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Negative and Positive Influences on the Sensations Evoked by Artificial Sex Partners: A Review of Relevant Theories, Recent Findings, and Introduction of the Sexual Interaction Illusion Model

Jessica M. Szczuka, Tilo Hartmann, and Nicole C. Krämer

Abstract The aim of this chapter is to provide a framework which structures different aspects that might positively and negatively influence the sensations nonliving sexual partners might evoke in order to guide future empirical research in the investigation of sexual responses toward machines. For this purpose, influential concepts from media psychology, human–machine interaction, and sexual science are explained and transferred to interactions with sex robots. This theoretical foundation is then used to develop the sexual interaction illusion model, which aims to conceptualize factors that are shaping users' psychological immersion in sexual interaction with technology-based sex partners. More specifically, the model focuses on understanding users' subjective (illusionary) experience that the interaction with an artificial partner feels like a sexual interaction with an existing, living social being.

Keywords Artificial sex partner · Sexual interaction illusion · Sexualized robots · Sexual scripts

1 Relevance

"Each and every instrument of communication that has been devised to date by men (including television) has been almost immediately turned to the service of what the culture in which it was invented called 'pornography'" (p. 33). This statement by

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Gordon (1980) illustrates that humans have used numerous technological developments to fulfill their sexual needs even if the technology's primary purpose was something else. While robots until now have primarily been used to assist humans based on their robustness (e.g., executing movements quickly and repeatedly or lifting heavy parts), there are first attempts to build social robots which are specifically designed for interactions with humans (Bar-Cohen & Hanson, 2009). In line with the initial statement by Gordon (1980), robotics have also developed in the direction of using robots for sexual pleasure. Different companies are working on prototypes of robots that can be used for sexual interactions. For example, the company Realbotix™ offers a robotic head system that can be mounted to the body of a hyper-realistic sex doll (Bartneck & McMullen, 2018). The robotic head is likely to fundamentally affect interactions with users, as it allows the impression to be created that the robot is able to engage in natural communication, even accompanied by matching facial expressions. In the near future, the whole body of a robot is supposed to be equipped with technology that will illuminate rich social interaction features known from human encounters, ranging from verbal and nonverbal reactions based on the user's touch to a heating system which aims to convey the impression of body temperature (CNET, 2017).

While sex dolls have been commercially available for years (Ferguson, 2010), the emerging possibility to sexually interact with robots seems to divide opinion. On the one hand, there are people who argue that the robots will provide an opportunity to act out sexual needs and fantasies (e.g., Levy, 2008). On the other, there are also people who advocate against the usage of the technology as it could, for example, cause negative consequences for the societal standing of women (e.g., Richardson, 2016). Academic research on sex robots at the moment is mainly composed of ethical considerations (e.g., Sullins, 2012). However, the emerging hopes and worries about sexualized robots require careful empirical scrutiny, too, as, for instance, a recent report from the Foundation for Responsible Robotics on sex robots remarks (Sharkey, van Wynsberghe, Robbins, & Hancock, 2017). The present scarcity of existing empirical research on how people experience and respond to sexualized robots might be due to the fact that the technology is just emerging and that scientific research has a tendency to neglect research on sexual aspects of technology usage (Brewer, Kaye, Williams, & Wyche, 2006). But research on how people experience and respond to artificial sex partners is important in order to facilitate the responsible evidence-based handling of sexualized technologies. For example, if research reveals risks such as potentially problematic influences on attitudes or relationship building, this would provide essential information to policy makers.

Therefore, one of the main aims of this chapter is to provide a framework which structures different aspects that might positively and negatively influence the sensations nonliving sexual partners might evoke in order to guide future empirical research in the investigation of sexual responses toward machines. For this purpose, influential concepts from media psychology, human–machine interaction, and sexual science are explained and transferred to interactions with sex robots. This theoretical foundation is then used to develop the *sexual interaction illusion model*, which aims to conceptualize factors that are shaping users' psychological immer-

sion in sexual interaction with technology-based sex partners. More specifically, the model focuses on understanding users' subjective (illusionary) experience that the interaction with an artificial partner feels like a sexual interaction with an existing, living social being.

Indeed, the main difference between already existing (potentially more "accepted") sex dolls and (potentially more debated) future sex robots is the ability of the latter to act interactively and to communicate in natural language. We argue that, therefore, sexualized robots are more powerful in triggering what we address as the *sexual interaction illusion*, which entails the subjective sensation of users to sexually interact with a real sex partner. More specifically, we argue that the sensation to interact with a real sex partner includes the subjective perception among users that the other is really present (in the here and now), physically embodied and alive (rather than just inanimate or lifeless technology), and human (if the other is meant to display a human character). Our concept of sexual interaction illusion is closely related to the concept of sexual trance, which was presented as one factor that contributes to a fully satisfying sexual experience in the sexual involvement theory (Mosher, 1988). Sexual trance is described as "…an altered state of consciousness…" (p. 11) that is explained to manifest itself in aspects such as "alterations in thinking (such as changes in attention and concentration, archaic modes of thought, decreased reflective awareness)" (p. 11) and "loss of control" (p. 11).

Sexual responses that the robots might be able to evoke throughout the interaction are accompanied by distinctive motivations, perceptions, and evaluations (Ariely & Loewenstein, 2006; Skakoon-Sparling, Cramer, & Shuper, 2016) that might positively foster the sexual interaction illusion. However, as robots differ from known human sex partners, sexual interaction with them might also trigger reflective thoughts that could interfere with—or negatively influence—the illusion. Therefore, the sexual interaction illusion model aims to grasp factors of sexualized robots that both potentially positively and negatively affect sexual arousal and, consequently, the sexual interaction illusion among users.

2 Theoretical Background

2.1 Social Reactions Toward Artificial Interaction Partners

A couple of media psychological theories about social reactions toward machines provide the theoretical foundations of the sexual interaction illusion model. We briefly review these theoretical foundations here, before explicating the model in more detail. Artificial sex partners are constructed to fulfill sexual needs. Their behavioral and communicative abilities are tailored to create sexual intimacy (e.g., Bartneck & McMullen, 2018). Accordingly, the appearance of sex robot prototypes is strongly sexualized. For example, they provide numerous human-like cues that would not be of relevance for robots (e.g., facsimile of female and male genitalia).

The combination of movements that represent nonverbal behavior, audio output which resembles the human ability to communicate verbally, and human-like (sexualized) visual cues make it more likely that users will respond socially toward artificial entities as they would do to other people. The idea that humans react socially toward artificial entities is probably most strongly advocated by the media equation theory by Reeves and Nass (1996). Numerous related empirical studies revealed that people, in general, treat and respond to computers, robots, and even virtual representations of humans in the same way they would treat and respond to other human individuals (e.g., Hoffmann, Krämer, Lam-chi, & Kopp, 2009; Nass & Moon, 2000; Powers et al., 2005; Reeves & Nass, 1996). Studies could, for instance, show that humans react politely to computers and agents (Hoffmann et al., 2009; Nass, Steuer, & Tauber, 1994), that they assign social categories to artificial entities and act accordingly (e.g., by applying stereotypes, Powers et al., 2005), and that computer-generated flattery results in similar reactions as flattery from a human, even if the participants know that the feedback is created randomly (Johnson, Gardner, & Wiles, 2004).

According to media equation theory, artificial interaction partners that provide social cues suggesting that the nonliving entity is capable of engaging in social interactions automatically activate the so-called social scripts, which subsequently guide users' mindless responses. Nass and Moon (2000) argue that the relevant social cues that contribute to these mindless social responses toward artificial interaction partners include speech as a form of communication, the interactivity of an interaction, and the performance of roles which are normally carried out by humans. However, although people might routinely respond mindlessly to computers and artificial agents (as if they were real social interaction partners), media equation theory also highlights that if asked, people are still aware they know that they are interacting with technology that does not warrant any social treatments. According to the theory, people only stay ignorant of this knowledge in their mostly automatic and "scripted" social responses. Accordingly, if viewed through the lens of media equation theory, users might automatically respond to artificial sexual interaction partners as they would respond to real-life counterparts, despite consciously knowing that they are only interacting with technology. Adapting media equation theory to artificial sex partners provides the basis of the sexual interaction illusion model: We assume that users might experience nonhuman sex partners in similar ways as (equivalent) real social interaction partners.

2.2 Willing Suspension of Disbelief

While media equation theory focuses on mindless behavior to explain people's social responses to machines, willing suspension of disbelief represents an alternative theoretical account that might explain how conscious knowledge about the artificial entity's nature is overcome. Willing suspension of disbelief originally described the process of getting involved with and accepting fiction. The

mechanism deals with users' suppression of aspects that might differ from the real world in order to get fully involved with a stimulus (Coleridge, 1817). The concept was brought up for watching stage plays at theaters, was then applied to the process of watching movies which display fictional stories, and has already been used to explain why people might engage in social interactions with robots (Duffy & Zawieska, 2012). Murray (2001) expanded the approach by stating that if entering a fictional world, people are not just suspending disbelief but rather actively creating belief. "Because of our desire to experience immersion, we focus our attention on the enveloping world and we use our intelligence to reinforce rather than to question the reality of the experience" (p. 107).

Adapted to interactions with artificial sex partners, this means that users may play an active part in the creation of the potentially evoked sexual interaction illusion by using their imagination. This process of actively creating a world requires fantasy, a concept that has been shown to be of importance in sexual interactions. Not only during masturbation but also while engaging in sexual intercourse, both men and women use their imagination in order to enhance sexual arousal (Leitenberg & Henning, 1995; Sue, 1979). Consequently, the usage of fantasy in sexual interactions with artificial entities might help people to overlook potential glitches and cues that remind of the partner's artificial nature. However, it is likely that even the most proficient artificial sex partners will still display cues that identify them as nonliving entities (e.g., errors in the audio output, jerky movements or if the system has to reboot), and some of these cues might be hard if not impossible to ignore. These cues might, therefore, disclose and underline the inappropriateness of the intimate interaction (compare Nass & Moon, 2000). It is imaginable that the mix of cues suggesting that the interaction partner is able to interact socially and at the same time is a nonliving entity might result in confused social reactions that negatively affect the user's sexual arousal. A related situation was feature, for example, in the movie "Blade Runner 2049," in which the protagonist and his female artificial partner wanted to kiss each other. Right before she could kiss him back, her behavior stopped in order to display an incoming message, which "broke the spell" and the romantic illusion ("Blade Runner 2049," 2017). Based on these elaborations, we argue that people who actively engage in sexualized interactions with artificial interaction partners are able to overlook minor flaws in their performance, while there might be still reminders of the others' artificiality that are difficult to suppress even with a willing suspension of disbelief.

In conclusion, media equation theory and suspension of disbelief both substantiate the idea that people tend to respond to sexualized robots in almost the same way as they would respond to other humans (including reactions of sexual arousal). Furthermore, active engagement in a sexualized interaction might help to foster the sexual interaction illusion "in the heat of the moment". However, a closer look at media psychology, sexual science, and social science provides reason to move beyond this basic idea and take a more nuanced view. Sexualized robots might entail characteristics that could not only trigger but also interfere with the sexual interaction illusion. Those characteristics, or factors, are structured in the sexual interaction illusion model.

3 Sexual Interaction Illusion Model

As the review revealed, users' social responses to artificial others hinge on both their mindless or automatic and also reflective processing of these others. To the extent users stay mindful and aware of the fact that the other is merely artificial, they might perceive these interaction partners as technological artifacts, and adapt their responses accordingly. In other words, the more reflective users stay during these encounters, the less social their responses might be. However, to the extent users either intentionally suppress their knowledge about the artificiality of the other or are prone to automatically displaying mindless responses, they might respond more socially, akin to how they respond in real social encounters. This general principle should also apply to how users respond to sexual encounters with artificial others.

A key question regarding encounters with artificial others then becomes to what extent users are able to maintain the illusion that the other is a real social being rather than a technological artifact. The intensity of the illusion should depend on users' ability to suppress or ignore their certainty about the other being "not real" and that an encounter "is not really taking place right here and now". This illusion might be particularly relevant in sexual encounters with artificial others since the use of sexualized technology might be driven by the intention to participate in sexual activities in order to pursue one's own sexual pleasure, potentially resulting in an orgasm (Safron, 2016). Other reasons for participating in sexual activities range from the desire to express closeness to the relief of sexual tensions (Leigh, 1989). Either way, it seems likely that it is important for users to experience the interaction with a robot as social in order to accept the intimate sexual nature of the interaction and to ultimately achieve sexual satisfaction. To foster this illusion, it might be necessary to suppress awareness about the artificialness of the partner (except for people whose preferences deviate from the norm by preferring to have sex with objects, Worthen, 2016). When this suppression is successful, the user might become immersed in the sexual interaction illusion, whereas failure to suppress awareness of the robot's artificiality might hamper the illusion.

Because the theories on which the sexual interaction illusion model is based are not gender- or sexuality-specific, the process of evoking the sexual interaction illusion might apply to all humans engaging in sexual interactions with artificial entities. Even though the market of sex dolls (which represent the preliminary stage of sex robots) strongly suggests that heterosexual representations will be predominant (e.g., about 80% of the customers of sex dolls are male and 80% of the produced sex dolls represent the female gender), and artificial representations of artificial partners are predominantly female (Bartneck & McMullen, 2018), we argue that the conceptualized influences on the process of how sexual interaction illusion might be evoked do not apply to heterosexual males only. It is imaginable that artificial sex partners might serve as a safe environment (without the fear of being judged) in the process of testing of what one might think to be a sexual boundary (e.g., gender specificity). Accordingly, the sexual interaction model might be equally applicable to, for example, homosexual encounters.

A sexual interaction illusion is not a delusion. Despite users' powerful sensation of participating in a sexual interaction with a real (living) partner, they are unlikely to forget the fact that the other is artificial. From our perspective, an illusion is characterized by the automatic sensation (or imagined sensation) that something is the case, while knowing it is not. Accordingly, in illusions, people stay aware of the illusionary (or artificial) character of sensations. According to the sexual interaction illusion model, the fact that even if the illusion unfolds, users are prone to staying somewhat aware of the artificial nature of the other does not mean that their sexual experience and satisfaction is hampered. Quite on the contrary, the sexual interaction illusion might provide the strongest pleasure and satisfaction if it is well maintained, and users have a powerful sensation to have "real sex with a real person" while still knowing that this is not the case. This hybrid nature characterizing the sexual interaction illusion might offer users the opportunity to engage in seemingly real, sanction-free, more exploratory, and daring sexual behavior that they otherwise might shy away from trying out. Potentially, this "living out of sexual fantasies" might enhance users' sexual satisfaction. This aspect was already described as one benefit of pornography/pornographic pictures: "[…] it permits, with less risk of negative affect than in everyday reality, the exploration in erotic reality of a range of fantasied variations around the core of a preferred sexual path within the script to discover the erotic potential, if any, of sexual variations in partners, acts, roles, orientations, and meanings" (pp. 71–72, Mosher, 1988). Likewise, sexualized robots might allow for experiences that are stimulating not only in a physiological sense but also with regard to the necessity to render reality and illusion compatible.

Next to reflecting the hybrid nature of illusions, another central aspect of the sexual interaction illusion model is the idea that sex robots might trigger both approach and avoidance tendencies in users. On the one hand people might be drawn toward sexual interactions with artificial entities, while on the other hand they might avoid the very same intimate interactions based on deeply rooted mechanisms of aversion and violations of sexual and societal norms. Sex robots might typically foster these classic approach–avoidance conflicts as described in theories by Lewin (1935) or as applied by Miller and Dollard (1941). Approach–avoidance conflicts are defined as situations in which a goal or an event has both positive and negative characteristics that make them simultaneously appealing and unappealing. Therefore, a person might be drawn to the goal and at the same time wants to avoid it. If both characteristics are equally strong, this might lead to indecision. If one is stronger, the corresponding behavioral tendency holds. In encounters with sex robots, factors motivating approach tendencies might be thought of as factors positively influencing the social interaction illusion, while factors motivating avoidance tendencies might represent factors negatively influencing the social interaction illusion.

This basic notion underpins the sexual interaction illusion model, as depicted in Fig. 1. As the figure shows, the model includes aspects that might negatively or positively influence the arousal a person might feel if confronted with a sexualized technology, and, consequently, the sexual interaction illusion.

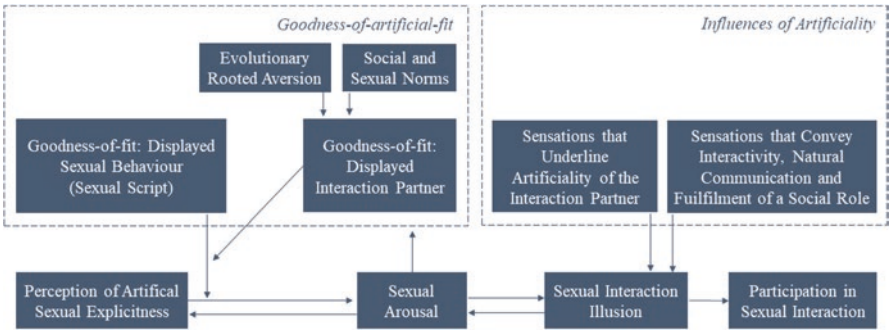

Fig. 1 The sexual interaction illusion model

Before we proceed with an in-depth explication of all concepts included in the model, we provide a short summary of the model in order to highlight some key mechanisms of the model. The model's path from users' perception of the artificial sexual explicitness to sexual arousal, followed and accompanied by the sexual interaction illusion, to participation in the sexual interaction represents different states that users are supposed to go through. As the arrows illustrate, we believe that these states can affect each other in multiple ways. For instance, while sexual arousal might trigger the sexual interaction illusion, once a user reaches the point in which s/he experiences the illusion with an artificial sex partner, sexual arousal might be further enhanced. Factors that might positively or negatively affect users' states are resumed in the dashed boxes and include the goodness-of-artificial-fit and potential influences of the artificiality of the technology.

The goodness-of-artificial-fit is based on considerations by Mosher (1988) who postulated that in order to get sexually aroused by a displayed scene (in the original work he referred to pornography), there has to be a goodness-of-fit between the displayed sexual behavior (including the social roles the actors are performing) and the individual's own sexual script. The sexual script is a set of rules that defines how people evaluate and perceive sexualized behaviors. If adapted to sex robots, this implies that sexual arousal might also hinge on the goodness-of-fit of the displayed behavior and goodness-of-fit of the displayed interaction partner. Sexualized interactions with artificial entities might be influenced by violations not only of social but also of sexual norms. For instance, while perceiving a sexually explicit sex robot, a user might instinctively reflect the fact that s/he would deviate from sexual norms if engaging in a sexual interaction (Worthen, 2016) or the social stereotype of not being able to have a human sex partner (Levy, 2008). These considerations might result in a poor goodness-of-fit of the interaction partner and consequently might negatively influence sexual arousal. Consequently, also the sexual interaction illusion might be diminished.

Another important set of intervening factors included in the model is labeled as "influences of artificiality." These factors are derived from media equation theory. Following this theory, we assume that certain social cues of a sex robot, namely

interactivity, natural language, and the social role the robot is representing, positively contribute to the resulting sexual interaction illusion. Vice versa, aspects that underline the robot's artificialness and that cannot be suppressed by suspension of disbelief (for instance system errors that might cause an intermission of the interaction) negatively affect the resulting sexual interaction illusion (compare Nass & Moon, 2000; Reeves & Nass, 1996). In the following, the theoretical foundations and initial empirical results substantiating the factors conceptualized in the model will be explained in more depth.

3.1 Perception of Artificial Sexual Explicitness

The sexual interaction illusion model starts out with the assumption that users' perception of sexual explicitness triggers sexual arousal. We think of this as stimulus–response reaction, with the number and explicitness of cues determining the resulting sexual arousal. The cues can be represented as verbal (Heiman, 1977) and nonverbal signals (predominantly the appurtenance and behavior). The response is likely to follow if the decisive cues are present, even if in more abstract or symbolic form, and independent of the extent to which they look photorealistic (see, for example, the community of people who get aroused by pornographic mangas and hentai porn, Ortega-Brena, 2009). Sexualized robots might commonly display auditive and visual aspects that users internalized as arousing. By means of an affective priming task, Szczuka and Krämer (2017) demonstrated that for heterosexual men the concept of attractiveness was associated with equal strength with women and female-looking robots. The authors assumed that the visual cues of robots (e.g., their shape, including breasts) activated deeply rooted perception mechanisms and according reactions toward unambiguously female cues.

Once triggered, sexual arousal might also influence the way people perceive the artificial sex partner and thus the perception of sexual explicitness (see related backward arrow in Fig. 1). With regard to sexual explicitness, Nummenmaa, Hietanen, Santtila, and Hyönä (2012) reported that people spend more time looking at the chest and pelvic region of a person once this person is shown naked, compared to fully covered in clothing. The authors argue that this is a deeply rooted mechanism helping people to efficiently gather visual information that is important in terms of mating and reproduction.

3.2 Goodness-of-Artificial-Fit

According to the model, the impact of a sex robot's sexual explicitness on sexual arousal is influenced by an interaction of the normative fit of both the displayed sexual scene/behavior and the type of interaction partner itself. A poor fit might trigger evolutionarily rooted processes of aversion that might substantially weaken the expected impact of sexual implicitness on sexual arousal.

3.2.1 Influence of Sexual Scripts (Goodness-of-Fit of Sexual Behavior and Interaction Partner)

Regarding the consumption of pornographic videos, Mosher (1988) argues that the displayed scenes need to be compatible with the sexual script an individual has. Given that also artificial entities will display specific behaviors, it needs to be guaranteed that they match the sexual script of the individual. The sexual script theory is based on work of Gagnon and Simon (1973) in which they defined sexual scripts as sets of rules that form the basis of how sexual information is processed. Those sexual scripts are formed not only by culture but also by personal experiences and mental representations of sex. Regarding pornography, the coherence between the displayed sexual behavior in the scene and the individual's sexual scripts is called goodness-of-fit. A good fit results in deeper involvement with the displayed sexual fantasy and eventually contributes to a sexual response (Mosher, 1988). With artificial sex partners, it might even be easier to achieve goodness-of-fit because contrary to noninteractive photographs or videos, artificial sex partners are able to spontaneously adjust the verbal and nonverbal behavior to match the user's sexual preferences.

In our model, we moreover argue that the displayed interaction partner might further moderate the qualifying impact of goodness-of-fit of the scene on the impact of explicitness on arousal, resulting in a double moderation. This aspect may be of special importance for virtual interaction partners that can easily be adjusted in appearance, resulting in different types of sex partners. Adjustments in appearance do include not only characteristics such as body shape and clothing/accessories but also changes in sexual characteristics like gender or a modification of the species to something that provides human-like cues, like eyes and a mouth while not being human (for instance, machine-like robots). Related changes might have an influence on the goodness-of-fit of the displayed sexual behavior. For example, it is imaginable that a user does not want to engage in aggressive behavior (as it is frequently displayed in pornography and therefore potentially internalized in the sexual scripts; compare Bridges, Sun, Ezzell, & Johnson, 2016) with a human-looking interaction partner, while it might address one of his or her sexual fantasies if the target does not resemble human form. Similarly, users might be normally attracted to (and aroused by) certain sexual behavior, but not if displayed by a certain type of sex robot, or a sex robot at all.

If users realize that they are in a sexual interaction (a process which among humans is associated with mating and producing offspring) with a nonliving entity, deeply rooted evolutionary psychological mechanisms of aversion might be triggered. MacDorman, Green, Ho, and Koch (2009) argue that this defense mechanism is evolutionary-driven as it aims to protect our species because robots do not represent a genetically adequate mating partner. This can be understood as one explanatory approach for the uncanny valley phenomenon. This states that realistic, but not yet perfect, human-like robots will evoke negative evaluations and yield a feeling of eeriness once they reveal subtle flaws that interfere with the illusion of being a human (MacDorman et al., 2009; Mori, 1970).

While first empirical studies on the uncanny valley theory in which participants have been confronted with an android robot focused on how participants initially react toward robots (Bartneck, Kanda, Ishiguro, & Hagita, 2009; Rosenthal-von der Pütten, Hoffmann, Klatt, & Krämer, 2011), there is no empirical data on the reactions toward robots which are built to have a sexual interaction with. However, the presented examples might suggest that evolutionary rooted processes of aversion could be of importance with regard to sexualized interactions with artificial interaction partners.

3.2.2 Influence of Social Desirability: Social and Sexual Norms

Next to deeply rooted mechanisms of aversion, there are also reasons to believe that people might avoid artificial sexualized partners based on potential violations of social and sexual norms (compare social desirability, Krumpal, 2013). These norms are strongly affected by the change of time. Levy (2008), for instance, forecasted that by the time it will be more common to have robotic assistance in households, it will not take long until it will be socially accepted to even marry robots. Regarding the violation of sexual norms, having sexual interactions with an object, which is also accurate for artificial sex partners, is categorized as paraphilia (Briken, von Franqué, & Berner, 2013; Ferguson, 2010; Worthen, 2016). The fact that sexualized interactions with an artificial sex partner deviates from current sexual norms may contribute to the avoidance of participating in sexual activities. However, because sexual norms are strongly affected by changes of time (Worthen, 2016), the influences of this variable need to be investigated with respect to changes of sexual norms.

With regard to the influence of social norms, one has to consider the societal understanding of artificial sex partners. With regard to sex robots, society is frequently confronted with the stereotypical representation that people who are emotionally and sexually drawn to artificial sex partners are lonely males who are incapable of finding a human partner. Examples for the replication of the stereotype can not only be found in newspaper articles (e.g., Das, 2017) but also in movies, such as Lars and the Real Girl ("Lars and the Real Girl," 2007). This is in line with a notion of the scholar David Levy (Levy, 2008) who claims that robots might help people who do not engage in romantic and sexual relations.

> Almost everyone wants somebody to love, but many people have no one. If this natural desire can be satisfied for everyone who is capable of loving, surely the world would be a much happier place. Many who would otherwise have become social misfits, social outcasts, or even worse will instead be better-balanced human beings (p. 304).

Szczuka and Krämer (2017) conducted a study in which they aimed to not only investigate differences in the explicit and implicit reactions toward sexualized female-looking robots but moreover they wanted to examine whether loneliness would be associated with the attractiveness ratings of the robots. The results showed that loneliness, importance of social contacts, fear of rejection, and the individual degree of interaction deficits did not predict the attractiveness ratings of robots. Therefore, the authors did not empirically confirm the stereotype of the lonely person who might be more drawn to sexualized robots.

Another aspect that might shape the societal understating of artificial sex partners might be negative societal consequences associated with the usage of the different technologies. The most prevalent example for this is the campaign against sex robots (Richardson, 2016). Here, negative concerns that are associated with the usage of technology with an emphasis on the societal standing of women are raised. The founder argues that the usage of sexualized robots might contribute to the objectification of women and children and that relationships with robots might decrease the sense of empathy humans develop through relations with other humans.

3.3 Sexual Arousal

While it is likely that both the evolutionary rooted processes of aversion and also societal and sexual norms rather have a negative effect on sexual arousal, we argue that sexual arousal can also diminish the importance of at least societal and sexual norms (see related arrow in Fig. 1). Sexual arousal is a combination of physiological and psychological changes within an individual based on an externally existing or internally imagined sexual stimulus. It manifests the motivation to engage in sexual behavior (Chivers, 2005; Frijda, 1986). Sexual arousal leads to a specific form of attentional focus on the aspects that are arousing rather than on distal aspects that constrain the arousal. Skakoon-Sparling et al. (2016) explained this by stating:

> […] sexual arousal incites a form of myopia, or tunnel vision, where attentional focus is placed on the object of desire, in this case, sexual gratification, and on the self (i.e., one's own enjoyment/pleasure), rather than being placed on more distal factors such as concern for others or on future considerations" (p. 34).

Based on these findings we argue that sexual arousal may have the potential to relocate the attention toward arousing factors of the artificial sex partner rather than on potential societal and sexual norms. We argue that the sexual arousal drives the sexual interaction illusion and makes a difference to the way people engage in interactions with artificial interaction partners: They rather accept them as real in a sexualized context as compared to how they would perceive the same interaction partner in a nonsexualized setting (e.g., if interacting with the robot in order to organize daily life, a task many robotic assistants are built for). This is mainly because of the relocated attention and the resulting sexual interaction illusion which causes a change in motivation to pursue a sexual behavior.

3.4 Sexual Interaction Illusion and the Resulting Participation in Sexual Behavior

In combination with sexual arousal, the sexual interaction illusion is at the center of the model. Based on the perception of displayed sexually explicit (visual, auditory, and haptic) cues and the resulting sexual arousal, a state is achieved in which the

user harbors the illusion of a sexual activity. This state not only affects the way individuals perceive the artificial sex partner as present and embodied without questioning the artificialness of it but also the sexual interaction itself is perceived as a form of sexual trance which also occurs during sexual interactions with other humans. The sexual interaction illusion is strongly connected to the behavior level (see "participation in a sexual activity" as displayed in the model), in the sense that increased sexual interaction illusion will lead to increased willingness to start and/or proceed with sexual interactions.

We propose that the artificialness of the sex partner might influence the sexual interaction illusion in both positive and negative ways. Firstly, we argue that cues that facilitate the reciprocity of the interaction might enhance the sexual interaction illusion as it contributes to both, not only the illusion that the sex partner is real but also that the sexual interaction follows dynamics that would also occur during sexual interactions with other humans. As reciprocity is also a basic element of sexual interactions among humans (Svab, 2010) and since it was already demonstrated that humans do apply this social dynamic in interactions with robots (Sandoval, Brandstetter, Obaid, & Bartneck, 2016), it further fuels the illusion that the sexual interaction is really taking place. An example might be that the artificial interaction partner expresses their attraction to the user while the user may also enjoy performing actions that seem to be enjoyable for the artificial interaction partner.

3.5 Influences of Artificiality

The last factors that might enhance or reduce the sexual interaction illusion, the sexual arousal, and therefore the motivation to participate in sexual interactions are the artificial sex partner's technological aspects. According to media equation theory, a technology might provide social cues (interactives, natural language, and the fulfillment of social roles) that can activate social scripts and result in social reactions (Nass & Moon, 2000; Reeves & Nass, 1996). We argue that the sexual interaction illusion might be positively affected by those social cues as they might contribute to the experience of the partner as a living entity.

Contrary to this, media equation theory also assumes that cues which underline the artificiality of the interaction partner and therefore the fact that the technology does not warrant social treatment might interfere with social reactions (Nass & Moon, 2000). In our model we argue that artificial cues that cannot be ignored, such as jerky movements, errors in the audio output (e.g., speaking in the wrong language), or the need to reboot the system, might negatively affect the evoked sexual interaction illusion. Errors like this are likely to underline the artificialness of the partner and might trigger considerations of being engaged in an inappropriate sexual interaction with a nonliving entity. While this might foster avoidance in case media equation processes are hindered, we have also argued above that it is not necessary (and sometimes not helpful) for the sexual interaction illusion that people

forget about the artificial nature of the interaction partner. The corresponding mechanisms should be scrutinized in future research as it is likely that at least in the next years even the most proficient artificial sex partners will still display cues that identify them as nonliving entities.

4 Conclusion

The presented sexual interaction illusion model is an attempt to summarize some of the important factors that might influence people's decision to engage in sex with artificial entities and to explain the mechanisms leading to the sexual interaction illusion. The factors are based on relevant theories from the areas of media psychology, communication science, and sexual research. All proposed relations are currently merely theory-based assumptions which need to be tested empirically. In future, research needs to indicate whether these factors are actually influential or whether other aspects are more decisive.

The present model was not tailored to individuals of one particular gender and/or sexual orientation. However, further research should include potential influences, especially as factors such as social norms might have different meanings for people of different gender and/or sexual orientation. Moreover, it needs to be noted that the present model focuses on reactions evoked by sex robots. Ongoing research on sexualized technologies should consider whether the social and sexual responses evoked by other artificial sex partners (such as virtual entities displayed on smartphones or in virtual reality) might be influenced by similar positive and negative influences as the ones conceptualized in the presented model.

As the model is intended to guide future research on psychological mechanisms that might influence the sensations evoked by sex robots, it could contribute to a better understanding of how sex robots will change the conceptualization of sexuality and relationship. In line with this, it could be used to investigate whether sex robots will be able to create sensations that for some people might serve as an extension to, for instance, existing sex services (compare Yeoman & Mars, 2012).

Future research needs to contribute to achieving a better understanding of the mechanisms that enable people to have sex with artificial entities. More specifically, further research needs to investigate whether the acceptance of an artificial sex partner is sufficient in order to classify a sexual interaction with an artificial entity as a new form of sexual interaction or whether the artificialness of the partner determines the act still as computer-assisted masturbation. This will, on the one hand, allow an estimation of the potential individual and societal risk that interactions with artificial sex partners might entail. On the other hand, understanding the mechanisms and constraints of sexual interactions with artificial beings will help to better understand the social nature of human beings and how technology might influence the conceptualization of sexuality.

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