THE EFFECT OF ANTHROPOMORPHIZED TECHNOLOGY FAILURE ON THE DESIRE TO CONNECT WITH OTHERS

Abstract

Extant work suggests that unsuccessful human-technology interactions elicit negative affective reactions, prompting users to seek social connections in an attempt to compensate for their experience. The current work presents one mechanism to explain these findings. Specifically, we propose that users may construe incidents of technology failure akin to incidents of social rejection: Across three studies, we demonstrate that when an anthropomorphized (vs. non-anthropomorphized) technology fails to function as expected, users experience feelings of rejection, and subsequently express a greater desire to connect with others. This paper contributes to the extant research on human-technology interactions by uniquely demonstrating that feelings of social rejection may arise from technological failure. Our work also deepens our understanding of the unintended negative consequences of product anthropomorphism and by doing so provides insight into better technology design.

Keywords: consumer-technology interactions, technology failure, product failure, anthropomorphized technology, feelings of rejection, desire to connect with others, product anthropomorphism, artificial intelligence.

1. Introduction

Anthropomorphized technology (AT) such as digital personal assistants (e.g., Apple's Siri), chatbots, and voice-controlled navigation systems has changed our human-technology interactions. Because of their advanced design features (e.g., artificial intelligence), these tools have revolutionized the way consumers interact with products, allowing for more meaningful interactions (e.g., Ramadan et al., 2021). Nonetheless, the proliferation of AT device usage has been accompanied by persistent incidents of technology failure. Indeed, recent reports find that the average person experiences as many as 63 technical mishaps a year — at least one a week (Knight, 2019). Among more frequent users, 95% of those who use voice-controlled search functions report frequent frustration with the technology, citing reasons such as their voice assistant misinterpreting their query and inadvertently activating itself (Cox, 2020).

While academics have demonstrated a great interest in researching AT in general (e.g., Pitardi & Marriott, 2021; Ramadan et al., 2021), incidents of AT failure have received less attention despite their pervasiveness. Although limited, extant research suggests that incidents of AT failure elicit negative affective reactions (Hadi & Block, 2019), prompting users to engage in compensatory behavior including seeking affiliation with others (Mende et al., 2019). We extend this line of inquiry by proposing one mechanism that can explain why users may experience a greater desire to connect with others after incidents of AT failure.

Extant research demonstrates that anthropomorphizing technology by imbuing it with human traits increases its perceived agency (i.e., perceptions that the technology is capable of acting with intentions; Epley & Waytz, 2009). This unique feature has transformed technology

into a social actor (Reeves & Nass, 1996; Nass & Moon, 2000), making user interactions with AT a semblance for human-human interactions. As such, consumers often consider anthropomorphized devices a friend (Ramadan et al., 2021) and apply social norms in their interactions with AT (Nass & Moon, 2000). However, while anthropomorphizing a product can enhance users' experiences in general (Aggarwal & McGill, 2007), it backfires when a product malfunctions as failures are perceived as more intentional compared to when the product is non-anthropomorphized (Puzakova et al., 2013).

In human-to-human interactions, individuals perceive unpleasant behaviors as acts of social rejection, particularly when the behavior appears deliberate (Asher et al., 2001). For example, a customer will feel rejected when intentionally ignored by a salesperson but not when ignored because the salesperson did not notice the customer's presence. Notably, individuals who experience social rejection attempt to re-establish their thwarted need for social belonging by seeking to connect with others (Maner et al., 2007). Given that users apply social rules in their interactions with AT (e.g., Hadi & Block, 2019), we propose that they will construe incidents of AT failure akin incidents of social exclusion, which will consequently elicit the same form of compensatory behavior. Specifically, we demonstrate across three studies that incidents of anthropomorphized (vs. non-anthropomorphized) technology failure elicit feelings of rejection in users, increasing these users' desire to connect with other.

The current work makes several contributions. First, we contribute to extant research on the complexity of technology-mediated relationships (Hoffman & Novak, 1996; Walther, 1992, 2007) by exploring social exclusion in mediated environments. Our work uniquely demonstrates that failed interactions with AT can elicit feelings of rejection and consequently result in an increased desire to connect with others, a form of compensatory behavior typically observed in

human-human interactions (e.g., Maner et al., 2007). By demonstrating that social exclusion affect can extend to human-technology interactions, we also contribute to research on social exclusion: While previous work has explored the social settings in which feelings of rejection may arise (e.g., Ward & Dahl, 2014), our work demonstrates that consumers may experience feelings of rejection from failed interactions with inanimate products. More generally, the current work deepens our understanding of the unintended negative consequences of brand and product anthropomorphism (e.g., Puzakova et al. 2013) by uncovering a context in which anthropomorphized products may thwart consumers' social needs.

From a practical perspective, our work cautions managers and product developers on the potential negative effects of AT failure. As more reports linking the use of technology to mental health issues emerge (e.g., Elhai et al., 2017), conducting empirical explorations to understand the factors that may influence consumer emotional wellbeing become crucial.

~~**THE EFFECT OF ANTHROPOMORPHIZED TECHNOLOGY FAILURE ON THE DESIRE TO CONNECT WITH OTHERS**~~

~~**Abstract**~~

~~Extant work suggests that unsuccessful human-technology interactions may prompt users to discontinue using the technology in favor of connecting affiliating with other humans. The current work presents one mechanism to explain why users may express experience a greater greater desire to affiliate connect with others after incidents of anthropomorphized technology failure. Specifically, we propose that incidents incidents of technology failure of technology malfunction may be construed by users akin to incidents of social rejection: in three studies, we demonstrate that when an anthropomorphized (vs. non-anthropomorphized) technology fails to~~

function as expected, users experience feelings of rejection, and subsequently express a greater desire to connect with others. In doing so, we contribute to extant research on human-technology interactions, and social exclusion by uniquely demonstrating that feelings of social rejection may arise in human-technology interactions. Our work also deepens our understanding of the unintended negative consequences of product anthropomorphism.

Keywords: technology failure, product failure, anthropomorphized technology, feelings of rejection, desire to connect with others, social affiliation, social rejection, human-technology interactions, parasocial interaction, product anthropomorphism, artificial intelligent assistant.

1. Introduction

Anthropomorphized technology (AT) such as digital personal assistants (e.g., Siri), chatbots, and voice-controlled GPS systems has changed our human-technology interactions. Because of their advanced design features (e.g., artificial intelligence), these tools have revolutionized the way consumers interact with products, allowing for more meaningful interactions (e.g., Ramadan et al., 2021). Nonetheless, the proliferation of AT device usage has been accompanied by persistent incidents of technology failure. Indeed, recent reports find that the average person experiences as many as 63 technical mishaps a year — at least one a week (Knight, 2019). Among more frequent users, 95% of those who use voice-controlled search

functions report frequent frustration with the technology, citing reasons such as their voice assistant misinterpreting their query and inadvertently activating itself (Cox, 2020).

While academics have demonstrated a great interest in researching AT in general (e.g., Pitardi & Marriott, 2021; Ramadan et al., 2021), incidents of AT failure have received less attention despite their pervasiveness. Although limited, extant research suggests that incidents of AT failure can elicit strong negative affective reactions (Hadi & Block, 2019), prompting users to discontinue using the technology in favor of connecting with other humans (Fan et al., 2016). Yet, little is known about the psychological mechanisms that may increase users' desire to connect with others after incidents of AT failure.

The present research attempts to fill this gap in the literature by proposing one such mechanism. Specifically, we build on extant research on human-technology interactions (e.g., Nass & Moon, 2000; van Doorn et al., 2017) to propose that incidents of AT failure may be construed by users akin to incidents of social rejection. In three studies, we demonstrate that incidents of AT failure elicit feelings of rejection in users, increasing these users' desire to connect with other humans in an attempt to satisfy their thwarted need for social affiliation.

Comentat [LL1]: We don't demonstrate that social affiliation needs are thwarted. Maybe better to remove this?

The current work makes several theoretical and practical contributions. First, we contribute to extant research on the complexity of technology-mediated relationships (Hoffman & Novak, 1996; Walther, 1992, 2007) by exploring social exclusion in mediated environments. Our work uniquely demonstrates that failed interactions with AT can elicit feelings of rejection and consequently result in an increased desire to connect with others, a form of compensatory behavior typically observed in human-human interactions (e.g., Maner et al., 2007). By demonstrating that social exclusion affect can extend to human-technology interactions, we also contribute to research on social exclusion: While previous work has explored the social settings

~~in which feelings of rejection may arise (e.g., Ward & Dahl, 2014), our work demonstrates that consumers may experience feelings of rejection from failed interactions with inanimate products. More generally, the current work deepens our understanding of the unintended negative consequences of brand and product anthropomorphism (e.g., Puzakova et al. 2013) by uncovering a context in which anthropomorphized products may thwart consumers' social needs.~~

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2. Conceptual Framework

2.1.The Dark Side of Anthropomorphized Technology

Anthropomorphized technology (AT) refers to software and technological devices imbued with human characteristics, motivations, intentions and emotions (Epley, Waytz, & Cacioppo, 2007). Examples include IOS's Siri, smartphone applications, and other voice-interactive technologies such as Amazon ~~GPS~~Alexa. The popularity of these devices has encouraged a wide stream of research around this topic. This work has largely focused on documenting the beneficial effect of AT on a wide range of consumer outcomes including engagement and loyalty (Moriuchi, 2019), trust (Pitardi & Marriott, 2021; Waytz, Heafner, & Epley, 2014), and intentions to use (Moussawi & Benbunan-Fich, 2021). In contrast, the possible negative effects of AT have garnered less attention, prompting scholars to encourage research around this topic (e.g., Zheng & Jarvenpaa, 2019). Further, extant work has mostly researched consumers' *successful* interactions with AT, dedicating less attention to ~~accompanied by persistent~~ incidents of technology *failure* ~~(Knight, 2019)~~. Incidents of technology failure occur

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when the technology disconfirms consumers' expectations by deviating from a desired or normal function (Sun, Li, & Yu, 2021). Examples ~~). These incidents, which have become part of everyday life,~~ may include a mobile application crashing, a virtual assistant misinterpreting a user-query, and a website failing to load~~, for example~~ (Cox, 2020; Knight, 2019).

Despite the pervasiveness of incidents of technology failure (Knight, 2019), the literature remains scarce around this topic (see Table 1). Extant research has primarily focused on exploring users' evaluations and perceptions of the technology after it fails (e.g., Choi et al., 2020; Desai et al., 2012; Lee et al., 2010), and on documenting users' nonverbal reactions and error handling strategies (e.g., Gieselmann 2006; Giuliani et al., 2015; Hayes et al., 2016; Schutte et al., 2017). Some academics have also explored how incidents of technology malfunction influence user performance (de Visser & Parasuraman, 2011; Ragni et al., 2016) and their attributions of blame to the technology (e.g., Kim & Hinds, 2006). Yet, less work has examined consumers' emotional reactions after these incidents (Hadi & Block, 2019). We therefore add to this line of inquiry by exploring consumers' affective responses and their subsequent motivations after incidents of AT failure. Specifically, we propose that users may construe these incidents akin to incidents of social rejection. We next turn to the literature on the computer as social actor paradigm (CASA; Nass & Moon, 2000) and extant work on service ~~AT~~ robots (e.g., Choi et al., 2020; Mende et al., 2019) to inform our predictions.

2.2. Anthropomorphized Technology Failures Elicit Feelings of Social Rejection

To begin with, a~~A~~ unique characteristic of AT is its perceived agency: Imbuing technology with human traits increases perceptions that the technology possesses a mind and is capable of acting with intentions (Epley & Waytz, 2009). This distinctive feature has turned technology into a social actor (Reeves & Nass, 1996; Nass & Moon, 2000) such that, interactions

with anthropomorphized machines engender a sense of "automated social presence" — a feeling of being in the presence of another social being (van Doorn et al., 2017). User interactions with AT are therefore often a semblance ~~for~~ of the emotional outcomes connected with human-to-human interactions. For example, consumers consider their virtual assistant a friend (Ramadan et al., 2021) and apply accepted social rules in their interactions with anthropomorphized computers (Nass & Moon, 2000).

While the perceived agency of AT can generally result in positive outcomes (e.g., increased trust; Waytz et al., 2014), it may also backfire~~s~~ when an anthropomorphized product malfunctions, as negative outcomes are perceived as more intentional (Puzakova et al. 2013). For example, Choi et al. (2020) found that participants who imagined that a robot with a human (vs. non-human) appearance neglected them at a restaurant evaluated the service more negatively. Notably, consumers' responses to AT failures depended upon the degree of product anthropomorphism, such that technologies with more humanlike features engendered greater dissatisfaction in the face of poor service (Choi et al., 2020). Collectively, these findings suggest that incidents of technology failure are more likely to be perceived as deliberate when a technology is anthropomorphized compared to when it is not (Puzakova et al. 2013).

Extant research demonstrates that users construe their interactions with AT akin to human-to-human interactions, applying the same social heuristics and biases (e.g.; Hadi & Block, 2019; Nass & Moon, 2000). In social settings, individuals often perceive unsuccessful or uncomfortable encounters with others as acts of rejection. For example, individuals may feel rejected when they are assisted by a condescending salesperson (Ward & Dahl, 2014), or when they find out that other people do not wish to work with them (Maner et al., 2007). However, only unpleasant social behaviors that appear to be *deliberate* elicit feelings of rejection (i.e.,

banning, exclusion, physical harm, coercion, defamation, and meddling; Asher et al., 2001; also see The Inclusionary-Status continuum; Leary, 1990). ~~For instance~~That is, a customer will feel rejected when intentionally ignored by a salesperson but not when ignored because the salesperson did not notice the customer's presence. Given that users apply social norms when interacting with AT (Nass & Moon, 2000), ~~it follows that~~we expect that users w~~sh~~ould construe incidents of AT failure as acts of social rejection ~~because the~~since technology is viewed as a social actor (van Doorn et al., 2017) and the failure ~~is~~ may be perceived as intentional (Puzakova et al. 2013).

Comentat [LL2]: Trying to clarify the argument

Comentat [VMA3R2]: Changed it a bit

Research on human-to-human interactions finds that ~~social rejection~~ unpleasant social behaviors may elicit ~~s~~ feelings of rejection (e.g., Ward & Dahl, 2014). This appears to carry into AT interactions, as extant work demonstrates that user interactions with anthropomorphized products elicit the same affective reactions as human-to-human interactions (e.g., Hadi & Valenzuela, 2014; ~~). For example, users who had an unsuccessful interaction with a virtual assistant with a female (vs. male) voice expressed more anger and frustration, just like they would if they were interacting with human agents (~~Hadi & Block, 2019). Therefore, we predict that users will be more likely to experience feelings of rejection after incidents of technology failure when the product is anthropomorphized than non-anthropomorphized. We next turn to the literature on the social reconnection hypothesis (Maner et al., 2007) to explain why incidents of AT malfunctions will increase the desire to affiliate with others.

Comentat [LL4]: This example isn't very useful; remove?

2.3. Anthropomorphized Technology Failures Increase the Desire to Connect with Others

The desire for positive social relationships is a fundamental human need (Baumeister & Leary, 1995). Social rejection can signal that one's need to belong is threatened (Maner et al.,

2007), prompting individuals to seek alternative ways to fulfill it (Gardner et al., 2005). Research in psychology suggests that individuals who experience rejection may attempt to reestablish social connections by seeking affiliation with others (DeWall & Richman, 2011; Williams & Nida, 2011). For example, Maner et al. (2007) found that participants who felt rejected expressed an increased interest in making new friends, had a greater desire in working with others, and assigned greater rewards to new partners.

The human-technology interactions literature provides some empirical evidence to support that the same pattern of behavior should be observed after failed interactions with AT. For example, participants who imagined a failed interaction with a self-check-in airport kiosk imbued with a human-like (vs. robotic) voice were more likely to report that they would rather interact with a human employee in the future (Fan et al 2016). While these results were contingent upon participants' sense of power and the presence or absence of other customers, these findings~~.~~ suggest that failed interactions with AT can indeed increase the desire for social connection. Along the same lines, Mende et al. (2019) demonstrate that interactions with AT can threaten users' self-identity, resulting in an increased need for social affiliation (Study 2; Mende et al., 2019).

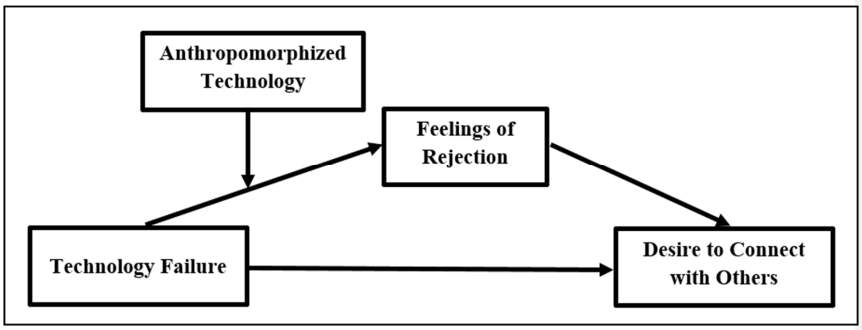
~~Consequently, b~~Building on the aforementioned literature, we evince that, when an anthropomorphized (vs. non-anthropomorphized) technology malfunctions, users will experience feelings of rejection and will consequently express an increased desire for social affiliation (Figure 1). More formally:

H_1: Anthropomorphized (vs. non-anthropomorphized) technology failure will increase the desire to connect with others

H_2: Feelings of rejection will mediate the effect of AT failure on the desire to connect with others

Figure 1

Conceptual Model



3. The current research

We test our predictions across two different technological products: a virtual shopping assistant and a computer-based game. ~~In studies 1 and 3, we~~Studies 1 and 3 test the basic effect of AT failure on the desire to connect with others (H_1) using different ~~participant~~ populations. ~~In s~~Study 2~~, we~~ replicates this ~~basic~~ effect and provides support for the mediating role of feelings of rejection (H_2). ~~Our work~~Our studies ~~also~~ rule out alternative explanations (e.g., frustration) ~~explore~~and explore the role of individual differences ~~that may~~in influenc~~e~~ing our results (e.g.,~~including~~ chronic feelings of loneliness)~~., the propensity to anthropomorphize technology, and technological self-efficacy.~~

4. Study 1

Study 1 aimed to test the effect of AT failure on the desire to connect with others (H_1).

4.1. Method

Participants, Design and Procedure. One-hundred-eleven undergraduate students (M_{age}= 21.69, SD = 2.06, 40.5% females) participated in the study in exchange for course credit. The study used a 2 (Anthropomorphism: Anthropomorphized vs. Non-anthropomorphized) x 2 (Technology Failure: Failure vs. No-Failure) between-subjects design. The study was introduced to participants as an effort to test Cobu, a shopping platform.

Consistent with prior research (e.g., Hur et al., 2015), we manipulated anthropomorphism by attributing humanlike features to the product: in the anthropomorphized condition, Cobu was depicted with eyes and spoke in the first person, while in the non-anthropomorphized condition, the interface was presented without humanlike traits and the text was written in the third person (see Appendix).

Participants were asked to imagine that they were shopping online for office supplies and first needed to create a profile in Cobu. They completed a form in which they entered a username and a password as well as some basic information (e.g.; age). Participants were then shown different office products (e.g., pens, stapler) and asked to choose an item. Cobu then suggested a similar product that was slightly discounted, and participants were given the option to swap the item they had selected with the one suggested. Once participants had made a final decision, they were prompted to enter their username and password again in order to check out (similar to online shopping).

In the technology failure condition, the participants' password was not recognized and they were asked to enter it again. After the second trial, they received an error message stating

that Cobu couldn't recognize them. The screen then automatically displayed a message indicating that the shopping task was finished. In the no-failure condition, the participants' password was recognized, and the same end-of-task message was displayed. All participants were then taken to the survey.

Dependent measures. To measure participants' desire to connect with others, we adapted a procedure by Maner et al. (2007) in which participants first read about a (fictitious) service designed to help students make new friendships (see Appendix), and then indicated their interest in trying the service using the items (r = .62, p < .001): "I have a strong interest in meeting new friends" and "[College Name] Connect is a student service that I might try" (1 = Strongly Disagree, 5 = Strongly Agree). To maintain the cover story, participants also ~~To maintain the cover story, we asked participants to evaluate Cobu by indicating their willingness to pay (WTP) for the app, their likelihood to recommend the app to a friend, and how useful they perceived the app to be~~evaluated Cobu (see Appendix for measures). Participants finally reported their age and gender.

Comentat [LL5]: Reducing word count

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4.2. Results

Desire to connect with others. An ANOVA on the desire to connect with others revealed no main effect of anthropomorphism, no main effect of technology failure, and a significant interaction (F(1,107) = 5.71, p = .019; Figure 2). As predicted by H_1, contrast analysis revealed that when the app failed, participants in the anthropomorphized condition ($M_{anthropomorphized}$= 3.95, SD = 0.82) reported a higher desire to connect with others compared to those in the non-anthropomorphized condition ($M_{non\text{-}anthropomorphized}$= 3.30, SD = 0.94; F(1,107) = 6.40, p = .013). Additionally, in the anthropomorphized condition, participants for whom the platform did not function properly ($M_{failure}$= 3.95, SD = 0.82) reported a greater desire to connect with others compared to those for whom the platform functioned normally ($M_{no\text{-}failure}$= 3.47, SD = 1.13;

$F(1,107) = 3.75$, $p = .055$). No differences on the desire to connect with others emerged in the non-anthropomorphized condition ($M_{failure} = 3.30$, SD = 0.94 vs. $M_{no\text{-}failure} = 3.69$, SD = 0.84; $F(1,107) = 2.14$, $p = .15$) or in the no-failure condition ($M_{non\text{-}anthropomorphized} = 3.69$, SD = 0.84 vs. $M_{anthropomorphized} = 3.47$, SD = 1.13; $F(1,107) = 0.72$, $p = .40$).

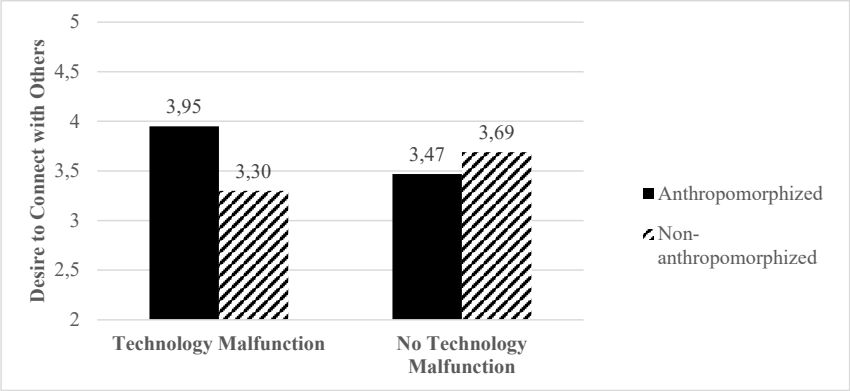
Other measures. An ANOVA on WTP revealed a marginally significant main effect of technology failure ($M_{failure} = 1.35$ vs. $M_{no\text{-}failure} = 1.05$; $F(1,107) = 3.26$, $p = .07$), no main effect of anthropomorphism and no significant interaction. No significant main or interaction effects emerged on the app evaluation measures (see Appendix for means).

2.1.Discussion

Study 1 confirmed H_1 that anthropomorphized (vs. non-anthropomorphized) technology failures increased the desire to connect with others. Specifically, when participants' passwords were not recognized by an anthropomorphized (vs. non-anthropomorphized) shopping assistant, participants expressed a higher desire to make new friends.

Fig. 2

Study 1: The effect of Anthropomorphism and Technology Failure on the Desire to Connect with Others



3. Study 2

The purpose of study 2 was to provide further support for the effect of AT failure on the desire to connect with others (H_1) and to provide evidence for the underlying mechanism (H_2). Additionally, study 2 aimed to rule out user performance and feelings of frustration as alternative explanations.

3.1. Method

Participants, Design and Procedure. Two-hundred-and-twenty undergraduate students (M_{age}= 22.89, SD = 4.60, 44.3% females[1]) participated in the study in exchange for course credit. The study used a 2 (Anthropomorphism: Anthropomorphized vs. Non-anthropomorphized) x 2 (Technology Failure: Failure vs. No-failure) between-subjects design, and was described as an

[1] Two participants did not report their age, and one participant did not report their gender

effort to test Brainy, a computer-based memory game. As in study 1, we manipulated anthropomorphism by attributing humanlike features to Brainy (see Appendix).

Participants read instructions about the game and were asked to test it. The game displayed an image for 3 seconds and then tested participants' memory by asking them to remember details in the image. Participants viewed four images and answered 16 multiple-choice questions in total. After playing the game, they were asked to wait to receive their score, which was displayed as the total number of correct answers. We manipulated technology failure by intentionally introducing a glitch to the game: participants in the failure (vs. no-failure) condition did not receive their score and saw an error sign instead (see Appendix). All participants were then thanked for testing Brainy and were taken to the survey.

Dependent measures. We measured feelings of rejection using a 4-item scale ($\alpha = .77$): "At the present moment, to what extent do you feel rejected/distressed/upset/angry?" (all anchored 1 = Not at all, 7 = Extremely). To measure desire to connect with others, participants read the same text that was used in Study 1 (see Appendix) and then indicated their agreement with the statement "I need a service like [College Name] College Connect to make new friends" (1 = Strongly disagree, 5 = Strongly agree). We also asked participants to evaluate Brainy on different attributes to maintain the cover story (see Appendix for measures).

Given that anthropomorphism can reduce performance (Shneiderman & Plaisant, 2010), we recorded participants' scores (i.e., number of correct answers) to rule out the alternative explanation that participants in the anthropomorphized (vs. non-anthropomorphized) condition performed worse on the game which increased their desire to connect with others to compensate for their negative experience. Additionally, extant research suggests that technology failure can lead to user frustration (Hadi & Block, 2019). We therefore gauged participants' frustration ("At

the present moment, to what extent do you feel frustrated?" 1 = Not at all, 7 = Extremely) to rule out the possibility that feelings frustration (rather than rejection) underlie our results.

The survey also included manipulation check measures for the anthropomorphism manipulation (Aggarwal and McGill (2007); $r = .61$, $p < .001$): "Brainy seems like a person" and "It seems as if Brainy has come alive," and for the technology failure manipulation ($r = .74$, $p < .001$): "Brainy executed all commands properly" (reverse-coded) and "Brainy did not work well." Participants finally reported their age and gender.

3.2. Results

Manipulation Checks. Both manipulations worked as predicted: An ANOVA on the anthropomorphism index revealed a significant main effect of anthropomorphism ($M_{\text{anthropomorphized}} = 2.59$, SD = 1.45 vs. $M_{\text{non-anthropomorphized}} = 1.85$, SD = 1.13; $F(1,216) = 17.66$, $p < .001$), and an ANOVA on the technology failure index revealed a significant main effect of technology failure ($M_{\text{failure}} = 3.77$, SD = 1.88 vs. $M_{\text{no-failure}} = 1.67$, SD = 0.94; $F(1,216) = 108.01$, $p < .001$).

Feelings of Rejection. An ANOVA on feelings of rejection revealed no main effect of anthropomorphism and a significant main effect of technology failure ($M_{\text{failure}} = 2.72$, SD = 1.26 vs. $M_{\text{no-failure}} = 2.36$, SD = 1.27; $F(1,216) = 4.38$, $p = .04$), the latter of which is consistent with the literature (Hadi & Block, 2019). More importantly, and consistent with our theorizing, the analysis revealed a significant anthropomorphism-by-technology failure interaction ($F(1,216) = 4.03$, $p = .046$; Figure 3). As predicted by H_2, contrast analysis revealed that, when the game failed, participants in the anthropomorphized condition reported higher feelings of rejection than those in the non-anthropomorphized condition ($M_{\text{anthropomorphized}} = 2.96$, SD = 1.23 vs. $M_{\text{non-}}$

$_{anthropomorphized}$= 2.48, SD = 1.27; $F(1,216) = 4.08$, $p < .05$). Additionally, in the anthropomorphized condition, feelings of rejection were higher in the failure condition than the no-failure condition ($M_{failure}$= 2.96, SD = 1.23 vs. $M_{no\text{-}failure}$= 2.26, SD = 1.29; $F(1,216) = 8.48$, $p < .01$). No differences emerged between the non-anthropomorphized ($M_{non\text{-}anthropomorphized}$= 2.46, SD = 1.26) and the anthropomorphized conditions when the game worked properly ($M_{anthropomorphized}$= 2.26, SD = 1.29; $F(1,216) = .68$, $p = .41$). Similarly, no differences emerged in the non-anthropomorphized condition when the game worked properly compared to when it failed ($M_{failure}$= 2.48, SD = 1.27 vs. $M_{no\text{-}failure}$= 2.46, SD = 1.26; $F(1,216) = .004$, $p = .95$).

Desire to connect with others. An ANOVA on the desire to connect with others revealed no main effect of anthropomorphism, no main effect of technology failure and a marginally significant interaction ($F(1,216) = 3.39$, $p = .067$). As predicted by H_1, contrast analysis revealed that when the game failed, participants in the anthropomorphized condition reported a higher desire to connect with others than those in the non-anthropomorphized condition ($M_{anthropomorphized}$= 2.87, SD = 1.13 vs. $M_{non\text{-}anthropomorphized}$= 2.35, SD = 1.28; $F(1,216) = 5.14$, $p = .02$). Contrast analysis also revealed that participants in the anthropomorphized condition reported a higher desire to connect with others when the game malfunctioned than when it did not ($M_{failure}$= 2.87, SD = 1.13 vs. $M_{no\text{-}failure}$= 2.40, SD = 1.30; $F(1,216) = 4.13$, $p = .04$). No differences emerged when the non-anthropomorphized game worked compared to when it did not work ($M_{failure}$= 2.35, SD = 1.28 vs. $M_{no\text{-}failure}$= 2.48, SD = 1.21; $F(1,216) = .33$, $p = .57$). Additionally, no differences emerged when the anthropomorphized version and the non-anthropomorphized versions of the game both worked as expected ($M_{anthropomorphized}$= 2.40, SD = 1.30 vs. $M_{non\text{-}anthropomorphized}$= 2.48, SD = 1.21; $F(1,216) = .12$, $p = .73$).

To test our full conceptual model (Figure 1), we ran a moderated mediation model (Model 7; Hayes, 2018), with technology failure as a predictor variable, anthropomorphism as a moderator, feelings of rejection as a mediator and desire to connect with others as the outcome variable. A bootstrap analysis with 10,000 resamples revealed that feelings of rejection mediated the effect of anthropomorphism on the desire to connect with others when the game failed (B = .07, SE = .03, $CI_{95\%}$= [.0140; .1444]) but not when it functioned as expected (B = .01, SE = .02, $CI_{95\%}$= [-.0523; .0499]). Additionally, the overall index of moderated mediation was significant (B = .07, SE = .04, $CI_{95\%}$= [.0007; .1666]), providing support for H_2.

Other measures. An ANOVA on performance in the game revealed no significant main effects and no significant interaction, casting doubt on the alternative explanation that poor performance underlies our results. Consistent with previous work (Hadi & Block, 2019), an ANOVA on feelings of frustration revealed a main effect of technology failure ($M_{failure}$ = 3.28, SD = 1.80 vs. $M_{no\text{-}failure}$ = 2.74, SD = 1.88; $F(1,216) = 4.65$, $p = .03$), but no main effect of anthropomorphism and, more importantly, no interaction, ruling out feelings of frustration as an alternative explanation. Finally, no significant results emerged on any of the game evaluation measures (see Appendix for means).

3.3.Discussion

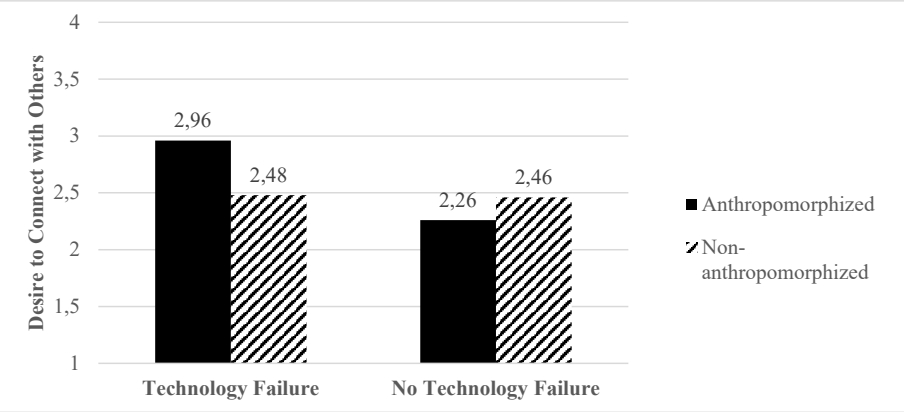
Study 2 provides support for H_1 and H_2: When an anthropomorphized (vs. non-anthropomorphized) computer-based memory game failed to give participants their score, participants reported feeling rejected, which increased their desire to make new friendships.

Although we tried to design stimuli that were as "emotion-neutral" as possible, it is possible that participants in the anthropomorphized condition perceived that the technology was

expressing emotions which could have influenced their responses. To address this limitation, we conducted post-tests in which participants evaluated the stimuli used in Studies 1 and 2 using the negative and positive affect scale (PANAS; Watson et al., 1988). Results revealed no differences on the extent to which the anthropomorphized versus non-anthropomorphized technology was perceived as expressing emotions (see Appendix for detailed results). We also updated the design of the stimuli used in Study 2 (i.e., Brainy) to create a more "emotion-neutral" version of it. A pre-test revealed no differences on perceived emotionality across the anthropomorphized and non-anthropomorphized conditions. We therefore used the updated version of Brainy in the next study (see Appendix for stimuli images and pre-test results).

Fig. 3

Study 2: The effect of Anthropomorphism and Technology Failure on Feelings of Rejection



4. Study 3

The purpose of Study 3 was to demonstrate the robustness of our results by providing further support for H1 with a different measure of desire to connect with others. This study also aimed to control for potential confounding variables by measuring individual differences that may influence our results namely, chronic feelings of loneliness, propensity to anthropomorphize technology, and technological self-efficacy.

4.1. Method

Participants, Design and Procedure. A total of 484 participants were recruited from Amazon Mechanical Turk in return for monetary compensation. The study used the same design and procedure as Study 2, the only difference being that the game included the updated, more emotion-neutral version of Brainy (see Appendix).

Dependent measures. To gauge desire to affiliate with others, we adapted a procedure by Mende et al. (2019): specifically, participants indicated whether they would prefer to eat a meal alone or with friends if they had a choice in the present moment (using a 7-point scale: 1 = Alone, 7 = With friends). They then completed manipulation check measures for the anthropomorphism manipulation ($r = .80$, $p < .001$): "Brainy seems like a person" and "Brainy reminds me of a human face," and for the technology failure manipulation: "Brainy did not work well" (all anchored 1 = Strongly disagree, 7 = Strongly agree). We also gauged participants' chronic feelings of loneliness ($\alpha = .93$; Hughes et al., 2004), their general propensity to anthropomorphize technology ($\alpha = .88$; Waytz et al., 2010) and their technological self-efficacy ($r = .50$, $p < .001$; McDonald & Siegall, 1992; see Appendix for measures).

Given recent concerns about the quality of data collected online (e.g., Aruguete et al., 2019), the survey also included an attention check measure ("This is an attention check, select 'strongly disagree'"). Participants finally reported their age and gender.

4.2. Results

We excluded 77 participants for failing to complete the questionnaire (N = 61) and/or failing the attention check (N = 16), resulting in 407 responses (M_{age}= 40.85, SD = 12.71, 41.3% females).

Manipulation Checks. Both manipulations worked as predicted. An ANOVA on the anthropomorphism index revealed a significant main effect of anthropomorphism ($M_{\text{anthropomorphized}}$ = 3.55, SD = 2.04 vs. $M_{\text{non-anthropomorphized}}$ = 2.87, SD = 2.04; $F(1,403) = 11.05$, $p < .001$). Additionally, an ANOVA on the technology failure manipulation check revealed a significant main effect of technology failure (M_{failure}= 4.95, SD = 2.05 vs. $M_{\text{no-failure}}$= 2.25, SD = 1.86; $F(1,403) = 194.94$, $p < .001$).

Desire to connect with others. An ANOVA on the desire to connect with others revealed no main effect of anthropomorphism, no main effect of technology failure and a significant interaction ($F(1,403) = 4.35$, $p = .04$). Contrast analysis revealed that when the game failed, participants in the anthropomorphized condition reported a higher desire to connect with others compared to those in the non-anthropomorphized condition ($M_{\text{anthropomorphized}}$= 5.23, SD = 1.83 vs. $M_{\text{non-anthropomorphized}}$= 4.71, SD = 2.19; $F(1,403) = 3.16$, $p = .076$), providing support for H_1. Further, participants in the anthropomorphized condition reported a higher desire to connect with others when the game malfunctioned compared to when it did not ($M_{failure}$= 5.23, SD = 1.83 vs. $M_{\text{no-failure}}$= 4.60, SD = 2.24; $F(1,403) = 4.80$, $p = .03$). In the no-anthropomorphism condition, no

differences emerged when the game worked compared to when it failed ($M_{failure}$= 4.71, SD = 2.19 vs. $M_{no\text{-}failure}$= 4.94, SD = 2.02; $F(1,403) = .60$, $p = .44$). Additionally, no differences emerged when the anthropomorphized version and the non-anthropomorphized version of the game both worked as expected ($M_{anthropomorphized}$= 4.60, SD = 2.24 vs. $M_{non\text{-}anthropomorphized}$= 4.94, SD = 2.02; $F(1,403) = 1.36$, $p = .24$).

Additional measures. ANOVA revealed no main effect of anthropomorphism, no main effect of technology failure and no interaction on chronic feelings of loneliness, propensity to anthropomorphize technology or technological self-efficacy (all *p-values* > .20). We conducted additional analyses in which these variables were introduced as covariates and as moderators in our model. These analyses did not reveal any noteworthy findings and are reported in the Appendix.

Discussion

Study 3 provides further support for our predictions: specifically, when an anthropomorphized (vs. non-anthropomorphized) online game failed, participants expressed a higher desire to eat a meal with others (vs. alone), suggesting a greater need for social affiliation.

5. General Discussion

~~The current work demonstrates that AT failures elicit feelings of rejection, which, in turn, increase the desire to connect with others. Specifically, in Study 1, we found that participants whose password was not recognized by an anthropomorphized (vs. non-anthropomorphized) shopping platform reported a higher desire to make new friends. Study 2 provided support for the mediating role of feelings of rejection by demonstrating that, when an anthropomorphized (vs.~~

~~non-anthropomorphized) computer-based memory game failed to give participants their score, participants felt rejected, and expressed a stronger desire to make new friends. Finally, Study 3 provided further support for our effect by showing that when an anthropomorphized (vs. non-anthropomorphized) computer-based memory game failed, participants expressed a greater desire to consume a meal with friends (vs. alone), demonstrating a higher need for social affiliation. Collectively, our studies replicate our results using two different participant populations and two different AT. Our studies also rule-out possible alternative explanations including feelings of frustration and performance on the task, and control for possible individual differences that may influence our results.~~

Extant research ~~on AT failure~~ has largely focused on ~~understanding~~ exploring consumers' attitudes and error--handling strategies after incidents of technology malfunction (see Table 1). We extend this line of inquiry by exploring consumers' emotional responses, and their subsequent behavior, after incidents of AT failure. In three studies, we demonstrate that users report feelings of rejection after failed interactions with anthropomorphized (vs. non-anthropomorphized) technological products, and subsequently express a greater desire to connect with others. Our work also contributes to literature on technology-mediated relationships (Hoffman & Novak, 1996) and the literature on social rejection (e.g.; Gardner et al., 2005; Maner et al., 2007) by demonstrating that incidents of social exclusion may extend beyond the realm of human-to-human interactions into technology-based environments.

The proliferation of AT devices in the marketplace has prompted academics to investigate the factors that ~~can~~ influence consumers' adoption intentions and attitudes toward these products -(Lee and Yi, 2022; Lim et al., 2022). This work demonstrates that pleasant affective experiences during human--technology interactions (e.g., social comfort; Lee and Yi,

Comentat [LL7]: This is repetitive as it is summarized in the study overview section, and in the discussion of individual studies. I cut it out to reduce word count and summarized our contribution in the next paragraph

Comentat [VMA8]: Well done

2022) are a major determinant of consumers' attitudes and evaluations of the technology. By demonstrating that AT failures elicit feelings of rejection, we uncover a consumption context that can engender negative affective reactions in users, potentially hindering their likelihood to use the product again in the future. Further, extant research documents the positive influence of consumer-technology interactions on consumer outcomes (e.g., Poupis et al., 2021; Whang & Im, 2021), suggesting that one-way para-social relationships with products may fulfill consumers' need for belonging (Derrick et al., 2009). In contrast, we uniquely identify a context (i.e., failed consumer-technology interactions) that may thwart (rather than fulfill) consumers' social needs.

From a practical perspective, our work cautions marketers on the negative consequences of AT failures. We find that incidents of technology failure ~~can result in worse consumer outcomes~~engender more negative affective reactions in users when the technology is anthropomorphized (vs. non-anthropomorphized). Given that new technologies are prone to incidents of failure particularly during their first year on the market (e.g., Samsung Phones; BBCNews, 2016), our findings suggest that practitioners should be cautious about how they market new technologies: for example, marketers could limit the extent to which new technologies are positioned as having human characteristics, at least until there is certainty that they work properly. This could potentially reduce negative emotional reactions in users if the new product does not operate as anticipated. Additionally, given the mounting evidence linking the use of technology to feelings of anxiety and depression (Elhai et al., 2017; Hoge et al., 2017), managers are unceasingly looking for ways to reduce the negative impact of technology ~~use~~ on users' mental health and wellbeing (e.g., Facebook hiding engagement metrics; Conger, 2019). ~~This has become an even more pressing issue as recent reports suggest that vulnerable~~

~~populations such as the elderly are increasingly using technology (Rosenblatt, 2019).~~ Our findings suggest that managers should implement measures to minimize ~~the~~ negative emotional ~~reaction~~ outcomes that may arise from technology failure. For example, including a statement that ~~explains that the failure was not intentional or one that~~ objectifies the AT when it fails could possibly reduce feelings of rejection (e.g., "the *software* is unable to complete you request"). This is particularly important for technology targeting vulnerable populations like the elderly given that seniors are more likely to struggle with technology, making them more susceptible to incidents of technology failure (Scharre, 2020). Our findings also highlight the importance of making customer support agents readily available to assist customers: Offering users the opportunity to chat with a human agent could fulfill users' heightened social affiliation needs after incidents of AT failure. This may be particularly helpful for vulnerable populations (e.g., seniors) who often suffer from social isolation.

Comentat [LL9]: I mention the elderly/vulnerable population below so this is repetitive

Comentat [LL10]: We never measured perceived intentionality so this is a stretch (this whole paragraph feels like a stretch but they asked us to expand on managerial relevance in previous round. I didn't edit since the editor did not ask us to)

5.1. Limitations and future research

~~We limit our current investigation to discrete events of AT failure, assessed through experiments and survey instruments to obtain self-reported affect data. Self-reported data has well-known shortcomings, but is widely accepted as the best way to ascertain individual affect. We have attempted to account for age-related phenomena by using different age pools for our various studies though our research is limited by the responses given by our participant samples.~~

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~~Further, w~~While we demonstrate that feelings of rejection can explain why consumers seek to affiliate with others after AT failure, we acknowledge that our results may be multiply-determined like many others in the consumer psychology literature. We therefore encourage future work to explore parallel mechanisms that may act in conjunction with ~~(or independently~~

~~from)~~ the one presented in this paper. For example, incidents of technology failure ~~are known to increase stress~~can ~~engender technology-induced stress~~ (i.e., technostress), resulting in poor consumer outcomes (Sun et al., 2021). Future research could therefore explore whether ~~technostress may contribute to users' increased need for social connectedness after incidents of AT failure~~users may choose to cope with any technostress engendered by technology failures by seeking affiliation with others.

E~~E~~xtant work finds that the timing of a failure (e.g., during the first vs. second use) influences consumers' attitudes toward the technology (Gompei & Umemuro, 2015). Further, previous research demonstrates that consumers' relationships with products can evolve over time following ~~incidents of malfunction~~product failures (Aaker et al., 2004). Therefore, while we limit our current investigation to discrete events of AT failure, ~~future~~ we invite future work to ~~research could~~ explore whether the frequency and timing of AT malfunctions can influence feelings of rejection and the subsequent need for social affiliation in ~~this topic using~~ a longitudinal ~~design~~ design. ~~in which both the frequency and the timing of the failures are manipulated.~~

~~Further~~Also, products with more humanlike features are more likely to be perceived as social agents. For example, physical resemblance to humans (Connell, 2013) and the use of voice (Moussawi & Benbunan-Fich, 2021) can increase the perceived agency of a product, making failures seem more intentional (Puzakova et al. 2013). Future research could therefore explore whether our findings may manifest differently across different products: for instance, would feelings of rejections after ~~an incident of~~ AT failures be less intense if the AT uses a text interface (~~instead of~~versus voice) to communicate with users?

~~Extant~~ Other stream of work suggests that ~~individuals~~ consumers who experience social exclusion may engage in different forms of compensatory behavior including selecting products

that signal group membership (Mead et al., 2011), and engaging in prosocial behavior (Lee & Shrum, 2012). Future studies could explore whether AT failure can result in similar outcomes: for instance, would ~~the~~ feelings of rejection after an AT failure ~~failure of one brand of anthropomorphized gadgets~~ prompt consumers to purchase a competitor brand ~~in an attempt~~ to signal ~~belonging~~ membership to a different group?

Finally, given the proliferation of AT like robots and virtual assistants that increasingly blur the line between product and person, understanding the effect of AT on consumers is more critical today than ever before. We hope that our work will inspire future studies to further explore the effect of AT on consumers' social and emotional well-being.

Table 1: Literature on AT failure listed in alphabetical order

Source	Method	Type of AT	Main Consumer Outcome(s)	Main Finding(s)
Bajones et al. (2016)	Experiment	Service robot	Willingness to help the robot, perceived intelligence, liking	Users working with a robot were willing to help it every time it malfunctioned. Malfunctions did not affect liking and intelligence ratings
Brooks et al. (2016)	Experiment	Service robot	Reaction to technology failure (i.e., trust, satisfaction)	Human support (e.g., updates about robot progress) and support features (e.g., robot returning to charging station) reduced negative reactions after failures.
Choi et al. (2020)	Experiment	Service robot	Satisfaction	Process (vs. outcome) failures reduced satisfaction for anthropomorphized (non-anthropomorphized) technology
Desai et al. (2012)	Experiment	Remote-controlled robot	Trust in robot, use of autonomous (vs. manual) mode	Poor performance resulted in lower trust as evidenced by switching to manual (vs. autonomous) setting
de Visser & Parasuraman (2011)	Experiment	Robot in a simulated military environment	User-robot performance	Machine reliability of 70% or more improved performance
Diederich et al. (2021)	Experiment	Online service agent	Humanness, uncanniness, familiarity, service satisfaction	Failures had a negative effect on humanness and a positive effect on uncanniness. Humanness (uncanniness) had a positive (negative) effect on satisfaction and familiarity
Fan et al. (2016)	Experiment	Self-service machine	Intentions to switch from using a self-service machine to being served by a human employee	In the absence (presence) of others, customers with a high sense of power reported higher (lower) switching intentions after an incident of anthropomorphized (non-anthropomorphized) self-service machine failure. Customers with a low sense of power reported lower switching intentions regardless of the presence/absence of others
Gieselmann (2006)	Observational	Service robot	Users' error-handling strategies	Achievement strategies (e.g., paraphrasing, reformulation of query) were most commonly used to recover from robot errors

Giuliani et al. (2015)	Observational	Service robots	User social signals (e.g., nodding, smiling) after technology failure	Head movements and smiling were the most commonly used social signals
Gompei & Umemuro (2015)	Experiment	Service robot	Perceived familiarity	Familiarity scores improved when the first user-robot interaction was successful and the failure took place during the second interaction (i.e., the next day)
Green et al. (2022)	Experiment	Service robot	Perceived warmth, competence, extent to which is perceived as teammate	Although using humor as a recovery strategy does not compensate for poor performance, self-defeating humor (vs. other types) provided the best results
Groom et al. (2010)	Experiment	Service robot	Robot evaluation (competence, friendliness, belligerence)	Evaluations were lowest when the robot attributed the failure to the user (vs. itself or the robot-user team)
Hadi & Block (2019)	Experiment	Virtual assistant	Frustration, evaluation	Unsuccessful interactions with AT resulted in more aggression/frustration when the technology was ascribed a female (vs. male) gender
Hayes et al. (2016)	Experiment	Service robot	Nonverbal user feedback (e.g., smile, head movements) during a robot training session	Head nods and smiles were most commonly observed during successful robot interactions while frowns and head shakes were observed during unsuccessful interactions
Hu et al. (2021)	Experiment	Service robot	Evaluations, sincerity	Apologies from human (vs. robot) employees are perceived as more sincere which increases satisfaction after service failures
Kim et al. (2017)	Survey	Famous robot characters seen in movies	Perceived imperfections, warmth, and enjoyment of robot companionship	Famous robots with more imperfections received higher warmth ratings which increased expected enjoyment of robot companionship
Kim & Hinds (2006)	Experiment	Service robot	Attribution of blame and credit to the robot and to the user(s)	When a robot was more autonomous, users attributed more credit and blame to it after incidents of malfunction and less toward themselves and other users
Lee et al. (2010)	Experiment	Service robot	Robot and service evaluation	Forewarning users that a task is complicated for a robot, and recovery strategies (e.g., apology) mitigated the

				detrimental effect of failures on evaluations
Lv et al. (2022)	Experiment	Virtual assistant	Evaluation, performance expectations	Cuteness improved evaluations of virtual assistants after failures. ~~was~~Performance expectations and feelings of tenderness mediated this effect
Mirnig et al. (2017)	Experiment	Service robot	Anthropomorphism, intelligence, liking	Failures increased liking and had no effect on perceived anthropomorphism and intelligence
Mozafari et al. (2022)	Experiment	Service robot	Blame attribution, usage intentions	Users are more likely to attribute responsibility for failures to themselves (vs. the robot) when the robot has a warm (vs. competent) design, which increases usage intentions
Ragni et al. (2016)	Experiment	Service robot	User performance, robot evaluation (e.g., intelligence), attitude toward the robot (e.g., liking)	Failures reduced user performance and robot evaluation and enhanced attitude toward the robot
Salem et al. (2015)	Experiment	Service robot	Robot evaluation (e.g., trustworthiness), user performance	Failures reduced evaluations but had no effect on user performance
Schutte et al. (2017)	Experiment	Service robot	Sequence of actions performed by user to resolve failures	Information about the robot's understanding of the environment allows users to easily resolve failures
Serenko (2007)	Experiment	Virtual assistant	Attributions of responsibility to the technology	As perceived autonomy of the AT increased, consumers assigned more negative (positive) attributions to it under conditions of failure (success)
Sun, Li, & Yu (2021)	Survey	Virtual assistant	Technology exhaustion, satisfaction and intentions to continue using the technology	Technology failure impacted users' cognitive load, resulting in negative consumer outcomes
Wang et al. (2021)	Experiment	Service robot	Revisit intentions	Compared to no apology, an apology from a robot (vs. human) employee is less effective at improving revisit intentions after service failures
Yasuda & Matsumoto (2013)	Experiment	Service robot	Robot evaluation	Users ~~provided more positive evaluations of~~rated a robot that malfunctioned more positively than~~compared to~~ one that did not when the former was able to correct its mistake

Our work				
	Experiment	Virtual shopping assistant, online game	Feelings of rejection, desire to connect with others	Uniquely demonstrates that AT failure results in feelings of rejection, increasing the desire to connect with others Suggests that AT failures may be construed akin to incidents of social rejection

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