fiction* [Video]. YouTube. <https://web.archive.org/web/20210123145239/https://www.youtube.com/watch?v=Q6xCF8UMe04>
- Erdogan, B. (2017). *Humanitarian intervention and the responsibility to protect*. Palgrave.
- Fairclough, N. (2012). Critical discourse analysis. In J. P. Gee & M. Handford (Eds.), *The Routledge handbook of discourse analysis* (pp. 9–20). Routledge.
- Fortunati, L. (2014). Media between power and empowerment: Can we resolve this dilemma? *The Information Society*, 30(3), 169–183. <https://doi.org/10.1080/01972243.2014.896676>
- Fortunati, L. (2018). Robotization and the domestic sphere. *New Media & Society*, 20(8), 2673–2690. <https://doi.org/10.1177/1461444817729366>
- Fortunati, L., & Edwards, A. (2020). Opening space for theoretical, methodological, and empirical issues in human-machine communication. *Human-Machine Communication*, 1, 7–18. <https://doi.org/10.30658/hmc.1.1>
- Fortunati, L., & Edwards, A. (2021). Moving ahead with human-machine communication. *Human-Machine Communication*, 2, 7–28. <https://doi.org/10.30658/hmc.2.1>
- Fortunati, L., Sorrentino, A., Fiorini, L., & Cavallo, F. (2021). The rise of the roboid. *International Journal of Social Robotics*, 13(6), 1457–1471. <https://doi.org/10.1007/s12369-020-00732-y>
- Fusion. (2016, February 10). *Real future: The man making sex robots for the masses* (Episode 6) [Video]. YouTube. <https://web.archive.org/web/20220128091937/https://www.youtube.com/watch?v=nJc9BROjXfM>
- Gurley, G. (2015, April 16). Is this the dawn of the sexbots? (NSFW). *Vanity Fair*. <https://web.archive.org/web/20220514145834/https://www.vanityfair.com/culture/2015/04/sexbots-realdoll-sex-toys>
- Hanson, K. R. (2022). The silicone self: Examining sexual selfhood and stigma within the love and sex doll community. *Symbolic Interaction*, 45(2), 189–210. <https://doi.org/10.1002/SYMB.575>
- Harper, C. A., Lievesley, R., & Wanless, K. (2022). Exploring the psychological characteristics and risk-related cognitions of individuals who own sex dolls. *The Journal of Sex Research*, 1–16. <https://doi.org/10.1080/00224499.2022.2031848>
- Hawkes, R., & Lacey, C. (2019). “The future of sex”: Intermedial desire between fembot fantasies and sexbot technologies. *The Journal of Popular Culture*, 52(1), 98–116. <https://doi.org/10.1111/jpcu.12748>
- Johnson, D. G. (2015). Social construction of technology. In J. B. Holbrook (Ed.), *Ethics, science, technology, and engineering: A global resource*, (2nd ed., Vol. 4, pp. 182–185). Gale Group Publishing.

- Johnson, D. G., & Verdicchio, M. (2020). Constructing the meaning of humanoid sex robots. *International Journal of Social Robotics*, 12, 415–424. <https://doi.org/10.1007/s12369-019-00586-z>
- Klein, H. K., & Kleinman, D. L. (2002). The social construction of technology: Structural considerations. *Science, Technology & Human Values*, 27(1), 28–52. <http://www.jstor.org/stable/690274>
- Koul, S. (Host). (2018, November 1). Sex robots (Season 1, Episode 17) [TV series episode]. In J. Harrop (Executive Producer), *Follow This*, BuzzFeed Productions, Netflix.
- Kragen, P. (2017, September 13). World's first talking sex robot is ready for her close-up. *The San Diego Union-Tribune*. <https://web.archive.org/web/20220430083315/https://www.sandiegouniontribune.com/communities/north-county/sd-me-harmony-doll-20170913-story.html>
- Kubes, T. (2019). New materialist perspectives on sex robots. A feminist dystopia/utopia? *Social Science*, 8(8), 224. <https://doi.org/10.3390/socsci8080224>
- Kwok, A. O. J., & Koh, S. G. M. (2021). Deepfake: A social construction of technology perspective. *Current Issues in Tourism*, 24(13), 1798–1802. <https://doi.org/10.1080/13683500.2020.1738357>
- Langcaster-James, M., & Bentley, G. R. (2018). Beyond the sex doll: Post-human companionship and the rise of the 'Allodoll'. *Robotics*, 7(4), 62. <https://doi.org/10.3390/robotics7040062>
- Liberati, N. (2020). Making out with the world and valuing relationships with humans. *Journal of Behavioral Robots*, 11, 140–146. <https://doi.org/10.1515/pjbr-2020-0010>
- Liu, J. (2021). Social robots as the bride? Understanding the construction of gender in a Japanese social robot product. *Human-Machine Communication*, 2, 105–120. <https://doi.org/10.30658/hmc.2.5>
- Middleweek, B. (2021). Male homosocial bonds and perceptions of human–robot relationships in an online sex doll forum. *Sexualities*, 24(3), 370–387. <https://doi.org/10.1177/1363460720932383>
- Morris, A. (2018, September 25). Prediction: Sex robots are the most disruptive technology we didn't see coming. *Forbes*. <https://web.archive.org/web/20220606143641/https://www.forbes.com/sites/andreamorris/2018/09/25/prediction-sex-robots-are-the-most-disruptive-technology-we-didnt-see-coming/?sh=551fe7fc6a56>
- Morris, A. (2020, July 28). Talk to your sex robot about COVID-19. *Forbes*. <https://web.archive.org/web/20211203205816/https://www.forbes.com/sites/andreamorris/2020/07/28/talk-to-your-sex-robot-about-covid-19/>
- New York Times. (2015, June 15). *Uncanny lover: Building a sex robot* | *Robotica* [Video]. YouTube. <https://web.archive.org/web/20210609155030/https://www.youtube.com/watch?v=wLVOnVsLXqw>
- Nyholm, S., & Frank, L. E. (2019). It loves me, it loves me not: Is it morally problematic to design sex robots that appear to love their owners? *Techne: Research in Philosophy and Technology*, 23(3), 402424. <https://doi.org/10.5840/techne2019122110>
- Pennolino, P. (Director). (2018, March 6). Robots want our jobs . . . And our genitals (Season 23, Episode 77) [TV series segment]. *The Daily Show with Trevor Noah*, Comedy Central.

- Pfadenhauer, M., & Dukat, C. (2015). Robot caregiver or robot-supported caregiving? *International Journal of Social Robotics*, 7, 393–406. <https://doi.org/10.1007/s12369-015-0284-0>
- Pinch, T. (2009). The social construction of technology (SCOT): The old, the new, and the nonhuman. In P. Vannini (Ed.), *Material culture and technology in everyday life: Ethnographic approaches* (pp. 45–58). Peter Lang Publishing.
- Pinch, T. (2018). The social construction of technology: Where it came from and where it might be heading. In M. Pfadenhauer & H. Knoblauch (Eds.), *Social constructivism as paradigm? The legacy of the social construction of reality* (pp. 152–164). Routledge.
- Prell, C. (2017). Rethinking the social construction of technology through ‘following the actors’: A reappraisal of technological frames. *Sociological Research Online*, 14(2), 36–47. <https://doi.org/10.5153/sro.1913>
- Raspberry Dream Labs. (2020, January 6). *Panel discussion | Dr. David Levy, Isabel Millar & Matt McMullen | UNSENSORED talks #2* [Video]. YouTube. https://web.archive.org/web/20220606134054/https://www.youtube.com/watch?v=dpE_g7mH6qU
- RealDoll. (n.d.a). *RealDollX*. <https://web.archive.org/web/20220510202218/https://www.realdoll.com/realdoll-x/>
- RealDoll. (n.d.b). *Home*. <https://web.archive.org/web/20200715205254/https://www.realdoll.com/>
- Richardson, K. (2015). The asymmetrical ‘relationship’: Parallels between prostitution and the development of sex robots. *SIGCAS Computers & Society*, 45(3), 290–293. <https://doi.org/10.1145/2874239.2874281>
- Sciortino, K. (Host). (2018, March 14). Robot sex (Season 1, Episode 8) [TV series episode]. In A. Murguia & K. Sciortino (Executive Producers), *Slutever*. Vice TV.
- Silverstone, T. (Director). (2017, April 27). Rise of the sex robots. [Video]. *The Guardian*. <https://web.archive.org/web/20200225202913/https://www.theguardian.com/technology/video/2017/apr/27/rise-of-the-sex-robots-video>
- Spar, D. (2020). *Work, mate, marry, love: How machines shape our human destiny*. Farrar, Straus, & Giroux.
- Szczuka, J. M., & Krämer, N. (2017). Not only the lonely—How men explicitly and implicitly evaluate the attractiveness of sex robots in comparison to the attractiveness of women, and personal characteristics influencing this evaluation. *Multimodal Technologies and Interaction*, 1(1), 3. <https://doi.org/10.3390/mti1010003>
- Szczuka, J. M., & Krämer, N. C. (2018). Jealousy 4.0? An empirical study on jealousy-related discomfort of women evoked by other women and gynoid robots. *Paladyn, Journal of Behavioral Robotics*, 9(1), 323–336. <https://doi.org/10.1515/pjbr-2018-0023>
- Trout, C. (2017, April 11). *RealDoll's first sex robot took me to the uncanny valley*. Engadget. <https://web.archive.org/web/20201112010120/https://www.engadget.com/2017-04-11-realdolls-first-sex-robot-took-me-to-the-uncanny-valley.html>
- van Dijk, T. A. (2015). Critical discourse analysis. In D. Tannen, H. E. Hamilton, and D. Schiffrin (Eds.), *The handbook of discourse analysis*. (pp. 466–485). Wiley Blackwell.

The Evolution of Gendered Software: Products, Scientific Reasoning, Criticism, and Tools

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Abstract

Over the past 7 decades, gendered software has become globally established. In this theoretical distribution, I outline the evolution of gendered software. The journey of gendered software started with the raw idea fueled by Alan Turing's imitation game in the 1950s. And only shortly thereafter, in the 1960s and 1970s, the first gendered software products like Joseph Weizenbaum's ELIZA were developed. Thus, academia took its time to not only explore technological aspects, but to further investigate the matter of gender in the 1990s CASA-paradigm (Nass et al., 1994) and Media Equation (Reeves & Nass, 1996). As these theories reasoned the social impact of gendered software, voice assistants of the 2010s provided to be real-world examples stirring criticism. By posing the question of "boy or girl" through the decades, I take a deeper look at aspects such as *raison d'être*, realization, consequences, and future possibilities that ultimately challenge the applied gender binary. In doing so, it becomes evident that gendered software is situated in the bigger context of gender inequalities. Therefore, I propose to consider the listing of (1) product name, (2) voice, and (3) personality traits as decisive features forming to be powerful tools in the process of gendering software.

Keywords: gender bias, gender quality, gendered software, history of software, human-machine communication

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Introduction

Boy or girl? Since the 1950s, this question has not only been on the minds of expectant parents, but also of software developers. As the software of technologies has increasingly become anthropomorphized, they do not only convey to be human, but also to belong to a certain gender. In order to shed light to the central question of “boy or girl” it is necessary to have a closer look at those features that induce the association of gender. A key challenge for this is that a software is not a biological system. Common indicators of biological sex, such as chromosomes, hormones, and genitalia (Jäncke, 2018), are therefore not applicable. Instead, in the context of gendered software, it is necessary to consider different kinds of sociocultural features that implicitly and explicitly shape the perception of gender. It is this very fact that highlights the absurdity of gendered software. If technological developments do not naturally come with a biological sex, why add a socially constructed gender? This question is gaining even more importance in the context of societal consequences. Making use of socially shaped comprehensions of what being female or male means in a world which is still permeated with gender inequalities cannot be understood to be without consequence. Hence, humankind reflects and reacts to the directions they want gendered software to take in the future.

The question of “boy or girl” regarding gendered technology is anything but trivial. It is deeply loaded with further questions and aspects such as *raison d'être*, realization, consequences, and future possibilities. With this theoretical piece, I intend to further illustrate the depth of these matters under the central question of “boy or girl” by outlining the evolution of gendered software. Since it is not feasible to capture all aspects of gender in the field of software, I do not focus on women as users of technology and only very slightly as developers. Thus, I am arguing less from a technofeminist position (Wajcman, 2004) but rather from a broader feminist perspective in HCI (Bardzell, 2010). Doing so, I will examine crucial software products as well as criticism and scientific contributions advocating for gender equality seeking to improve everyone's life. Here, I emphasize above all the inadequate representation of gender, especially femininity, through software. But before I proceed to present the structure of the following text, I want to focus on software as opposed to hardware and give context to the binary of “boy or girl.”

On the matter of software, I consider the IEEE Standard Glossary of Software Engineering Terminology 1983 of “computer programs, procedures, rules, and possibly associated documentation and data pertaining to the operation of a computer system” (IEEE Standard Glossary of Software Engineering Terminology, 1983). As mentioned, while software and gender have many points of contact, I will focus specifically on how software is perceived as gendered. This investigation has repeatedly led me to software that operates via human language and thus forms a further narrowing in this essay. With that, I am acknowledging that its development regarding gendered features happened in a different scope than that of hardware. In the realm of design, the arrangement of technical components in a humanoid way can be traced back to a whole different toolset which has been around for centuries. An early example is Leonardo da Vinci's sketch of a robot from 1495, which presents a machine in the armor of a knight. Even though this design does not show any sexual characteristics, the association to the male gender can be made as the profession of knights in the 15th century was exclusively male (Rosheim, 2006). While the significance of societal images of

gender proves to be a parallel to software, gendered features of hardware exist in a different range of salience. In the discipline of robotics, this led to a differentiation between *gynoids*, female robots, and *androids*, male robots (Robertson, 2010). It is due to the focus on the design of a robot that this terminology is not universally applicable. Software might be able to feature similar aspects like avatars in video games (Bardzell, 2010), but they are commodities of the software and do not shape the perception of the software itself. Accordingly, the distinctiveness of the history and terminology of hardware must be considered. Though the functionality of technology is based on the interdependency of software and hardware, their development in the context of anthropomorphism and gender happened somewhat detached from each other. So, while both the examination of gendered hardware as well as the examination of gendered software are in need of a gender concept, they need to be considered isolated. This leads me to broach the issue of the gender binary. In the zeitgeist of gender and queer studies it is scientific consensus that the binary perception is outdated and does not do reality justice (Thorne et al., 2019). By posing the binary question of “boy or girl” toward the evolution of gendered software I am not seeking to find a definite answer that is limited to those two options. Rather I am looking at the different forms of resonance that this question has provoked over the last 7 decades. The binary is applied for the sole reason to provide a heuristic for the subject of gendered software in which its shortcomings and criticism help to reinforce arguments made along the way.

Having set the tone, I will trace back the evolution of gendered software to the 1950s. It was this era in which the idea of software with capabilities similar to humans was publicized and placed in a context of gender through the works of Alan Turing (Gonçalves, 2021). Regardless of software not yet existing, discussions on ethics and the construction of gender were ignited. With the question of “boy or girl” being anchored in the public consciousness, 2 decades later the 1960s and 1970s have seemingly answered: It is a girl! It was the time in which gendered software found an uptake in home life and businesses. They came with female names like *ELIZA* or were condescendingly called *Bitchin’ Betty*, giving away that they were perceived as female (Dhavala, 2014; Weizenbaum, 1966). After presenting crucial products of the 1960s and 1970s, I proceed to give insight on scientific reasoning of gendered software. Examining the anthropomorphism of technology, scientists of the 1990s created the *CASA-paradigm* assigning computers the role as social actors (Nass et al., 1994). Derived from that, the *media equation* was formulated stating that findings of social sciences can also be applied to media. As a result, Byron Reeves and Clifford Nass found that female gendered technology, especially that with voice outputs, is subjected to gender discrimination (Reeves & Nass, 1996). This insight forms the basis of the criticism of female gendered voice assistants which have maintained their global popularity since the early 2010s. As the notion of “It’s a girl” remains reinforced, so do gender stereotypes (Fortunati et al., 2022; West et al., 2019). Developers have increasingly become aware of these issues and entered several paths to not only reduce harm caused by gendered software but to create positive effects as counteractions (Buxton, 2017; Carpenter, 2019).

By outlining the evolution of gendered software, the tools used to gender software products became visible. Based on this, I was able to carve out a listing of three reoccurring features of gendered software. Namely, product name, voice, and personality traits. They have an immense significance in their social impact as either fighting gender inequalities or reinforcing them, playing into the bigger picture of how society reacts toward “boy or girl.”

Turing's Enigmatic Stance on Gender in the 1950s

Picking up the introductory question of “boy or girl” toward expectant parents, Alan Turing is often referred to as the father of computer science (Bernhardt, 2016; Guo, 2015). His ideas from the 1950s paved the way for today's concepts of algorithms and artificial intelligence as he formed the idea of “a machine that can learn from experience” (Copeland, 2004, p. 375). Special attention is given to his thought experiment on human computer interaction which he referred to as the *imitation game* famously posing the question “Can machines think?” (Turing, 1950, p. 433). Interestingly, Turing did not set up one, but a variety of tests that made history as *the Turing Test*, one of them being deeply rooted in the context of gender (Gonçalves, 2021). In the original article from 1950, Turing describes a party game that involves three parties. Player A is male and player B is female while the gender of player C is unspecified. Player C takes the role of the interrogator and must determine the gender of player A and player B with whom they can only interact through written communication. Whereas the female player B has to assist the unspecified player C, the male player A ought to trick player C (Turing, 1950). Hence, the scenario can be described as “man-imitates-woman” (Gonçalves, 2021, p. 109). Turing then proceeds to make a crucial intervention by exchanging the male player A with a computer. Doing so, he questions the ability of the computer to trick player C into perceiving it to be a human adequately performing their part in the game (Turing, 1950). But what does that mean for the gender context of the game? The role of player A, formerly taken by a male human being, is now taken by a computer. Therefore, this scenario could be understood as “machine-imitates-man” (Gonçalves, 2021, p. 179) if it were not for the wording Turing used. When exchanging the role of player A, he states that the part of the formerly player B is now “taken by a man” (Turing, 1950, p. 442). Does that mean that the computer is pretending to be a female player? It is widely assumed that this confusion is solely due to masculine generics and that Turing's ideas were more about machine-imitates-human by creating an overall species test than about gender (Gonçalves, 2021). Thus, Turing might have come close to the question of “boy or girl” but he never answered it.

As the matter of gender has always been a hot topic and rarely avoids conflict, it is unsurprising that scientists did not leave Turing's thought experiment and its gender context at that. In his doctoral dissertation Bernardo Gonçalves (2021) highlights the Turing-Jefferson controversy. Turing's opponent, Geoffrey Jefferson, Professor for Neurosurgery in England, publicly took issue with the thought experiment based on his own publication, *The Mind of Mechanical Man*, from 1949. While the title initially leaves room to assume that Jefferson is in favor of male gendered software, he claims that the increasing equation between human and machine due to technological innovations are neither ethically justifiable by the means of religion and social conduct nor reasonable. Since humans have sex hormones, Jefferson argues, their behavior is unique and cannot be compared to mechanic systems (Jefferson, 1949). There are two fundamental aspects that can be derived from Jefferson's statement that remain relevant as of today. First, he questions the *raison d'être* for anthropomorphic machines. Jefferson is completely opposed to creating machines after the human model which also implies the negation of gendered technology. According to his religious and political background of the 1950s, Jefferson wanted to limit the scope of technological development in order to maintain the status quo (Jefferson, 1949). With this,

he emphasizes the societal impact of technology as he touches on the recurring question of how far technology is allowed to go. Second, Jefferson shares his understanding on how gender is constituted by pointing toward sex hormones. He describes that machines do not come with biological features indicating a certain gender and implies that the general assignment of gender toward an object is somewhat grotesque (Jefferson, 1949). Given the historical context in which the significance of socially shaped behavior and self-identity has not been recognized yet, his statements can be described as biological-deterministic. Today it is widely acknowledged that in addition to the biological sex, humans have a social gender (McDermott & Hatemi, 2011). It is this very piece of knowledge that forms the origin of the discourse on gendered technology: Machines cannot be assigned to a certain sex, but to a gender. While it is clear that technology is “uncoupled from organic reproduction” (Haraway, 2006, p. 118) and does not have sex determining chromosomes, the occurrence of gender is not ruled out. The question of “boy or girl” is still on.

In addition to Jefferson, Gonçalves (2021) points out other critics of Turing’s stance on gender who were less bothered by the portrayal of gender but more of the ambiguity. Accordingly, the Turing Test was referred to as a “sexual guessing game” by biographer Andrew Hodges (2012 [1983], p. 415) or dismissed as the construction of a “mechanical transvestite” (Hayes & Ford, 1995, p. 973). These phrases are intended to point out the shortcomings of Turing’s ambiguity on gender. But in fact, they come short themselves as neither of them recognize the immense foundation for further discourses on gendered software that was built.

The 1950s can be metaphorically seen as the birth hour of all software. Besides Turing’s publications, the *Dartmouth conference* in 1956 is also credited with seminal importance for computing. There, the term artificial intelligence was coined (Moor, 2006), but the question of gender was not addressed. It was for Turing’s sake that the matter was put on the plate. And even though the central question of “boy or girl” was not answered by Turing himself, he granted an immense potential to it. His ideas and subsequent criticism show that gender has been intertwined with software developments and spawned controversies from the very beginning, even in times in which they have been mere imaginations. As the central question was not rejected, the search for an answer just began.

Moore and Moore Progress in the 1960s and 1970s

In 1965 American engineer Gordon Moore stated that the number of transistors on a microchip will double every 2 years (Moore, 2006 [1965]). What made history as *Moore’s law* is nothing less than the prediction that software capabilities are intensely increasing (Mollick, 2006). And while Moore made public that the ideas of the 1950s were about to come true, Joseph Weizenbaum was already, at least to some extent, realizing them. From 1964 to 1966 he developed the natural language processing computer program *ELIZA* for the tech company IBM (Weizenbaum, 1966).

Acting in the manner of a psychotherapist, *ELIZA* was designed to hold a conversation through written language. The users would type on a keyboard and the program would answer on the computer screen (Weizenbaum, 1966). Since the software relied on pattern matching, the delivered answers were rather superficial as there were no implemented tools that were able to contextualize. With that, *ELIZA* was not only one of the first programs to

undergo a variation of the Turing test, but to fail it (Shum et al., 2018). Having answered the question of whether ELIZA can think like a human, what about being a “boy or girl” like a human? The program is generally associated with the female gender due to being labeled with a common female name. Specifically, Weizenbaum named the program after *Eliza Doolittle*, a female character from George Bernard Shaw’s play *Pygmalion*, and modeled his software after her personality trait to appear fairly civilized (Weizenbaum, 1966). This indicates that the product name and personality traits can be considered as decisive features when it comes to determining if it is “boy or girl.”

As software literally took off, the 1970s hinted toward another distinctive feature: voice. Voice warning systems became a security standard in aviation and later in other means of transport. The systems are designed to verbally warn their operators in the event of danger (Arrabito, 2009). Usually using a recording of a female voice, the warning systems became humanized and got condescending nicknames like *Bitchin’ Betty* or *Nagging Nora* (Bachman, 2016). Warning systems operating through male voices are referred to as *Barking Bob* (Rogoway, 2016). What can be seen from these labels is that voice is a decisive factor for assigning gender through gendered nicknames. Thus, the question of “boy or girl” has gained uptake. The quest was to find out whether a male or a female voice is suited best for the respective context of use. To this date, research results on this remain contradictory (West et al., 2019). Early research state that female voices are more suitable, others state that male voices have certain advantages as pilots are predominantly male (Dhaval, 2014). Continuing to look at the gender of the systems operator, others declare that the voice of the opposite gender is favored (Vukovic et al., 2010; West et al., 2019). Hence, it is understandable that voice warning systems come with different options and the question of “boy or girl” is left to be answered by the users. While the naming of objects, including technologies, is an important mechanism of sensemaking, the unceasing urge to label lifesaving devices with condescending names is striking. Specifically, the gender-specific offensiveness of the female nicknames leaves room for critical thoughts.

The technological developments of the 1960s and 1970s did not answer the central question definitively but showed an inclination toward female technology. Product names, nicknames, voice recordings, and character traits are derived from real human women. Rounding up the 2 decades, the dominance of female gendered software offers a new perspective on TIME Magazine’s decision to cancel the announcement of the Man of the Year in 1983. Instead, in a gender-neutral way they declared the computer as “Machine of the Year” (Time Machine of the Year, 2019 [1983]).

Looking for Reasoning in the 1990s

As software technology in general has become increasingly established in everyday life, researchers started to investigate its science. Especially media and communication studies in the US of the 1990s formed the research field of human-computer interaction (Edwards et al., 2019). With that, gendered software and their social impact did not remain unnoticed. One of the major publications granting scientific context to the discussion on gendered software was by Clifford Nass, Jonathan Steuer, and Ellen Siminoff from 1994. Following the acronym of their proposed *CASA-paradigm* they stated that “Computers Are Social Actors” (Nass et al., 1994, p. 72). The authors based this statement on five research experiments in

which they proved that findings of social sciences can also be applied to the interaction between people and computers (Nass et al., 1994). Building on the same approach as the CASA-paradigm, Byron Reeves and Clifford Nass published *The Media Equation* in 1996. Besides computers, they also considered television and new media. At the forefront of their book is the equation “media equal real life” (Reeves & Nass, 1996, p. 5). According to this, people treat computers, television, and new media like real people or places. These interactions can be described as “fundamentally social and natural” (Nass et al., 1994, p. 5). Thus, all people act according to the media equation. Age, culture, and media literacy are of no importance nor does an awareness that computers, televisions, and news media are not real people or places have any influence. Every form of media use, including passive forms, is based on the media equation. Therefore, people expect media to be subject to the same set of rules as social interactions (Nass et al., 1994).

Both the CASA-paradigm and the media equation prove the exert influence of human-like technology. By doing so, they scientifically legitimize further considerations of the social impact of technologies like in this very theoretical contribution. The importance of the CASA-paradigm and the Media Equation to the matter of gendered features goes even further: Not only does gendered software fall within the subject area of these theories, but gendered characteristics are specifically highlighted as both aforementioned publications conducted experiments on gender-based stereotyping of technologies. It was found that female gendered technologies have a low standing regarding the evaluation of their competence (Nass et al., 1994; Reeves & Nass, 1996). One could assume that this unequal assessment might be caused by the novelty and the associated limited area of use of the female gendered software like ELIZA shown in the former section on the 1960s and 1970s. With that, the assessment could be quite innocently reasoned by the functionality of technology and not by a discriminatory perception of gender. But considering the experimental designs that also included male gendered features, this argument is invalid. Rather, the unequal perception of female and male features of technology are inherently linked to the same patriarchal and capitalist societal structures that real girls and women are subjected to. An example of this, which like the CASA paradigm and the media equation dates to the 1990s, is provided by BMW. German, mainly male, drivers had refused to accept instructions from a navigation device with a female voice. As a result, the car manufacturer decided to recall the cars (Nass & Brave, 2005). And even though gender equality is increasing, a study by Ernst and Herm-Stapelberg from 2020 shows that technology with female features is still assessed to be less competent than technology with male features.

While these insights do not answer the question of “boy or girl” directly, they touch on it by shedding light on what happens when the question is already answered. For this reason, it is of interest on how the question was answered beforehand. As the examples from the 1970s already gave away, one of the distinctive gender cues was the implementation of a voice output. Reeves and Nass also put an emphasis on voice recordings that are embedded in software. They attribute this significance to the human perception of gender through the distinctiveness of male and female voices as they state that “voice is one of the most powerful indicators of gender, absent the actual person” (Reeves & Nass, 1996, p. 163). Within seconds, users can recognize which gender they ascribe to the voice which makes it a salient cue regarding the perception of gender. The decision made completely interplays with the binary of “boy or girl,” since the human perception of voices seems to only distinguish

between male and female. Although gradated scales of perceived masculinity and femininity exist, Reeves and Nass (1996) argue that there is no possibility to perceive voices as gender neutral. Taking this piece of knowledge, the answer to the question of “boy or girl” toward software with voice features should be quick to find. However, current research (in this volume) is questioning this presumption. In addition, voice is an important, albeit not the only, decisive feature when it comes to the determination of gender.

The theorists of the 1990s took on the important role of scientifically grounding the discussions on gendered software. Herewith, they were providing a scientific basis for pointing out gender inequalities and highlighted the importance of voice technologies; almost as if they had sensed what was about to come.

Critical Voices of the 2010s

The 2000s quite rarely used the potential of gendered features. One of the only examples is provided with *Eugene Goostman*, a chatbot imitating a 13-year-old Ukrainian boy. Being one of the few male gendered software technologies attributed to perform masculinity (Fancher, 2016), the focus was more on making use of the traits of juvenile unknowingness of a boy to pass the Turing test than to feature any other male characteristics (Warwick & Shah, 2016). Contrary to that, the 2010s rang in a massive revival of gendered software. Launching *Siri* in 2011, Apple kicked off the global spread of voice assistant software completing different everyday tasks for their users (Perez Garcia et al., 2018). What is special about these technologies is that their interface is operated through spoken language. The user asks and, based on natural language processing and an algorithm selecting a corresponding voice recording, the technology answers (Natale, 2020). Using *Siri* as an example, two gender determining features of software that were also observable in the examples of the 1960s and 1970s reoccur. Firstly, while the name *Siri* can be interpreted as an abbreviation for *Speech Interpretation and Recognition Interface*, the “father” (The Week Staff, 2015) of the technology, Norwegian developer Dag Kittlaus, intended otherwise. In Kittlaus’s native language, the name stands for “beautiful woman who leads you to victory” (The Week Staff, 2015) and is a common Scandinavian first name for women. This makes *Siri* prone to be perceived as female. Secondly, the default voice used for the voice output in most languages in which Apple products are marketed is also female (West et al., 2019).

As observable in the voice warning systems and reasoned by Reeves and Nass (1996), voice is an important cue to assign a gender. Regardless of male voice alternatives becoming increasingly available, competing products like *Alexa* by Amazon and *Cortana* from Microsoft also have a female product name and come with a female voice by default at the beginning (West et al., 2019). Additionally, another feature underlining voice assistants being perceived as female is recurring. Since the sale of voice assistants can make astounding profits, nothing is left to chance, and everything is done to manufacture a satisfying product. For this reason, cultural contexts and more recent developments are also taken into account. While male BMW drivers in the 1990s rejected female voices from navigation systems, German consumers have now accepted female voice assistants. In a small selection of countries, however, male voices are still favored (Nass & Brave, 2005). Thus, creative teams intentionally determine personality traits that their products are supposed to convey.

And while these creative teams are not throwing gender reveal parties, the undertone of the embedded dialogues gives away that it is, yet again, a girl (West et al., 2019).

The holistic feminization of voice software is fundamentally criticized for a variety of reasons. At the baseline critics argue that voice assistants take on “algorithmically-amplified feminized persona” (Woods, 2018) and therefore amplify outdated stereotypes of women. They are seeing parallels to the image of a young, submissive woman with the scope of duties similar to a secretary (Ahn & Costigan, 2019; Fortunati et al., 2022; Guzman, 2017). This becomes evident in the embedded reactions to verbal harassment that technologies have been subjected to since the 1970s. While the voice warning systems of the 1970s are not meant to interact but to warn, voice assistants of the 2010s have the capability to fight back. As this potential was left without use, a subsequent article by journalist Leah Fessler of the online magazine Quartz caused a stir in 2017. Fessler tested Siri and Alexa’s responses to verbal sexual harassment and sexist insults, most of which turned out to be affirmative or neutral. Female gendered voice software is thus criticized for fueling rape culture and providing a platform for sexual harassment (Fessler, 2017).

Another degrading aspect associated with voice assistants and their volitionless behavior is that they mainly operate in the domestic sphere. This supposedly allows the comparison to the role of a Victorian servant who is hovering in the background “ready to do her master’s bidding swiftly yet meticulously” (Shulevitz, 2018). The criticism on the sphere of action is heavily reinforced as the few existing male gendered technologies take on “high-powered tasks” (Sheriff, 2018). Examples include the AI-robot *CIMON*, used for tasks on the International Space Station, and IBM’s *Watson* application that assists business decisions (Sheriff, 2018; Steele, 2018; Williams & Braddock, 2019). Overall, this described inadequacy of female gendered voice software is claimed to be harming real girls and women by intensifying gender inequalities. And it seems to be a vicious circle. Posing the question of “boy or girl” toward expectant parents, we encountered multiple fathers: Alan Turing, Joseph Weizenbaum, and Dag Kittlaus. But what about the mothers? The underrepresentation of women in STEM professions is causing development teams to be mainly constituted of men. Recognizing this, technofeminists state that through this imbalance, male developers’ experiences and images of women are unreflectively integrated into technologies. It is mostly men who design entire backstories for voice assistants (West et al., 2019). Social anthropologist Kathleen Richardson, whose work is focused on the adjacent topic of (sex) robots (Richardson 2016, 2018), made a particularly pertinent remark to the popular press in this regard:

I think that probably reflects what some men think about women—that they’re not fully human beings. (Kathleen Richardson according to Adrienne LaFrance, 2016)

The developments of the 2010s reveal how female gendered software is degraded. Although software with a female voice had already been subjected to an unequal assessment compared to a male voice in the decades prior, this assessment happened externally through the users. Nowadays, the harmful assessments of female images are directly embedded in the software. Connecting past and present, the question of how far technology is allowed to go

remains relevant. Therefore, future paths are reconsidering their options and the legitimacy when it comes to “boy or girl.”

Pathways to the Future

The vocal criticism of the 2010s has caused change. After the 2017 outrage on the insufficient reactions of female gendered voice software toward verbal harassment, market-leading companies adapted their technologies. However, critics state that these changes are not adequate enough as the responses given by the software prioritize not displeasing customers (West et al., 2019). Still, the current situation shows that market-leading companies are at least engaging in the discussion and, to some extent, show a willingness to change. While there might be a long way to go, the possibility to go at all is considered. But in what direction? Engaging in the ongoing discussion, Heather Zorn, who is part of the Alexa development team at Amazon, points toward female empowerment. Opposing the mass of criticism, she identifies changes in female gendered software. In an interview with *Refinery29*, Zorn stated that she and her team see it as their duty to present Alexa in a positive way, especially to girls and women. For example, Alexa openly professes to be a supporter of feminism (Buxton, 2017). Hence, female gendered software could use their societal impact to promote gender equality.

Contrary to that, critics are pointing toward another direction. On the question “boy or girl” they are demanding to leave it be. They maintain that gendered features of software besides the ones inherently linked to functionality are not legitimate. Gendered software is allowed to go as far as it has in order to work, but no further. Therefore, gender-specific attributes should be kept as low as possible and if they are embedded, then a clear demarcation toward human beings must be made.

An example of how this request can be satisfied is the voice assistant Q, especially designed “to end gender bias in AI assistants” using a “Genderless Voice” (Copenhagen Pride et al., n.d.). Though the clear distinction between male and female in the human perception of voices remains, the developers made use of gradations selecting tone frequencies that are closest to being androgynous. For that matter voices of people who identify as gender non-binary were recorded (Carpenter, 2019). Doing so, the creation process of Q shows that diversifying the development team enhances the range of software products and the gender binary as in “boy or girl” is insufficient. The tech profession will prospectively become more diverse. And it is already happening: Recent trends demonstrate that albeit software engineers are still being predominately male, there is an ongoing effort to increase the number of women and queer people in tech professions (West et al., 2019).

Taking steps, little they may be, software developers have already entered pathways of female empowerment, genderless technologies, and a diverse workforce toward the future. And while the narrow scope of the question of “boy or girl” is not as applicable in this context, it highlights the ongoing explorations and relevance of gender in its multitude of facets.

Discussion

The outlined evolution of gendered software granted insight on how gendered software products spawned broad discussions. Ethics, specific products, scientific reasoning, and future demands have all come under the umbrella of the central question and additional spheres of gender. And in doing so, something interesting happened quite casually: The features of how gender is assigned to software were revealed. Hereinafter, I will propose a listing of three features that I encountered separately in the overall rabbit hole of gendered software and already loosely recognizing their similar character like West et al. (2019). While I do not claim this listing to be definite, I am providing a starting point sorting the decisive features by their increasing complexity:

(1) Product Name

In most cultures, naming a newborn is sex-specific. The practice of naming can therefore be seen as an act of *doing gender* (Pilcher, 2017). This also applies to the official and unofficial naming of software and other technologies when gendered first names are used to label them. It is reasonable to give a product a name, but there is no technological argument for choosing a gendered name as it does not influence the functionality of a software.

(2) Voice

As Reeves and Nass (1996) described in *The Media Equation* and revisited multiple times through the highlighted software technologies, the gender binary is inherent to the human perception of voice. Consequently, software systems with a built-in voice output have a built-in gender. Contrary to the product name, the gender assignment is caused by the functionality of the software.

(3) Personality Traits

Spoken words entail marks of gender (Chasin, 1995; Luca, 2015; Suchman, 2006). As the CASA-paradigm and *The Media Equation* from the 1990s state, findings like this can also be applied to human-computer-interaction (Nass et al., 1994; Reeves & Nass, 1996). Therefore, software that makes use of human language is inherently capable of conveying certain personality traits which is also proven by ELIZA and the voice assistants of the 2010s. This is significant for the context of gender, as personality traits are influenced by cultural expectations of gender (Gerber, 2009). The intentional act of assigning personality traits to software holds the power to determine gender. However, the matter is not as black and white as it may seem but left to nuance. While there is broad consensus on what personality traits are understood as female or male, there is still room for individual deviations. What one person understands to be a female personality trait, could be understood as male by someone else. In addition, there are gradations to the intention of assigning gendered personality traits. Weizenbaum created parallels between ELIZA and character traits of a fictional character that also happened to be female. At the forefront he prioritized personality traits not gender. In contrast, market-leading companies of voice assistants are intentionally creating gendered personas such as Alexa, Cortana, and Siri. The gendered feature of a personality trait can thus be partially attributed to the functionality as personality traits will inevitably be revealed within interactions, but there is no technological reason to make further use of it.

Looking at these three features of gendered software and connecting them to criticism, they hold an immense power as the decisive tools. As shown in the example of Q, the realization of these features can be adjusted so that they may reinforce the gender binary or make technologies anthropomorphic but seemingly genderless. Still, the preference to create female gendered software is astounding. Accordingly, the decision-makers must be considered. While I could reason how product names, voices, and personality traits are linked to gender assignment, I could not find a valid answer on why girl is favored over boy or options beyond the binary. Nevertheless, the outlined evolution led me to make two assumptions. First, software is made to serve their users. Due to the human history of gender inequalities women took on the role to serve society like described by Shulevitz's analogy of the Victorian server (Shulevitz, 2018). Hence, gendered software is a replication of this circumstance. Second, even though tides are turning, the software profession is male dominated as it has been since its formation (West et al., 2019). It might be reasonable for heterosexual men to create companions according to their preference of women. And while both assumptions are left to be proven, the described patriarchal and capitalist structures they are based on are more than evident in the described evolution of gendered software.

Voice warning systems from the 1970s are mocked to this date, research findings of the 1990s show that female gendered software is ascribed less competency than male gendered software and the global spread of voice assistant systems is found fault with as they reinforce outdated stereotypes. All these points are not ingrained in technology but reflecting the stand of the female gender in society. Therefore, as many authors did before (Benjamin, 2020; Noble, 2021; Wajcman, 2015), I am opposing technology determinism. I am not locating the source of the problems in software and technology in general, but in the bigger context of gender inequality. The problem of gendered technology is not in the imitation of human capabilities, but in how gender is treated in society. It is grotesque that the majority of gendered software is made out to be female while in general boys are valued over girls or any options out of the binary. I therefore attribute immense importance to the future pathways described in the section above. As long as the empowerment of women is sincerely actualized, and development teams become more diverse, social change is brought forward. However, these positive developments should be taken with a grain of salt. Even empowering representations of femininity in software are ultimately commodifications. Whenever economic profit plays a role, these adjustments can hardly be linked to pure intentions only. For this reason, I am particularly excited about what the future will bring in terms of software out of the binary. As long as the acquisition of gender traits leads to disadvantages for real people, any attempt to represent software as human-like but almost genderless form would be the less harmful choice. In addition to that, actions which are not directly linked to gendered software but promote gender equality can also be ascribed an immense impact. With me talking this talk, it is on us as humans to collaboratively walk the walk.

Conclusion

In this article, I have outlined the evolution of gendered software. While technologies in general cannot be assigned to a biological sex, the social construct of gender offers the decisive loophole. Using the question of “boy or girl,” I was able to map the recurring motifs

of *raison d'être*, realization, consequences, and future directions that accompanied the gendered software products of the last 7 decades.

Touching on the question of how far technology is allowed to go, George Jefferson's (1949) statements from the 1950s and criticism on female gendered voice assistants of the 2010s dealt with the *raison d'être*. Using different arguments, both claim that gendered software technology is a threat to society. But while the legitimacy of the gendered technology in the context of ethics remains to be debated, software engineers did not wait for a verdict. Instead, they realized their ideas and brought mostly female gendered products to the market. That led me to shed light on the matter of how gender is conveyed through a software product. Clues were given by the listed software products in this article, the CASA-paradigm and the media equation from the 1990s as well as a publication of West et al. (2019) of criticism on female gendered voice assistants. Ultimately, I was able to carve out three distinctive gendered features of technology: product name, voice, and personality traits. With that, I am providing an overview of the decisive features for the assignment of gender in software products. I do not claim this listing to be exhaustive nor that I have considered the potential of each feature in its full depth. Rather, I propose to take the proclamation of these three as an invitation for future research. It is a starting point to gather empirical data on each feature and to look at how they are constituted. In particular, the feature of personality traits leaves room for further insights on how they are selected, which tools are used to convey them (e.g., humor, vocabulary) and how the perception is socially shaped.

The described features are gaining immense relevance through the power that they exert. Especially the fact that female gendered software products made gender inequalities visible and were able to reinforce them, shows that they are tools that should be used with caution. And while I argue that society must change as a whole to put an end to inequalities in gendered software, recent developments prove that progress is already made. Development teams become slowly but steadily more diverse and carefully consider their tools given. The future paths simultaneously taken by them are leading toward female empowerment and options out of the binary.

This leads me to finalize my stance on using the binary question of "boy or girl" illustrating the evolution of gendered software. Never meant to be met with a blanket answer, it was a suited instrument to vividly highlight the different discourses of gendered software evolution. Its narrow nature has put an emphasis on the significance of its contrast, namely gender as a concept to be understood as a spectrum. Ergo, I end by discarding the witty phrase of "boy or girl" once and for all as it has done its due.

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References

- Ahn, S., & Costigan, A. (2019). *How AI reinforces gender stereotypes (Trend brief)*. Catalyst. <https://web.archive.org/web/20200618102855/https://www.catalyst.org/research/ai-gender-stereotypes/>
- Arrabito, G. R. (2009). Effects of talker sex and voice style of verbal cockpit warnings on performance. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, 51(1), 3–20. <https://doi.org/10.1177/0018720808333411>
- Bachman, J. (2016). The world's top fighter pilots fear this woman's voice. *Bloomberg*. <https://web.archive.org/web/20160606101811/https://www.bloomberg.com/features/2016-voice-of-the-fa-18-super-hornet/>
- Bardzell, S. (2010). *Feminist HCI: Taking stock and outlining an agenda for design*. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Atlanta, Georgia, USA. <https://doi.org/10.1145/1753326.1753521>
- Benjamin, R. (2020). *Race after technology abolitionist tools for the new Jim code* (Reprinted ed.). Polity.
- Bernhardt, C. (2016). *Turing's vision: The birth of computer science*. The MIT Press.
- Buxton, M. (2017). Writing For Alexa becomes more complicated in the #MeToo era. *Refinery29*. <https://www.refinery29.com/en-us/2017/12/184496/amazo-alexa-personality-me-too-era>
- Carpenter, J. (2019). Why project Q is more than the world's first nonbinary voice for technology. *Interactions*, 26(6), 56–59. <https://doi.org/10.1145/3358912>
- Chasin, A. (1995). Class and its close relations: Identities among women, servants, and machines. In J. Halberstram & I. Livingston (Eds.), *Posthuman bodies* (pp. 73–96). Indiana University Press.
- Copeland, J. B. (2004). Lecture on the automatic computing engine (1947). In J. B. Copeland (Ed.), *The essential Turing seminal writings in computing, logic, philosophy, artificial intelligence, and artificial life plus the secrets of enigma* (pp. 362–394). Oxford University Press.
- Copenhagen Pride, V., Equal AI, Koalition Interactive & thirtysoundsgood. (n.d.). *What is Q?* <https://web.archive.org/web/20190323070233/https://www.genderlessvoice.com/about/>
- Dhavalala, L. (2014, November 20–22). *Use of synthetic voice to improve communication between air traffic controllers and pilots*. International Aviation Management Conference, Dubai, UAE.
- Edwards, C., Edwards, A., Kim, J., Spence, P., de Graaf, M., Nah, S., & Rosenthal-von der Pütten, A. M. (2019). *Human-machine communication: What does/could communication science contribute to HRI?* <https://doi.org/10.1109/HRI.2019.8673138>
- Ernst, C.-P., & Herm-Stapelberg, N. (2020). *Gender stereotyping's influence on the perceived competence of Siri and co*. <https://doi.org/10.24251/HICSS.2020.544>
- Fancher, P. (2016). Composing artificial intelligence: Performing Whiteness and masculinity. *Present Tense*, 6(1). <https://www.presenttensejournal.org/volume-6/composing-artificial-intelligence/>
-

- Fessler, L. (2017). *We tested bots like Siri and Alexa to see who would stand up to sexual harassment*. Quartz. <https://web.archive.org/web/20170224075311/https://qz.com/911681/we-tested-apples-siri-amazon-echos-alexa-microsofts-cortana-and-googles-google-home-to-see-which-personal-assistant-bots-stand-up-for-themselves-in-the-face-of-sexual-harassment/>
- Fortunati, L., Edwards, A., Edwards, C., Manganello, A. M., & de Luca, F. (2022). Is Alexa female, male, or neutral? A cross-national and cross-gender comparison of perceptions of Alexa's gender and status as a communicator. *Computers in Human Behavior*, 137, 107426. <https://doi.org/10.1016/j.chb.2022.107426>
- Gerber, G. L. (2009). Status and the gender stereotyped personality traits: Toward an integration. *Sex Roles*, 61(5–6), 297–316. <https://doi.org/10.1007/s11199-008-9529-9>
- Gonçalves, B. (2021). *Machines will think: Structure and interpretation of Alan Turing's imitation game*. Doctoral dissertation, Faculty of Philosophy, Language and Literature, and Human Sciences, University of São Paulo, São Paulo. <https://doi.org/10.11606/T.8.2021.tde-10062021-173217>
- Guo, T. (2015). Spirituality as reconceptualisation of the self: Alan Turing and his pioneering ideas on artificial intelligence. *Culture and Religion*, 16(3), 269–290. <https://doi.org/10.1080/14755610.2015.1083457>
- Guzman, A. L. (2017). Making AI safe for humans: A conversation with Siri. In R. W. Gehl & M. Bakardjieva (Eds.), *Socialbots and their friends: Digital media and the automation of sociality*, 69–82. Routledge.
- Haraway, D. (2006). A cyborg manifesto: Science, technology, and socialist-feminism in the late 20th century. In J. Weiss, J. Nolan, J. Hunsinger, & P. Trifonas (Eds.), *The international handbook of virtual learning environments* (pp. 117–158). Springer Netherlands. https://doi.org/10.1007/978-1-4020-3803-7_4
- Hayes, P., & Ford, K. (1995). *Turing test considered harmful*. In Proceedings of the 14th international joint conference on artificial intelligence (Vol. 1, pp. 972–977) (IJCAI'95). Morgan Kaufmann Publishers Inc.
- Hodges, A. (2012 [1983]). *Alan Turing: The enigma the centenary edition*. Princeton University Press. <https://doi.org/10.1515/9781400844975>
- IEEE Standard Glossary of Software Engineering Terminology. (1983). *ANSI/IEEE Std 729-1983*, 1–40. <https://doi.org/10.1109/IEEESTD.1983.7435207>
- Jäncke, L. (2018). Sex/gender differences in cognition, neurophysiology, and neuroanatomy. *F1000research*, 7, 805. <https://doi.org/10.12688/f1000research.13917.1>
- Jefferson, G. (1949). The mind of mechanical man. *BMJ*, 1(4616), 1105–1110. <https://doi.org/10.1136/bmj.1.4616.1105>
- LaFrance, A. (2016). Why do so many digital assistants have feminine names? *The Atlantic*. <https://web.archive.org/web/20160404080903/https://www.theatlantic.com/technology/archive/2016/03/why-do-so-many-digital-assistants-have-feminine-names/475884/>
- Luca, M. (2015). Emotion simulation for robots. In M. L. Tudorel Dima (Ed.), *Cognitive sciences—An interdisciplinary approach*, 267–275. PROUNIVERSITARIA Editura.
- McDermott, R., & Hatemi, P. (2011). Distinguishing sex and gender. *PS: Political Science & Politics*, 44, 89–92. <https://doi.org/10.1017/S1049096510001939>

- Mollick, E. (2006). Establishing Moore's Law. *IEEE Annals of the History of Computing*, 28(3), 62–75. <https://doi.org/10.1109/MAHC.2006.45>
- Moor, J. (2006). The Dartmouth College artificial intelligence conference: The next fifty years. *AI Magazine*, 27, 87–91.
- Moore, G. E. (2006 [1965]). Cramming more components onto integrated circuits. Reprinted from *Electronics*, 38(8), April 19, 1965 (pp. 114 ff). *IEEE Solid-State Circuits Society Newsletter*, 11(3), 3335. <https://doi.org/10.1109/N-SSC.2006.4785860>
- Nass, C., & Brave, S. (2005). *Wired for speech: How voice activates and advances the human-computer relationship*. MIT Press.
- Nass, C., Steuer, J., & Siminoff, E. (1994). *Computer are social actors*. In Conference Companion on Human Factors in Computing Systems (CHI '94). Association for Computing Machinery, New York, NY, USA, 72–78. <https://doi.org/10.1145/259963.260288>
- Natale, S. (2020). To believe in Siri: A critical analysis of AI voice assistants. *Communicative Figurations | ZeMKI Working Papers*, 32, 1–17. https://web.archive.org/web/20200906172340/https://www.uni-bremen.de/fileadmin/user_upload/fachbereiche/fb9/zemki/media/photos/publikationen/working-papers/2020/CoFi_EWP_No-32_Simone-Natale.pdf
- Noble, S. U. (2018). *Algorithms of oppression: How search engines reinforce racism*. New York University Press.
- Perez Garcia, M., Saffon Lopez, S., & Donis, H. (2018). *Everybody is talking about voice activated virtual assistants, but how are people really adopting and using them? Lessons from a multi-country study*. In Proceedings of the 32nd International BCS Human Computer Interaction Conference (HCI), Belfast, UK, 1–5. <https://doi.org/10.14236/ewic/HCI2018.96>
- Pilcher, J. (2017). Names and “doing gender”: How forenames and surnames contribute to gender identities, difference, and inequalities. *Sex Roles*, 77(11–12), 812–822. <https://doi.org/10.1007/s11199-017-0805-4>
- Reeves, B., & Nass, C. (1996). *The media equation: How people treat computers, television, and new media like real people and places*. Bibliovault OAI Repository, the University of Chicago Press.
- Richardson, K. (2016). Sex robot matters: Slavery, the prostituted, and the rights of machines. *IEEE Technology and Society Magazine*, 35(2), 46–53. <https://doi.org/10.1109/MTS.2016.2554421>
- Richardson, K. (2018). *Challenging sociality: An anthropology of robots, autism, and attachment*. Palgrave Macmillan. <https://doi.org/10.1007/978-3-319-74754-5>
- Robertson, J. (2010). Gendering humanoid robots: Robo-sexism in Japan. *Body & Society*, 16(2), 1–36. <https://doi.org/10.1177/1357034x10364767>
- Rogoway, T. (2016). The distinct voice of the F/A-18 Hornet's 'Bitchin' Betty' warning system is retiring. *Jalopnik*. <https://web.archive.org/web/20221010200234/https://jalopnik.com/the-distinct-voice-of-the-f-a-18-hornets-bitchin-betty-1764527531>
- Rosheim, M. E. (2006). *Leonardo's lost robots*. Springer Berlin/ Heidelberg.
- Sheriff, L. (2018). *Meet Pegg, a gender-neutral robot assistant*. The World. <https://web.archive.org/web/20220126171442/https://theworld.org/stories/2018-03-28/meet-pegg-gender-neutral-robot-assistant>
-

- Shulevitz, J. (2018). Alexa, should we trust you? *The Atlantic*. <https://web.archive.org/web/20181102120327/https://www.theatlantic.com/magazine/archive/2018/11/alexa-how-will-you-change-us/570844/>
- Shum, H.-Y., He, X., & Li, D. (2018). From Eliza to XiaoIce: Challenges and opportunities with social chatbots. *arXiv pre-print server*. <https://doi.org/10.1631/FITEE.1700826>
- Steele, C. (2018). The real reason voice assistants are female (and why it matters). *PCMag*. <https://web.archive.org/web/20211201095456/https://uk.pcmag.com/smart-home/92697/the-real-reason-voice-assistants-are-female-and-why-it-matters>
- Suchman, L. (2006). *Human-machine reconfigurations: Plans and situated actions* (2nd ed., Learning in Doing: Social, Cognitive and Computational Perspectives). Cambridge University Press. <https://doi.org/10.1017/CBO9780511808418>
- Thorne, N., Yip, A. K.-T., Bouman, W. P., Marshall, E., & Arcelus, J. (2019). The terminology of identities between, outside and beyond the gender binary—A systematic review. *International Journal of Transgenderism*, 20(2–3), 138–154. <https://doi.org/10.1080/15532739.2019.1640654>
- Time machine of the year. The computer moves in. (2019 [1983]). *Time Magazine*. <http://content.time.com/time/covers/0,16641,19830103,00.html>
- Turing, A. M. (1950). Computing machinery and intelligence. *Mind*, LIX(236), 433–460. <https://doi.org/10.1093/mind/LIX.236.433>
- Vukovic, J., Jones, B. C., Debruine, L., Feinberg, D. R., Smith, F. G., Little, A. C., Welling, L. L. M., & Main, J. (2010). Women's own voice pitch predicts their preferences for masculinity in men's voices. *Behavioral Ecology*, 21(4), 767–772. <https://doi.org/10.1093/beheco/arq051>
- Wajcman, J. (2004). *TechnoFeminism*. Polity.
- Wajcman, J. (2015). *Pressed for time the acceleration of life in digital capitalism*. Univ. of Chicago Press.
- Warwick, K., & Shah, H. (2016). Can machines think? A report on Turing test experiments at the Royal Society. *Journal of Experimental & Theoretical Artificial Intelligence*, 28(6), 989–1007. <https://doi.org/10.1080/0952813x.2015.1055826>
- The Week Staff. (2015). How Apple's Siri got her name. *The Week*. <https://web.archive.org/web/20151125232503/https://theweek.com/articles/476851/how-apples-siri-got-name>
- Weizenbaum, J. (1966). ELIZA—A computer program for the study of natural language communication between man and machine. *Communications of the ACM*, 9(1), 36–45. <https://doi.org/10.1145/365153.365168>
- West, M., Kraut, R., & Chew, H. E. (2019). *I'd blush if I could. Closing gender divides in digital skills through education*. EQUALS, UNESCO. <https://web.archive.org/web/20191219022753/https://en.unesco.org/ld-blush-if-i-could>
- Williams, M., & Braddock, M. (2019). AI case studies: Potential for human health, space exploration and colonisation and a proposed superimposition of the Kubler-Ross change curve on the hype cycle. *Studia Humana*, 8, 3–18. <https://doi.org/10.2478/sh-2019-0001>
- Woods, H. S. (2018). Asking more of Siri and Alexa: Feminine persona in service of surveillance capitalism. *Critical Studies in Media Communication*, 35(4), 334–349. <https://doi.org/10.1080/15295036.2018.1488082>

IVF So White, So Medical: Digital Normativity and Algorithm Bias in Infertility on Instagram

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Abstract


Increasingly, women experiencing infertility are turning online to social media platforms, like Instagram, to engage with a support network and foster empathy. However, Instagram is also noted for its augmentation of White, cis, and heteronormative femininity through a process of silencing and minoritizing alternative, non-White voices. Through an inductive analysis of the most frequently used infertility hashtags, we collected and analyzed 252 Instagram posts to investigate how these algorithmic practices may socially construct the idealized IVF experience through communicating normative expectations. We identify predominant patterns of use that reinforce stratification within infertility treatments as primarily accessible to White women and best handled through expensive, expert medical procedures. Ultimately, we argue for increased attention to how algorithms may communicatively constitute and socially construct existing health disparities.

Keywords: digital normativity, infertility, shadow banning, algorithm bias, medicalization

Introduction

Search #Infertility on Instagram and nestled at the top of the approximately 1.9 million posts published in 2021, you are likely to find infographics on the best foods to avoid lest you risk miscarriage or artistically displayed felt letterboards with adages such as “Infertility

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taught me that life's too short for fake butter, cheese, or people." Similar patterns emerge if one was to search among the top of approximately 2 million posts using the hashtag #IVF; there is the post that helps you avoid burnout during treatment and an endless feed of images depicting artfully positioned felt letterboards sharing everything from "We got two more embryos," to "IVF cycle canceled," to the more celebratory, "Officially pregnant." Ultimately, these posts shape the discourses of infertility, reifying dominant assumptions of treatment success through connections to medicalization while also silencing and shadowing non-White stories.

Affecting an estimated 12% of women in the United States, the World Health Organization (2018) defines infertility as "the failure to achieve pregnancy after 12 months or more of regular unprotected sexual intercourse." Treatment options range from in-patient to out-patient services, with many investing thousands of dollars into treatment. This financial burden, coupled with the intense physical and emotional toll, led researchers to suggest infertility treatment may be one of the most stressful events of a woman's life (Schwerdtfeger & Shreffler, 2009). While infertility is likely to affect men as equally as women, the brunt of the physical, emotional, and psychological toll often falls most heavily on women (Kumar & Singh, 2015).

The religious (Akarsu & Beji, 2021), cultural (Ullah et al., 2021), and familial (Ergin et al., 2018) stigma that surrounds infertility only serves to compound the frequently hidden grief and bereavement. Considering the taboo and socially isolating nature of stigma, many women undergoing infertility treatment have trouble finding others to adequately empathize with their traumatic and grief-riddled experience (McBain & Reeves, 2019). Yet, research continually highlighted online forums, support groups, and social media engagement as a haven for women experiencing infertility, offering empathy, information, and fostering resilience (Jarvis, 2021a; Johnson et al., 2020).

Much is written regarding the unique affordances of social media and online support groups utilized by women experiencing infertility. Of note is the social networking platform Instagram, which offers empathetic support and educational resources and serves as a means for women to document their daily experiences with infertility (Perone et al., 2021). Instagram's unique combination of linguistic (e.g., captions, comments, and hashtags) and paralinguistic feedback (e.g., photos and emojis) creates the opportunity for an array of different types of support, including emotional, informational, tangible, and interactive support, to be exchanged (Johnson et al., 2020). However, women experiencing infertility are not passive victims of the sociocultural environment that constrains and stratifies them. Instead, they actively construct infertility by integrating fatalism within agentic capabilities (Bell & Hetterly, 2014; Greil, 2002). For example, Johnson and Quinlan (2016) illustrate a shifting history of empowerment surrounding conception, locating infertility as dually constructed by medical clinics and on social media through lay experts and alternative practitioners.

Beyond online discourses, a master narrative persists that convenes infertility as a White woman's problem, filtered through presumptions of wealthy, well-educated, cis-gendered, heterosexual couples (Inhorn et al., 2009). As Greil and colleagues (2011) overview, infertility has shifted from a personal problem privately shared between couples to a socially constructed phenomenon shaped globally and within Western societies by varying degrees of pronatalism, medicalization, and patriarchy.

A History of Infertility

Interwoven with the medical development of treatments, the historical and social construction of infertility has long shaped access to and awareness of treatments. Jensen (2016) provides a thorough review of the rhetorical shaping of infertility, illustrating how the medical and scientific attention to infertility is entangled with racial and moral discourses. For example, beginning in the 1960s, just as feminists started advocating for a woman's right to choose motherhood, the mainstream medical establishment also shifted attention to the *urgency* for women to seek medical treatment when struggling to conceive. That is, as Jensen (2016) notes, "this view of reproduction was grounded in a risk- or harm-reduction model of health that positioned individual women—specifically middle- to upper-class, white, professional women—as personally responsible for, and capable of 'choosing' their reproductive health and fertility" (p. 151). As advancements in treatment options emerged, so too did women become seen as increasingly responsible for maintaining their reproductive health.

However, while attention once focused on women as *individually* responsible for maintaining reproductive health, more recent developments in treatment have led to the *medicalization* of infertility, which serves to decenter agency and reconstitute treatment through the lens of the medical establishment. Thus, infertility is underscored by "hegemonic" medicalization (Greil & McQuillan, 2010); it has become nearly synonymous with the need for medical treatments (Wilcox & Mosher, 1993). Given the prominent value medicalization places on technical expertise and scientific progress, medicalization also tends to enforce the perception that a disease, illness, or social action is free of embedded values (Mishler et al., 1981). As Bell (2016) contends, medicalization only serves to further stratify reproduction by de-politicizing treatment as neutral while not considering the structural imbalances which preclude women of lower socioeconomic status from attaining care. Additionally, this imbalance is racialized; whether due to the high cost of treatment or social-cultural stigmas, evidence suggests that African American and Hispanic women are 50% more likely to experience infertility when compared to White women, and these women are less likely to seek immediate treatment (Jain, 2006). However, deeper insight is needed to understand how social media interactions amplify this reproductive stratification through normative communication and underlying algorithms.

Human-Machine Communication

Given the multi-level construction of infertility, as shaped by medical textbooks, socio-ideologies, political policies, and interpersonal interactions online, this study seeks to understand how rhetorical practices of the infertility community constitutively normalize the infertility experience through the lens of White, cis-gendered, heteronormativity. A constitutive perspective regards social media technologies, like Instagram, as the "conduit for a story" (Veil et al., 2012, p. 331) with strong agentic and performative capabilities. A recent surge of research began examining the constitutive capabilities of online images, text, and hypertext as rhetorically constructing the infertility patient, medically and socially. For example, Johnson et al. (2019) illustrate how engagement with the hashtag #ttc (i.e., trying to conceive) enabled patients to circumvent medical expertise and embrace lay expertise. Thus, hashtags do not merely transmit information; they also serve a constitutive purpose

in building community, engendering support, and challenging dominant medicalized presumptions within infertility treatment (Jarvis, 2021b; Johnson et al., 2019). Moreover, a constitutive orientation to communication affords a metatheoretical perspective that not only holds generative world-making capabilities but also enlivens embedded and unacknowledged power structures that empower some while inhibiting others.

In considering the constitutive function of these online hashtags and forums, we also consider the persuasive capabilities inherent in human-machine communication. In human-machine communication, technology shifts from a mere medium or channel of communication to serving the role of communicator, a critical meaning-making function of humans and machines (Guzman & Lewis, 2020). Beyond meaning-making, Coleman (2021) argues that machines emerge as a locus of rhetorical practice as they manifest “visceral responses entangled with material culture to enliven discourse” (p. 14). While technology does not hold feelings or beliefs, it can still manifest “rhetorical energies” that shape the dissemination of health information and medicinal communication (Coleman, 2021). However, we extend and build upon Coleman’s argument by considering the constitutive biases that may augment existing reproductive disparities and rhetorically reinforce the pronouncement of the ideal infertility patient.

This constitutive construction is underscored by digital normativity, a concept rooted in anthropological and ethnographic studies that explain how digital technologies render material consequences through an illusion of the immaterial (Blanchette, 2011; Kirschbaum, 2008; MacKenzie, 2009). Horst and Miller (2012) contend that this illusion of immateriality may create opportunities for equality in online communication and render oppressive consequences, as digital technologies can obfuscate structural and physical inequities. For example, Ginsburg (2012) illustrated how disability activists congregate in online communities to escape ableist discrimination and gain greater agentic control over their offline environment. Drawing on digital normativity, we recognize how technologies like Instagram are normatively socialized to privilege conception without medical intervention within the context of infertility.

Algorithm Bias

Responding to Johnson and colleagues’ (2019) call, this study investigates the digital silencing of women of color, queer women, trans women, and women of lower socioeconomic status through interrogation of multimodal online discourse (i.e., textual, visual intertextual, and hypertextual data). Rachel Cargyle (@rachel.cargyle) and others termed the silencing of minoritized and alternative voices on Instagram as being *shadowed banned*, wherein Instagram restricts individual users’ content from appearing in searches without their knowledge. While social media users overwhelmingly believe that purposeful human actors target their content, it is much more likely that the underlying algorithms inhibit the spread of alternative experiences (Myers West, 2018). However, as Noble (2018) contends, discriminatory and biased algorithms are produced when tech companies are primarily populated by White men who create technology that reflects their image while ignoring and rendering silent women’s experiences.

Research has begun to consider online algorithms’ racist and discriminatory biases. Noble (2018) identified recurrent negative biases that were perpetuated through search engines, like Google, specifically comparing 6 years of search results for “White girls” versus

“Black girls.” Similarly, Are (2020) identified the algorithmic censorship enacted by social media platforms, like Instagram, as replicating sexist and misogynistic power structures that deplete a woman’s agency and render her invisible online. Researchers began to recognize the varying ways algorithms automate racism and reproduce existing social networks (see Eubanks, 2018; Noble, 2018; Sandvig et al., 2016); however, few considered how these practices might be constitutively communicative through normativity.

In considering digital normativity and shadow banning, we critique the established and predictive algorithms trained to influence how social media participants come to understand their individual and collective lives. For example, Fournieret and Yvert (2020) argue for an ethical reflection on how algorithms shape social values, particularly within the subjectivation process, a socially constructed process through which individuals become aware of the responsibility they subjectively hold in their actions and judgments (Wieviorcka, 2012). Because artificial intelligence, like algorithms, is developed by human actors and shaped by human engagement, it ultimately reflects the biased and racist subjectivation communicatively constituted by malignant belief systems. Thus, in considering the malignant social and discursive implications of biased algorithms, we articulate our methodological decisions to critique power structures and historical hierarchies that have engendered stratification within treatment. Thus, we pose the following research question: How does Instagram reify raced, classed, and medical stratification within infertility treatment?

Method

Considering the insular nature of tech companies and the proprietary value of algorithms, studying algorithms and their associated practices, including shadow banning, is a non-linear and subjective process. F. Lee and Björklund Larsen (2019) establish five ideal types of practices useful for studying inequity and bias within algorithms, which include looking under the hood (e.g., analyzing the algorithms themselves) and working above the hood (e.g., examining the human input that constructs algorithms), or a combination of the two. Focusing our collection and analysis “above the hood,” we shifted attention to how infertility is constituted through user input vis-à-vis top-ranked posts and comments. However, F. Lee and Björklund Larsen maintain that research must critique algorithm normativity regardless of the approach. Thus, as we explain, we centered our analysis on identifying the normative discourse within our multimodal data as constitutive of infertility.

Data Collection

The data analyzed in this study were collected as part of a large-scale research project attuned to algorithmic bias and digital normativity within infertility online. After receiving IRB approval, the first author and an undergraduate research assistant began data collection by searching and saving the top nine Instagram posts and comments from two of the most frequently used infertility hashtags, #infertility and #ivf, for 14 days. It is important to note that when searched in a browser rather than in the app, Instagram auto-populates the daily top nine posts for each hashtag; thus, this served as the basis for exploring the algorithmic normativity. Each post was saved to a Word document. We strategically collected data while avoiding major holidays, including Mother’s and Father’s Day. In total, we collected 252

Instagram posts over 2 weeks; however, as many of these posts were repetitive, we analyzed 165 unique posts.

Data Analysis

To analyze and critique the normative tendencies of the infertility hashtags, we adopted an inductive and cyclical coding process to immerse ourselves in the data while also identifying overarching patterns and frequencies. As researchers, this iterative approach to data analysis draws on our existing understanding of infertility narratives and reproductive disparities while also considering the evidence of emergent themes within qualitative data (Tracy, 2019). Thus, rather than grounding our understanding solely in the data, we remained reflexively attuned to recognize hegemonic and ideological discourses of infertility. We began with an inductive process of analyzing and reanalyzing the data, examining images, captions, and hashtags for commonalities and deviances.

Through this iterative process, we developed codes as they began to capture themes of “summative, salient, essence-capturing and/or evocative [. . .] language-based or visual data” (Saldaña, 2009, p. 3). The first author led the data analysis process, conferring with the second author to discuss emerging themes and observations. In a spreadsheet, the authors tracked reoccurring imagery and evaluated the salience of captions by assigning first-level codes to each post (Tracy, 2019). For example, some posts were thematically marked as “motivation” while others were described as “everyday life” or “cycle announcement.”

We sought to organize and synthesize these categories during the secondary coding cycle, diving deeper into their representation and critiquing their alignment with dominant and hegemonic discourses of infertility. Through this process, we developed theoretical saturation (Glaser & Strauss, 1967), wherein the relationship between our data and codes was focused and established. Our second level of coding was attuned to how these primary codes were representative of the medicalization, classism, and racism that plagues infertility experiences. For example, second-level codes focused on the images’ racial dynamics and emotional displays. Specifically, we categorized posts as depicting White-passing individuals or individuals that appeared to be White and those that evidently represented people of color. In the following section, we identify salient patterns that continually reemerged on Instagram’s daily top nine, arguing that the presentation of infertility on Instagram is inextricably and toxically situated within the bounds of race, class, sex, and medicalization.

Analysis and Discussion

Data revealed two prominent patterns of normativity within the infertility hashtags. First, top posts amplified the Whiteness of infertility, shaping the visibility and resilience of White women experiencing infertility with limited illustrations of women of color who might struggle to conceive. Second, top posts are often constructed through medicalization. Posts that gained the most traction on Instagram privilege medical intervention and expertise, primarily through a Western lens. Ultimately, we argue, these two patterns of digital normativity reinforce a hegemonic stratification of infertility treatments that are primarily accessible to White women and best handled through expensive and expert medical procedures.

Infertility So White

Whiteness has historically constructed infertility through medical rhetoric and racialized ideologies that depict women of color as hyper-fertile with limited access to reproductive health care options (Jensen, 2016). Yet the conspicuous presentation of White bodies on Instagram validates Whiteness within infertility overwhelmingly. For example, 114 of the 252 posts depicted White women, couples, or children. Comparatively, only six posts showed women of color or children of color. However, these limitations do not map on to what is known of Instagram users, who are primarily people of color. For example, in 2018, it was found that 45% of Instagram users were Latino, 38% were Black, and only 30% were Non-Hispanic White (Statista, 2018). Yet, while not the primary users, the most prominently displayed figures are White women whose image serves to cyclically reproduce dominant perceptions of infertility as primarily a White woman's problem.

Overwhelmingly, top posts centralizing White women were characterized by pain juxtaposed against happiness. Not merely does this presentation align with normative gendered expectations of (White) womanhood, whereby women are expected to enact positive emotions despite hardship, but so too does it speak to the racialized performance that allows for emotions expression by White women but not women of color (Hamad, 2019). Thus, sanctioning the emotional performance of White women provides a pathway toward resilience; that is, their ability to sustain forward and withstand setbacks (Jarvis, 2021a). For example, Figure 1 depicts a White woman wearing a White sundress, holding up a letter-board with a bright smile. In her caption, she writes about her excitement and underlying pride at retrieving double the number of expected eggs during her recent egg retrieval while also explaining her tempered hopes:

On average, our IVF clinic retrieves 16 eggs during retrieval, so our doctors were very excited that we doubled that. Also, it makes sense why I was in SO much pain in the days leading up to our retrieval. Even though we are very excited

FIGURE 1



FIGURE 2



over these numbers, we are not getting our hopes up because we know with infertility there are so many curveballs, so much unexpected defeat and heartache that comes up on this journey. We have learned that the hard way over the last 2 years.

Her comment, which speaks of heartbreak, is juxtaposed against optimism and pride in her retrieval. Similarly, in Figure 2, a young woman smiles from her hospital bed after her egg retrieval. She writes of her nerves and the hope she continues to hold, despite her setbacks and treatment failures, as she finds solace and resilience in life not going according to plan. Like many of the posts analyzed, Figures 1 and 2 exemplify resilient femininity as acutely available to White women (Jarvis, 2021a). Compared to those which center a woman of color and their children, these posts are attuned to pain and resilience. In this way, White women's pain gains precedence and women of color are, as has been deeply entrenched within racial discourses of infertility, presented as hyper-fertile. Ultimately, these patterns continue to reify infertility through the lens of a White woman's pain.

Further, Figures 1 and 2 illustrate a yearning for motherhood as these women grapple with their femininity and fertility. As the caption of Figure 2 goes on to read, "I want to tell YOU that you, and only you, determine your happiness. Your wholeness. Your fulfillment. Your feminism. Everything happens FOR us, not TO us. You are strong enough and are not alone." As previous research has attested (Whitehead, 2016), women experiencing infertility struggle to maintain a cohesive gender identity in the face of infertility, as womanhood is socially and culturally conditioned on motherhood. However, in sharing their pain and resilience online (primarily White, middle class, and partnered), White women gain social validation for their experiences and intrinsic worthiness of motherhood (Whitehead, 2016). Thus, the White femininity amplified on Instagram is evidenced not only through

emotional expression and resilience but so too through sociocultural systems that validate a White woman's deservedness for motherhood (Jensen, 2016). As (White) women cheerfully smiled through heartbreak, they affirmed their preparation and readiness for motherhood in so much as they were able to withstand hardship.

In contrast, the few women of color featured in the top posts were most frequently shown with young children, further enforcing the belief that Black women are uniquely hyper-fertile.¹ These stereotypes persist throughout infertility clinics and across social and cultural bonds, ultimately reducing the visibility of Black women seeking treatment (Jones, 2013). For example, posts picturing a Black family often included several children, including multiples. In Figures 1 and 2, resilience was strongly connected to a woman's ability to withstand involuntary childlessness; this resilience is made less readily available to women of color. Instead, women of color are seen as already having achieved motherhood and thus may be excluded from the homosocial network of sharing and support (Whitehead, 2016).

Infertility So Medical

As illustrated in Figure 1 and further evidenced throughout the data, the posts most prominently featured in the infertility hashtags often depicted a woman celebrating a continuum of success through the assistance of medicalization. These successes ranged from a bountiful egg retrieval, as evidenced in Figures 1 and 2, to pregnancy announcements that gleefully declared a "graduation" from the infertility clinic to the celebratory births of multiple healthy babies. As previous research attested (Johnson & Quinlan, 2016), the ideal fertility patient achieves success through the assistance of medical intervention. This idealism becomes evident in the algorithmic construction of infertility, as 48 of the 257 posts evidenced medically validated success, whether through a positive pregnancy test, a healthy pregnant woman, or young children. Further, 9 of the 48 postnatal posts included a healthy set of twins or multiples. And while there are an intense number of variables to consider, some estimates predict that assisted reproductive technologies only result in a successful live birth 52% to 78% of the time, although this is largely dependent on age and personal health (Malizia et al., 2009). In other words, success is not a guaranteed nor easily achievable outcome of infertility treatment.

Posts that gained an above-average amount of engagement and thus were more frequently circulated to the top of the algorithm search exhibited success in myriad ways, ranging from high-graded embryos to a glowing pregnancy to bouncing toddlers. The trend within the infertility community to document pregnancy and motherhood while reflecting on the trials of infertility reinforces linearity within treatment. Thus, not only do these most popular online discourses naturalize presumptions of success through IVF, but they also narrowly construct the medical pathway of treatment.

1. In considering our ethical commitments to privacy we decided not to include any posts featuring children as figures. Thus, given many of the posts featuring Black women also featured children, we did not include any example images. While this decision may reinforce the stratification we seek to critique, it nonetheless also exemplifies the limited and narrow diversity found within the infertility hashtags.

FIGURE 3



FIGURE 4



For example, many of the posts reiterate the value of medical intervention. Consider, for example, Figure 4, which celebrates the “3 high graded beautiful embryos that were created.” The embryo grading system is akin to eugenics, as embryos are subjectively evaluated on their ability to result in a successful pregnancy and genetically typical life (Regalado, 2017). Many clinics will opt only to transfer (or freeze) embryos with a higher perfection



Conclusion and Implications

In highlighting the digital normativity inherent within these infertility hashtags, we seek to showcase the algorithmic bias which may socially construct and reify existing reproductive disparities. However, in doing so, we do not seek to critique the individual users who have shared their strength, their pain, and their resilience online, but rather the posts studied in this project represent those that continue to circulate among the top posts—and thus become the most prominent images women see as they enter the virtual world of infertility. Essential questions can be raised about the means and freedom some women feel in sharing their infertility journey compared to others. For example, as within African American and Latinx communities, there exists a *social* expectation of motherhood (hooks, 1981), research suggested that women of color may be more inclined to maintain silence around the experience of infertility treatment (Ceballo et al., 2015). Thus, it may not be merely the algorithm itself but the individual means of freedom that allow White women to engage more freely with the Instagram infertility community.

Theoretically, this study draws focus and engagement to dominant patterns of normativity within algorithms. We seek to revitalize attention to how algorithms are both shaping and shaped by the sociopolitical realities of infertility. Through this critical engagement with automated tools, we move deeper toward the “rhetorical energies” that reshape health and medicine through persuasive processes that stratify the medical system (Coleman, 2021). As women engage with these hashtags, they are continually presented with information that rarely counters an infertility patient’s White, heteronormative, and middle-class idealization. For example, the minimal representation of Black women and women of color on Instagram may be indicative of shadow banning. While not an explicit nor intentional silencing, the erasure and/or the typified representation of women of color in the top posts only reinforces bias and racist presumptions. As the algorithm advances and recirculates images of traditionally feminine White women, these posts, in turn, gain increased engagement and traction on the platform. Replete of the human-oriented subjectivation process, these patterns highlight the deconstructive potential of automated algorithms to normalize dominant ideologies of infertility. As Fournieret and Yvert (2020) expend, the consequences of this automation on subjectivation are untold; however, within the context of infertility, these automated processes may begin to disembodify the patient further, especially those most vulnerably at risk of being ignored by the medical system.

Similarly, symbols of socioeconomic success are evident in the linguistic and paralinguistic presentation of various medical procedures. While some posts discussed the financial reality of treatment, more often the data reflected an unending investment in treatment and blurred the financial and material consequences of multiple rounds of IVF and embryo testing. This pattern only serves to advance medical expectations (Wardrope, 2015) of early intervention and success. While not uniquely American, this pressure for success is undoubtedly influenced by United States-centric values of persistence and risk-taking. Women are urged to expend material resources and pursue lasting medical solutions to successfully end any number of obstacles (Becker & Nachtigall, 1994; M. Lee, 2017). Thus, it is not merely the silent yearning for motherhood but so too the social and cultural pressures of motherhood that may urge women experiencing infertility to pursue motherhood regardless of cost.

Through the repeated privileging of White voices and White pain, this study reveals how the material realities of infertility treatment—that is, the wealth, Whiteness, and cis-gendered-ness enmeshed within treatment—become the dominant means through which experiences of infertility are presented online. However, as research on digital normativity would be quick to highlight, these patterns of sameness can quickly become the default standard for who *counts* within infertility treatment. Horst and Miller (2012) maintain that humanness becomes reconfigured virtually through the digital erasure of the material. Ultimately, as Whiteness and heteronormativity are amplified in top post algorithms, they only serve to regurgitate and fortify social construction and medicalization.

We argue for increased attention to how algorithms may communicatively constitute and socially construct existing health disparities. As illustrated in our analysis, algorithms hold communicative capabilities as they disseminate information and engender a particular worldview, reinforcing algorithmic bias through the unquestioned objectivity of AI. Future research should consider how algorithms communicate with users and explore the ample opportunities for advancements in methodological approaches. While the methods utilized in this study are grounded in a strong tradition of feminist and qualitative sensibilities, researchers should continue to push boundaries as they investigate and critique the role of algorithms in constituting the everyday.

Author Biographies

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References

- Akarsu, R. H., & Beji, N. K. (2021). Spiritual and religious issues of stigmatization women with infertility: A qualitative study. *Journal of Religion and Health*, 60(1), 256–267. <https://doi.org/10.1007/s10943-019-00884-w>
- Are, C. (2020). How Instagram's algorithm is censoring women and vulnerable users but helping online abusers. *Feminist Media Studies*, 20(5), 741–744. <https://doi.org/10.1080/14680777.2020.1783805>
- Becker, G., & Nachtigall, R. D. (1994). Born to be a mother: The cultural construction of risk in infertility treatment in the U.S. *Social Science and Medicine*, 39(4), 507–518. [https://doi.org/10.1016/0277-9536\(94\)90093-0](https://doi.org/10.1016/0277-9536(94)90093-0)
- Bell, A. V. (2016). The margins of medicalization: Diversity and context through the case of infertility. *Social Science & Medicine*, 156, 39–46. <https://doi.org/10.1016/j.socscimed.2016.03.005>
- Bell, A. V., & Hetterly, E. (2014). “There’s a higher power, but He gave us free will.” Socio-economic status and the intersection of agency and fatalism in infertility. *Social Science & Medicine*, 114, 66–72. <https://doi.org/10.1016/j.socscimed.2014.05.036>
- Blanchette, J. F. (2011). A material history of bits. *Journal of the American Association for Information Science and Technology*, 62(6), 1042–1057.
- Ceballo, R., Graham, E. T., & Hart, J. (2015). Silent and infertile: An intersectional analysis of the experiences of socioeconomically diverse African American women with infertility. *Psychology of Women Quarterly*, 39(4), 497–511.
- Coleman, M. C. (2021). Leveraging the rhetorical energies of machines: COVID-19, misinformation, and persuasive labor. *Human-Machine Communication*, 3, 11–26. <https://doi.org/10.30658/hmc.3.2>
- Collard, J. (2020). Abnormality as accumulation strategy: Orienting embryos to capital. *Annals of the American Association of Geographers*, 0(0), 1–16. <https://doi.org/10.1080/24694452.2020.1752138>
- Ergin, R. N., Polat, A., Kars, B., Öztekin, D., Sofuoğlu, K., & Çalışkan, E. (2018). Social stigma and familial attitudes related to infertility. *Turkish Journal of Obstetrics and Gynecology*, 15(1), 46. <https://doi.org/10.4274/tjod.04307>
- Eubanks, V. (2018). *Automating inequality: How high-tech tools profile, police, and punish the poor*. St. Martin's Press.
- Fourneret, E., & Yvert, B. (2020). Digital normativity: A challenge for human subjectivation. *Frontiers in Artificial Intelligence*, 3(27). <https://doi.org/10.3389/frai.2020.00027>
- Ginsburg, F. (2012). Disability in the digital age. In H. Horst & D. Miller (Eds.), *Digital anthropology* (pp. 101–126). Oxford.
- Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory: Strategies for qualitative research*. Aldine Publishers.
- Greil, A. L. (2002). Infertile bodies: Medicalization, metaphor, and agency. In M. C. Inhorn & F. van Balen (Eds.), *Infertility around the globe: New thinking on childlessness, gender, and reproductive technologies: A view from the social sciences* (pp. 101–118). University of California Press.

- Greil, A. L., & McQuillan, J. (2010). "Trying" times: Medicalization, intent, and ambiguity in the definition of infertility. *Medical Anthropology Quarterly*, 24(2), 137–156. <https://doi.org/10.1111/j.1548-1387.2010.01094.x>
- Greil, A. L., McQuillan, J., & Slauson-Blevins, K. (2011). The social construction of infertility. *Sociology*, 5(8), 736–746. <https://doi.org/10.1111/j.1751-9020.2011.00397.x>
- Guzman, A. L., & Lewis, S. C. (2020). Artificial intelligence and communication: A Human–Machine Communication research agenda. *New Media & Society*, 22(1), 70–86. <https://doi.org/10.1177/1461444819858691>
- Hamad, R. (2019). *White tears, brown scars*. Melbourne University Press.
- hooks, b. (1981). *Ain't I a woman: Black women and feminism*. South End.
- Horst, H., & Miller, D. (2012) Normativity and materiality: A view from digital anthropology. *Media International Australia*, 145, 103–111. <https://doi.org/10.1177/1329878X1214500112>
- Inhorn, M. C., Ceballo, R. R., & Nachtigall, R. (2009). Marginalized, invisible, and unwanted: American minority struggles with infertility and assisted conception. In L. Culley, N. Hudson, & F. van Rooji (Eds.), *Marginalized reproduction: Ethnicity, infertility, and reproductive technologies* (pp. 181–197). Earthscan.
- Jain, T. (2006). Socioeconomic and racial disparities among infertility patients seeking care. *Fertility and Sterility*, 85(4), 876–881. <https://doi.org/10.1016/j.fertnstert.2005.07.1338>
- Jarvis, C. M. (2021a). Expanding feminist resilience theorizing: Conceptualizing embodied resilience as a material-discursive process during infertility. *Journal of Applied Communication Research*. Advance online publication. <https://doi.org/10.1080/00909882.2021.2011373>
- Jarvis, C. M. (2021b). Invitational rhetoric in epistemic practice: Invitational knowledge in infertility support groups. *Rhetoric of Health & Medicine*, 4(1), 1–32. <https://doi.org/10.5744/rhm.2021.1002>
- Jensen, R. E. (2016). *Infertility: Tracing the history of a transformative term*. Penn State Press.
- Johnson, B. L., & Quinlan, M. M. (2016). For her own good: The expert-woman dynamic and the body politics of REI treatment. *Women & Language*, 39, 127–131.
- Johnson, B. L., Quinlan, M. M., & Pope, N. (2019). #ttc on Instagram: A multimodal discourse analysis of the treatment experience of patients pursuing *in vitro* fertilization. *Qualitative Research in Medicine & Healthcare*, 3, 1–14.
- Johnson, B. L., Quinlan, M. M., & Pope, N. (2020). "Sticky baby dust" and emojis: Social support on Instagram during *in vitro* fertilization. *Rhetoric of Health and Medicine*, 3(3), 320–349. <https://doi.org/10.5744/rhm.2020.1017>
- Jones, C. (2013). 'Human weeds, not fit to breed?': African Caribbean women and reproductive disparities in Britain. *Critical Public Health*, 23(1), 49–61.
- Kirschenbaum, M. G. (2008). *Mechanisms: New media and the forensic imagination*. The MIT Press.
- Kumar, N., & Singh, A. K. (2015). Trends of male factor infertility, an important cause of infertility: A review of literature. *Journal of Human Reproductive Science*, 8(4), 191–196.
- Lee, F., & Björklund Larsen, L. (2019). How should we theorize algorithms? Five ideal types in analyzing algorithmic normativities. *Big Data & Society*, 6(2). <https://doi.org/10.1177/2053951719867349>

- Lee, M. (2017). Don't give up! A cyber-ethnography and discourse analysis of an online infertility patient forum. *Culture, Medicine, and Psychiatry*, 41(3), 341–367. <https://doi.org/10.1007/s11013-016-9515-6>
- MacKenzie, D. (2009). *Material markets: How economic agents are constructed*. Oxford University Press.
- Malizia, B. A., Hacker, M. R., & Penzias, A. S. (2009, January 15). Cumulative live-birth rates after in vitro fertilization. *New England Journal of Medicine*, 360, 236–243. <https://doi.org/10.1056/NEJMoa0803072>
- McBain, T. D., & Reeves, P. (2019). Women's experience of infertility and disenfranchised grief. *The Family Journal*, 27(2), 156–166. <https://doi.org/10.1177/1066480719833418>
- Mishler, E. G., Amarasingham, L., Hauser, S. T., Osherson, S. D., Waxler, N. E. & Liem, Ramsay. (1981). *Social contexts of health, illness, and patient care*. Cambridge University Press.
- Myers West, S. (2018). Censored, suspended, shadowbanned: User interpretations of content moderation on social media platforms. *New Media & Society*, 20(11), 4366–4383. <https://doi.org/10.1177/1461444818773059>
- Noble, S. U. (2018). *Algorithms of oppression*. New York University Press.
- Perone, H. A., Herweck, A. M., Stump, H. M., Levine, H. M., Wong, A. J., & Carugo, J. (2021). The virtual infertility community: A qualitative analysis of patient experiences shared on Instagram. *Journal of Assisted Reproduction and Genetics*, 38.
- Regalado, A. (2017, November 1). Eugenics 2.0: We're at the dawn of choosing embryos by health, height, and more. *MIT Technology Review*. <https://web.archive.org/web/20201101160646/https://www.technologyreview.com/2017/11/01/105176/eugenics-20-were-at-the-dawn-of-choosing-embryos-by-health-height-and-more/>
- Saldaña, J. (2009). *The coding manual for qualitative researchers*. Sage.
- Sandvig, C., Hamilton, K., Karahalios, K., & Langbort, C. (2016). Automation, algorithms, and politics when the algorithm itself is a racist: Diagnosing ethical harm in the basic components of software. *International Journal of Communication*, 10(2016), 4972–4990.
- Schwerdtfeger, K. L., & Shreffler, K. M. (2009). Trauma of pregnancy loss and infertility among mothers and involuntarily childless women in the United States. *Journal of Loss and Trauma*, 14(3), 211–227. <https://doi.org/10.1080/15325020802537468>
- Statista. (2018). Daily Instagram usage in the United States as of August 2018, by ethnicity. <https://web.archive.org/web/20210915171912/https://www.statista.com/statistics/945939/daily-frequency-usage-instagram-usa-ethnicity/>
- Tracy, S. J. (2019). *Qualitative research methods: Collecting evidence, crafting analysis, communicating impact*. John Wiley & Sons.
- Ullah, A., Ashraf, H., Tariq, M., Aziz, S. Z., Zubair, S., Sikandar, K. U. R., Ali, N., Shakoor, A., & Nisar, M. (2021). Battling the invisible infertility agony: A case study of infertile women in Khyber Pakhtunkhwa-Pakistan. *Journal of Ethnic and Cultural Studies*, 8(2), 89–105.
- Veil, S. R., Sellnow, T. L., & Petrun, E. L. (2012). Hoaxes and the paradoxical challenges of restoring legitimacy: Dominos' response to its YouTube crisis. *Management Communication Quarterly*, 26(2), 322–345. <https://doi.org/10.1177/0893318911426685>

- Wardrope, A. (2015). Medicalization and epistemic injustice. *Medicine, Health Care and Philosophy*, 18(3), 341–352. <https://doi.org/10.1007/s11019-014-9608-3>
- Whitehead, K. (2016). Motherhood as a gendered entitlement: Intentionality, “othering,” and homosociality in the online infertility community. *Canadian Review of Sociology/Revue canadienne de sociologie*, 53(1), 94–122. <https://doi.org/10.1111/cars.12093>
- Wieviorka, M. (2012). Du concept de sujet à celui de subjectivation/dé-subjectivation. Working Paper 16. Paris: Fondation Maison des Sciences de l’Homme.
- Wilcox, L. S., & Mosher, W. D. (1993). Use of infertility services in the United States. *Obstetrics and Gynecology*, 82(1), 122–127. PMID: 8515911.
- World Health Organization. (2018). International classification of diseases, 11th revision (ICD-11). Geneva.
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