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Call It Robot: Anthropomorphic Framing and Failure of Self-Service Technologies

Abstract

Purpose

This work is aimed at testing the effect that anthropomorphic framing (i.e., robot vs. automatic machine) has on consumers' responses in case of service failure. Specifically, we hypothesize that consumers hold an unconscious association between the word "robot" and agency and that the higher agency attributed to self-service machines framed as robots (vs. automatic machines) leads, in turn, to a more positive service evaluation in case of service failure.

Design/methodology/approach

We have conducted four experimental studies to test our framework. In Study 1a and Study 1b, we used an Implicit Association Test (IAT) to test for the unconscious association held by consumers about robots as being intelligent machines (i.e., agency). In Study 2 and Study 3, we tested the effect that framing technology as robots (vs. automatic machines) has on consumers' responses to service failure using two online experiments across different consumption contexts (hotel, restaurant) and using different dependent variables (service evaluation, satisfaction, word of mouth).

Findings

We show that consumers evaluate more positively a service failure involving a self-service technology framed as a robot rather than one framed as an automatic machine. We provide evidence that this effect is driven by higher perceptions of agency and that the association between technology and agency held by consumers is an unconscious one.

Originality/value

This work investigates a novel driver of consumers' perception of agency of technology, namely how the technology is framed. Moreover, the study sheds light on consumers' responses to technology's service failure.

Keywords: *self-service technology, robots, service failure, agency, framing*

1. Introduction

The investment in automatic machines and self-service technologies (SSTs) that allow consumers to complete tasks and interact with firms without direct contact with front-line employees is a strategic decision that many businesses are currently facing (e.g., Cao et al., 2022). The range of automated services currently offered in the marketplace is wide and varied, and consumers are now familiar with self-ordering kiosks in restaurants such as McDonald's (Rensi, 2008) and self-check-in options in airports (Weed, 2020) and hotels (Bonte, 2022). The advancement in automation solutions now includes also the employment of humanoid self-service machines in the shape of service robots (Naylor, 2019; Rajesh, 2015). Furthermore, the reduced need for human contact brought about by the COVID-19 pandemic has further made automation a priority in hospitality-oriented sectors (Liu et al., 2022; Knani et al., 2022). Thus, understanding how individuals and in particular consumers, react to these technologies in these contexts is increasingly important (Chang & Kim, 2022; Mehta et al., 2022).

While previous literature suggests that consumers will be more likely to appreciate humanoid service robots because of their perceived ability to execute tasks typically performed by humans (Gray & Wegner, 2012), such technologies are extremely costly compared to similar solutions with less anthropomorphic features such as automatic machines (Goldman Sachs, 2022). Despite this price difference, the effectiveness of humanoid and nonhumanoid solutions is similar, with instances in which the nonhumanoid robot outperforms the humanoid one (Aslam et al., 2016; Huang & Liu, 2022). Nevertheless, most of the time service and hospitality companies tend to invest in extremely expensive humanoid machines, because of the higher perceived agency associated with these technologies (Yam et al., 2021a; Martini et al., 2016), disregarding cheaper but equally performing non-humanoid, traditional self-service machines. Then one may question if it is possible to make consumers

believe in the agency of the non-humanoid self-service machine while keeping the physical appearance of the technology intact. This research aims to answer this question, proposing that how the company frames self-service technologies might affect consumers' perceptions of agency and subsequent behaviors.

Consumers' responses to self-service technologies are largely dependent on the form taken by the machine (Fan et al., 2020), with the technology commonly placed on a continuum that goes from traditional automatic or self-service machines (e.g., self-check-out machines) to humanoid service robots (e.g., Pepper; Huang & Liu, 2022; Kim et al., 2021). Humanoid service robots are usually perceived as having more agency and autonomy (Yam et al., 2021a; Martini et al., 2016). However, previous literature has given less attention to the drivers of such perceived agency. In particular, building on previous studies according to which the way the technology is framed (e.g., called with a human name, or as a companion; Darling, 2015; Darling et al., 2015; Sung et al., 2007) affects consumers' responses, we argue that the association between robots (vs. automatic machines) and agency is unconsciously activated. In particular, we build on research on linguistic framing (e.g., Cheema & Patrick, 2008; Kopp et al., 2022; Mayer & Tormala, 2010) and argue that consumers perceive self-service machines as more intelligent and agentic when they are simply framed as a robot – therefore as an inherently humanoid machine – rather than as an automatic or self-service machine – therefore as a non-humanoid machine. We show that this occurs even when consumers are not aware of the physical appearance of the machine and they do not have access to objective and precise information about its functionalities.

The activation of agency, in turn, has important consequences on how consumers react to the technology. Despite some studies underlining that objects that have been attributed agency can generate feelings of unease and aversion (Gray & Wegner, 2012), and can threaten "human distinctiveness" (Mende et al., 2019), other research demonstrates that

agentic machines are trusted more (Waytz et al., 2014) and are perceived as more socially present (Lee et al., 2015).

We propose that the extent to which consumers respond to agency, and therefore to different types of linguistic frames, depends on the service outcome (failure vs. success). We combine attribution theory (Weiner, 1985; Harris et al., 2006) and the current literature showing that machines that have been attributed agency are perceived as social entities (van Doorn et al., 2017; Yam et al., 2021a), to argue that consumers are more likely to forgive a machine framed as "robot" rather than one framed as an "automatic machine".

Overall, this work investigates the effect that anthropomorphic framing (i.e., robot vs. automatic machine) has on consumers' responses in case of service failure of self-service machines. Specifically, the aim of this research is threefold. First, we aim to show that consumers hold an unconscious association between the word "robot" and agency. In this sense, we fill a gap in the literature (Choi et al., 2021; Liu et al., 2022; Fan et al., 2016; Fan et al., 2020) by focusing on a different way of anthropomorphising machines (i.e., linguistic framing) and by providing evidence for a simple intervention that could alter consumers' responses to SSTs. Second, this work is aimed at providing evidence that SSTs that have been framed anthropomorphically (i.e., robot) are perceived as having more agency, and therefore are evaluated more positively than SSTs that have been framed as traditional automatic machines in case of service failure. Therefore, we fill a gap in the literature on agency attribution (e.g., Yam et al., 2021a; Martini et al., 2016) that has largely focused on the appearance of the machine (e.g., Broadbent et al., 2013; Fan et al., 2016; Müller et al., 2021; Song & Kim, 2022). Third, we aim to show that the positive effect of anthropomorphic framing on agency perception and SSTs evaluation holds in different contexts and for different interactions with the machine

Moreover, by shedding light on the drivers and consequences of perceived agency, our research provides some useful insights for emerging companies offering services to consumers and that are looking to invest in automation and suggests that strategies focused on how self-service machines are framed could be beneficial in terms of how consumers respond to the employment of technology in service contexts.

The remainder of this paper is organized as follows. First, we develop the conceptual background and research hypotheses by focusing on the implicit association of a higher agency attributed to the technology framed as "robot" versus "automatic machine", and the consequences that this attribution has on consumers' reactions based on the service outcome. Subsequently, we report the empirical evidence that provides support for our conceptualization. Finally, we present the theoretical and practical implications of our results and discuss both limitations and directions for future research.

2. Theoretical Background

2.1. Linguistic framing and consumers' responses to anthropomorphic self-service machines

While self-service technologies (SSTs) have been around for years and the drivers of consumers' responses to these machines have been studied for decades (e.g., Meuter et al., 2000; Meuter et al., 2003), the use of and interest in these solutions in retailing and service has been steadily mounting in recent years (e.g., Chen et al., 2021; Cao et al., 2022). Self-service technologies can be defined as technological interfaces that allow customers to complete tasks and enjoy a service without direct involvement from human employees (Meuter et al., 2000), often enabling a more frictionless and convenient service encounter (Blut et al., 2016; Collier & Kimes, 2013).

In this context, it is worth noting that one of the most common strategies to facilitate consumers-machine interaction is the integration of human-like features in the design of the self-service technology (Fan et al., 2016; Fan et al., 2020), a process defined *anthropomorphism* (Epley et al., 2007). Self-service technologies can be anthropomorphised by adding realistic human features that make their appearance or their voice similar to that of a real human (e.g., Broadbent et al., 2013; Fan et al., 2016; Müller et al., 2021; Song & Kim, 2022); as a result, these technologies can end up physically resembling intelligent and independent humanoid service robots, even when their technical features do not enable them to complete more tasks than traditional self-service machines.

However, the tendency to consider technologies as more human-like has been noted also for objects that are simply given a name suggestive of humanity (Darling, 2015; Darling et al., 2015; Sung et al., 2007); for example, when the self-service machine is called with a personified name or "companion" (Darling et al., 2015).

Nevertheless, research has mainly focused on consumers' responses to self-service machines with a human-like appearance. For example, humanoid robots are perceived as warmer (Choi et al., 2021; Kim et al., 2019), more trustworthy (Park, 2020; Waytz et al., 2014), are liked more (Letheren et al., 2021), are associated with higher levels of satisfaction (Choi et al., 2021; Yam et al., 2021b), and result in higher attachment to the object (Hermann, 2021), and better interaction between humans and objects (Blut et al., 2021).

However, we argue that consumers' reactions to humanlike self-service technologies are triggered not only when the agent has a humanlike appearance, but also when it is linguistically framed using an anthropomorphic label such as "robot" (vs. "automatic machine"). We build on the literature on *linguistic framing,* which focuses on how the use of similar, albeit not equivalent, words can affect consumers' perceptions and behavioural responses (Cheema & Patrick, 2008; Mayer & Tormala, 2010; Patrick & Hagtvedt, 2012).

For example, recent research shows that different words (e.g., want vs. need) can trigger significant differences in consumers' reactions (e.g., donation behaviour) (Su et al., 2023). Specifically, we draw on prior research showing that framing self-service machines anthropomorphically changes individuals' mental models and expectations about the technology (Kopp et al., 2022; Roesler et al., 2020). However, while prior research has focused on anthropomorphic framing based on providing descriptions of the machine (Kopp et al., 2022; Roesler et al., 2020), we take a step back and argue that the use of the word "robot" can be effective in activating different reactions compared to the use of the word "automatic machine" or "self-service machine".

We argue that this occurs because individuals implicitly think about robots as self-governing and *autonomous* (Scheutz, 2011) and tend to associate robots with novelty (Wang et al., 2022). Therefore, the associations triggered by observing a humanoid robot should be equally triggered when interacting with a self-service machine that is simply framed as such, and even in the absence of objective information about what the technology can do and which functions can perform.

In particular, prior research shows that an important feature of humanlike agents is that they are perceived as having agency (Yam et al., 2021a), namely as having "the capacity to do, to plan and exert self-control" (Gray & Wegner, 2012, p. 126). Taken together, we argue that the association that consumers hold about humanlike robots and agency is an unconscious one that is activated both when the self-service machine has a humanlike appearance and when it is simply framed as a robot (vs. automatic machine).

Formally, we hypothesize that:

H_1: *Consumers attribute more (less) agency to a self-service machine when it is framed as a robot than when it is framed as an automatic machine.*

2.2. The effect of attribution of agency and service failure on consumers' responses to self-service machines

Understanding the drivers of agency attribution is critical because perceiving machines as agentic and capable of volition has important implications for how humans respond to them, especially when the technology fails. According to the attribution theory (Weiner, 1985), people try to discover the causes of certain events to understand why they occur. When people experience a service failure, they naturally look for the causes of the problem and who or what was responsible for it (e.g., Harris et al., 2006; Van Vaerenbergh et al., 2014). In particular, people often make attributions based on *locus*, defined as the extent to which the cause of the failure is attributed internally (e.g., by blaming themselves) or externally (e.g., by blaming others) (Weiner, 1985). The idea of locus is closely related to how people evaluate the service failure of the SST (Fan et al., 2016).

When consumers interact with SSTs, their level of participation in service creation is high as customers take the lead in the service production process (Dong et al., 2015). Thus, if the SST fails, given the participatory nature of the interaction with the machine, consumers might blame themselves more than in cases of service failure caused by human service staff (e.g., Harris et al., 2006). The effect is even stronger when the SST is anthropomorphised, with studies showing that the liking generated by anthropomorphic features of the technology reduces consumers' dissatisfaction responses to service failure (Fan et al., 2020).

Moreover, when people have a social relationship with someone, they are often more likely to forgive if something goes wrong (McCullough & Witvliet, 2002). The recognition of agency to the technology allows for the creation of such social bond. Indeed, non-human agents that are attributed mind and agency are perceived as social entities (van Doorn et al., 2017). As a result, they are considered as having a higher ability to learn from their mistakes and improve in the future and therefore are seen as worthier of forgiveness than non-

humanoid agents in case of failure (Arikan et al., 2023). In addition, higher agency is also associated with better capacities to communicate and interact with others (Gray et al., 2007). For example, one cannot engage in meaningful conversations with someone who has a low ability to communicate and act. If the technology is more interactive, people are more hopeful that it will be able to solve the problem because they can communicate with it and are more forgiving if it makes a mistake (Zhu et al., 2013).

Finally, customers tend to hold machines to a higher standard and are less tolerant of machine failure than of human mistakes (Chen et al., 2021; Dietvorst et al., 2015). Thus, since anthropomorphism leads to the attribution of human characteristics to technology, people will be less inclined to consider that simply as a machine and be more tolerant in case of service failure.

Overall, these findings support the idea that a SST is better placed to mitigate consumers' potential negative reactions to service failure when it is framed as a "robot" rather than as an "automatic machine" or "self-service machine" because of the implicit association of "robot" with higher agency. More specifically, we argue that consumers will respond less negatively (i.e., higher evaluations) to service failure involving a SST framed as a robot rather than as an automatic machine. Formally:

H_2: *The higher perceived agency attributed to a self-service machine framed as "robot" rather than "automatic machine" leads to a less negative service evaluation in case of service failure (vs. service success).*

2. Overview of the Studies

We progressively test for the relationships hypothesized in a series of four experimental studies. First, in Study 1a and Study 1b, we provide evidence that consumers attribute more agency to SSTs framed as robots rather than as automatic machines (H1). Second, in Study 2

we show that consumers react more positively to a service failure in a hotel when this involves a machine framed as a robot rather than as an automatic machine (H2), and we show that this effect is driven by the higher agency attributed to the machine framed as a robot. Finally, in Study 3, we replicate and expand Study 2's results considering a different service context (i.e., restaurant) and a different interaction with the technology. The conceptual model and hypotheses tested in our work are summarised in Figure 1.

FIGURE 1 ABOUT HERE

3. Study 1a

3.1. Method and procedure

The aim of Study 1a is twofold. First, we want to establish a measure to capture agency that would replicate the existing findings on the effect of human appearance on attribution of agency (e.g., Kim & McGill, 2018). Second, we want to show consumers' tendency to attribute different levels of agency to automatic machines and humanoid robots. To avoid demand effects, we used a survey-based version of the Implicit Association Test (IAT; Greenwald et al., 1998) developed by Carpenter and colleagues (2019). The method was demonstrated to be valid and reliable and has been largely used by recent literature (e.g., Fuduric et al., 2022; Kowenig-Lewis et al., 2022; Tse et al., 2023). The IAT assesses the degree to which target pairs (images of *robots* vs. *automatic machines*) and categories (*intelligent* vs. *unintelligent*) are mentally associated.

A total of 82 students at a large European university (73% female; M_{age} = 22.91, SD_{age} = 0.94) participated in the study for course credit. Participants completed a survey-based IAT in Qualtrics comparing "Robot" and "Automatic Machine" images, also called targets, on an "Intelligent" versus "Unintelligent" category to assess agency perception for robots over automatic machines. We used several pictures to describe the target words (robot vs.

automatic machine; stimuli are reported in Appendix A). Error feedback was provided by displaying an "X" for 300 ms (Greenwald et al., 1998). Participants placed their hands on the keyboard and completed seven blocks of stimuli sorting trials as described in Table 1. The setups for Blocks 1 and 2 were counterbalanced to avoid order effects. Participants had to press one button on the keyboard (either "E" or "I") that matched the designed target or category.

TABLE 1 ABOUT HERE

The premise behind the IAT is that one can more rapidly sort stimuli when pairings are compatible with associations. For example, if participants see automatic machines as less intelligent than robots, they should respond faster when using the same hand for robots and intelligent and the other hand for automatic machines and unintelligent (known as a "compatible block"; in our study Blocks 3 and 4 are examples of compatible blocks). Conversely, they should be slower when pairings are reversed (an "incompatible block"; in our study Blocks 6 and 7 are examples of incompatible blocks). Participants complete the procedure under both conditions; an association is indicated if people are faster in one condition relative to the other. The entire IAT lasted approximately 10 minutes. After completing the IAT, participants reported their age, gender, and nationality.

3.2. Results of Study 1a

D-score. To interpret the results of the IAT and to test for whether consumers indeed hold an unconscious association between the word "robot" and perceptions of agency, a standardized difference score called *D-score* was computed (Greenwald et al., 2003; Lane et al., 2007). The D-score is calculated for each participant, indicating in which condition (compatible vs. incompatible) participants were faster using the combined data in the combination blocks (3, 4, 6, and 7). A *D* score of 0 indicates no difference in speeds; a

positive score indicates that the participant was faster in the compatible block; a negative score indicates that the participant was faster in the incompatible block.

Among the participants who completed the IAT, one was eliminated due to excessive speed. The final analysis was conducted with 81 participants. The error rate for the whole IAT test was 0.067. The internal consistency reliability was high ($\alpha = 0.88$). The results indicated that participants had the tendency to attribute agency to the robots rather than to the automatic machine images ($M_{D\text{-}score} = 0.15$, $SD_{D\text{-}Score} = 0.49$; $t(80) = 2.78$, $p < .001$, 95% CI [.0428, .258]). Thus, Study 1a replicated previous literature showing that consumers attribute more agency to technology with a humanoid physical appearance. The words developed in this study are then used in Study 1b as a measure of agency.

4. Study 1b

4.1. Method and procedure

Study 1b aims to further investigate the relationship between anthropomorphic framing (i.e., robot) and consumers' agency perceptions of SSTs. In particular, Study 1b tests our hypothesis that the tendency of consumers to attribute more agency to a humanoid robot than to an automatic machine goes beyond the technology's appearance. Similar to Study 1a, we employed a survey-based version of the IAT (Carpenter et al., 2019). The IAT assesses the degree to which target pairs (*robots* vs. *automatic machines* frames) and categories (*intelligent* vs. *unintelligent*) are mentally associated.

A total of 72 students at a large European university (81% female; $M_{age} = 22.09$, $SD_{age} = 0.94$) participated in the study for course credit. The design of the study was equal to the one presented in Study 1a, with the key difference that participants did not see the images of the robots vs. automatic machines but only read words describing the targets (see Appendix B). This enabled us to test for the unconscious association held by consumers about robot (vs.

automatic machine) framing and agency. As in Study 1a, participants placed their hands on the keyboard and completed seven blocks of stimuli sorting trials. Participants had to press one button on the keyboard (either "E" or "I") that matched the assigned target or category. After completing the task, participants reported their demographic information (i.e., age, gender).

4.2. Results of Study 1b

Hypothesis Testing. To test for the relationship between anthropomorphic framing and agency, and in line with the procedure followed in Study 1a, we used the D-score to interpret the findings. The error rate for the whole IAT test was 0.07. The internal consistency reliability was high ($\alpha = 0.88$). The results indicated that participants had the tendency to attribute agency to the robots rather than to the automatic machine ($M_{D\text{-score}} = 0.16$, $SD_{D\text{-Score}} = 0.44$; $t(71) = 3.09$, $p < .002$, 95% CI [.0567, .2640]). A positive D-score means that participants responded faster when the "robot" words were paired with the "intelligence" words than when the "automatic machine" words were paired with the "intelligence" words. These results also indicate that participants responded faster when the "automatic machine" words were paired with the "unintelligence" words than when the "robot" words were paired with the "unintelligence" words. Thus, in Study 1b, we provide support for H_1.

Overall, both Studies 1a and 1b show that consumers infer agency from a machine when it is presented not only visually but also verbally as a robot, as participants were faster in replying when the robot (word or image) was associated with intelligence than when the robot was associated with unintelligence. Moreover, participants were faster in associating automatic machines with unintelligence than they were in associating automatic machines with intelligence.

5. Study 2

5.1. Method and procedure

This study is aimed at investigating the effect that anthropomorphic framing has on consumers' agency perceptions and evaluations of SSTs in the context of service failure.

Specifically, Study 2 tests H_2 and whether consumers will respond more positively to service failure when a machine is framed as a "robot" rather than as an "automatic machine" because of higher attribution of agency. Conversely, we do not expect any differences in consumers' responses between the machine framed as a "robot" versus an "automatic machine" in case of successful service. The study employed a 2 (Anthropomorphic frame: self-check-in machine vs. robot) × 2 (service outcome: failure vs. success) between-participants design. We recruited 400 participants (85% female, 4% non-binary; M_{age} = 24.17, SD_{age} = 6.82) from the US on Prolific.

At the beginning of the study, participants were randomly assigned to one of the four conditions describing the service experience. The scenario was adopted from previous literature (e.g., Belanche et al., 2020; Choi et al., 2021; Ho et al., 2020) and is similar to the automated check-in process already used by some real hotels[1].

In particular, we asked participants to imagine they had to check-in in at a hotel where the check-in process had been completely automated. Depending on the type of agent condition, participants had to check in with a robot or a self-service machine. After inserting their data, some participants managed to successfully enter their room (success condition) while others could not (failure condition). Participants did not see any pictures of the technology, but they just read the names of the two technologies in the scenario (see Appendix C). After reading

[1] See real hotels such as "Lo Nardo Accommodation" (https://www.lonardo.it/en/index) or Ostelzzz (https://www.ostelzzz.com/) that use self check-in in their structures.

the scenario, we asked participants to rate their evaluation of the hotel on a 7-point scale (α = 0.98; Keaveney et al., 2012).

As a measure of agency, participants reported the extent to which the machine described in the scenario had "a mind of its own", "intention", "a personality", and "free will" (α = 0.79; Kim & McGill, 2018). As a manipulation check, we asked participants to rate the extent to which they would describe the service experience depicted in the scenario as unsuccessful (1) or successful (7). As a primary attention check, we also asked participants to report whether the scenario assigned to them included "a robot", "a self-check-in machine" (automatic agent condition), or "a human employee". We also included another instructional attention check in the text (Meyvis & Van Osselaer, 2018).

Finally, we measured the frequency of travel (adapted from Wu et al., 2019), familiarity with AI, fear of Covid 19 (adapted from Ahorsu et al., 2020), and demographic information (gender, age).

5.2. Results

Manipulation Check. We excluded 26 participants who failed to recognize which machine was described in the scenario. We performed the final analysis with a sample of 374 participants.

As expected, participants in the service failure condition reported that the service was more unsuccessful (M= 1.91, *SD* = 1.08) than did the participants in the service success condition (M = 5.72, *SD* = 1.45; $F(1, 373) = 819.68$, $p < .001$).

Hypothesis testing. To test H_2 and show the effect of the anthropomorphic frame and service outcome on consumers' evaluation of the service, we performed a conditional moderated mediation on PROCESS (model 14, Hayes 2018). We run the model with 10,000 bootstrap analyses by setting services' evaluation as the main dependent variable,

anthropomorphic frame as the main independent variable (0 = automatic machine, 1 = robot), perceived agency as the mediator, and service outcome as the moderator (0 = failure, 1 = success). We included familiarity with AI, frequency of traveling, and fear of COVID-19 as covariates in the model.

The results show that compared to the automatic machine, participants attribute more agency to the robot (b = .28, SE = .11, 95% CI [.0610, .5069]). These results replicate the findings of Study 1b by showing that robots are associated with higher agency than automatic machines. Moreover, the analysis demonstrates that an increase in perceived agency leads to an increase in hotel evaluation (b = .35, SE = .09, 95% CI [.1706, .5418]). Most importantly, the index of moderated mediation was significant (Index = - .07, BootSE = .05, 95% CI [- .1794, - .0004]). In particular, the results indicate that the indirect effect of the anthropomorphic frame on hotel evaluation through perceived agency depends on the service outcome.

When the service is a failure, participants tend to give higher hotel evaluations when they perform the check-in with the machine framed as a robot instead of as an automatic machine (b = .10, BootSE = .05, CI 95% [.0160, .2245]). When the service is a success, there is no significant effect of the anthropomorphic frame on hotel evaluation (b = .03, BootSE = .02, 95% CI [- .0038, .0912]). The direct effect of the anthropomorphic frame on hotel evaluation was not significant (b = - .11, SE = .12, 95% CI [- .3499, .1333]). The results are shown in Figure 2.

FIGURE 2 ABOUT HERE

For the covariates, the effects of familiarity (b = .03, *p* = *ns*), frequency of travelling (b = .04, *p* = *ns*), and fear of Covid (b = .04, *p* = *ns*) on perceived agency are not significant. Moreover, the effect of frequency of traveling (b = - .03, *p* = *ns*) and fear of Covid (b = .01, *p*

= *ns*) on evaluation are not significant. Instead, the effect of familiarity on evaluation is marginally significant (b = .27, *p* = .04). Finally, given the gender skew of our sample, we re-run the analyses considering gender as an additional control varible, without finding any significant effect of gender on our focal variables, and confirmimg the direction and the significance of our results (b = -0.07, BootSE = .0.05, 95% CI [- .1931, -.0023] see Appendix E).

In Study 2, our results support H_2. In Study 3, we replicate the effect in a different service context and with a different service failure.

6. Study 3

6.1. Method and procedure

The objective of Study 3 is threefold. First, we aim to replicate the effect of anthropomorphic frame and service outcome on consumers' perceptions of the service. Second, we want to generalize the effect to a different hospitality context (restaurant) and a different type of interaction with the robot (vs. automatic machine). Specifically, participants in Study 2 assigned to the robot frame condition read that they had to tell their information to the robot to check in; conversely, participants in the automatic machine condition read that they had to insert their information to check in. The different ways of interacting with the technology might have influenced the extent to which respondents attributed agency to the robot vs. the automatic machine. To address this limitation, in Study 3 we explain to the participants that the two frames (robot and iPad) perform the same task in the same way. Third, we show that the effect of the anthropomorphic frame used influences not only the service's evaluation but also satisfaction and likelihood of engaging in word-of-mouth (WOM).

We recruited 400 participants (76% female, 3% non-binary; M_{age} = 26.14, SD_{age} = 7.87) from the US on Prolific. As in Study 2, we employed a 2 (anthropomorphic frame: iPad vs. robot) × 2 (service outcome: failure vs. success) between-subjects design.

Unlike Study 2, participants read a scenario describing a hypothetical order in a restaurant. In the condition with the automatic machine frame (i.e., iPad), participants were ordering their food by ticking on an iPad and receiving the food through an automatic cart. In the condition with the robot frame, participants were ordering their food by ticking on a robot and receiving the food through the same robot. Depending on the service outcome, participants were receiving either the correct or the wrong order (scenario adapted from Choi et al., 2021). As in Study 2, participants did not see any pictures but just read the description of the two technologies in the scenario (see Appendix D).

After reading the scenario, participants were asked to evaluate the service on the same scale we used in Study 2 (α = 0.98; Keaveney et al., 2012). Moreover, we asked participants to express on a 7-point scale their satisfaction with the service (α = 0.98; Voss et al., 1998), and their likelihood of engaging in positive WOM (α = 0.98; Markovic et al., 2018).

Then, participants answered a scale to measure perceived agency (α = 0.85; Kim & McGill, 2018), the manipulation check, and the attention checks. As control variables, we asked about the frequency of eating at a restaurant (Wu et al., 2019), familiarity with AI, and fear of Covid 19 (Ahorsu et al., 2020). Finally, participants reported some demographic information (gender, age).

6.2. Results

Manipulation check. We excluded 26 participants who either failed to recognize which machine was described in the scenario or the instructional attention check (Meyvis & Van Osselaer, 2018). We performed the final analysis with a sample of 374 participants. As

expected, participants in the service failure condition reported that the service was more unsuccessful (M= 1.98, *SD* = 1.13) than did the participants in the service success condition (M = 5.95, *SD* = 1.23; $F(1, 373) = 1041.69$, $p < .001$).

Hypothesis testing. To replicate the findings of Study 2, we performed a conditional moderated mediation on PROCESS (model 14, Hayes, 2018) to test the effect of anthropomorphic frame and service outcome on consumers' evaluation of the restaurant. We run the model with 10,000 bootstrap analyses by setting services' evaluation as the main dependent variable, anthropomorphic frame as the main independent variable (0 = automatic machine, 1 = robot), perceived agency as the mediator, and service outcome as the moderator (0 = failure, 1 = success). We included familiarity with AI, frequency of eating out, and fear of COVID-19 as covariates in the model.

The results show that participants attribute higher agency to the machine framed as a "robot" than to the one framed as "automatic machine" (b = .45, SE = .13, 95% CI [.1922, .7106]). Moreover, an increase in perceived agency leads to an increase in evaluation (b = .38, SE = .08, 95% CI [.2244, .5273]). Most importantly, the index of moderated mediation was significant (Index = - .12, BootSE = .06, 95% CI [- .2518, - .0096]). In particular, the results indicate that the indirect effect of the anthropomorphic frame on evaluation through agency depends on the service outcome. When the service is a failure, participants have more positive evaluations when they perform the order with the humanoid robot rather than the automatic machine (b = .1697, BootSE = .07, CI 95% [.0539, .3074]). When the service is successful, there is no significant effect of the anthropomorphic frame on evaluation (b = .05, BootSE = .04, [- .0112, .1253]). The direct effect of the anthropomorphic frame on evaluation was not significant (b = .06, SE = .14, 95% CI [- .2200, .3337]). The results are shown in Figure 3.

FIGURE 3 ABOUT HERE

Our findings are replicated when we run a moderated mediation model with the other two dependent variables, namely satisfaction with the service and WOM. In all cases, we show that participants are more satisfied (Index: - .1614, BootSE = .0621, 95% CI [- .2947, - .0535]) and more likely to engage in positive WOM (Index: - .1417, BootSE = .0654, 95% CI [- .2807, - .0206]) in case of service failure involving a machine framed as robot rather than as automatic machine, and that the effect is mediated by perceived agency.

For the covariates, the effect of familiarity on perceived agency is marginally significant (b = - .26, p = .04). However, the effects of frequency of eating out (b = .07, p = *ns*), and fear of Covid-19 (b = - .01, p = *ns*) are not significant. Moreover, the effects of familiarity with AI (b = .15, p = *ns*), frequency of eating out (b = .03, p = *ns*), and fear of Covid-19 (b = .05, p = *ns*) on evaluation are not significant. Finally, we re-run the analyses considering gender as an additional control varible, again confirming the direction and the significance of our results (b = -0.07, BootSE = .0.05, 95% CI [- .1931, -.0023]) (see Appendix E). However, while gender (1 = male, 0 = female) did not affect perceived evaluation (b = 0.20, p *ns*) we found that it significantly and negatively affected perceived agency (b = -0.68, $p <$ .01); this suggests that compared to males, females report a lower levels of perceived agency.

Thus, Study 3 replicates our previous findings and shows additional evidence for the influence of the type of anthropomorphic frame and service outcome on customers' evaluation.

7. Discussion

Across four studies, we aimed to investigate the role of anthropomorphic framing on consumers' perceptions and evaluations of SSTs in the context of service failure.

Specifically, Study 1a and Study 1b aimed to establish that consumers have a tendency to attribute agency to objects when they are framed as robots rather than automatic machines Indeed, findings show that consumers subconsciously believe that the name "robot" without any image of the agent implies more intelligence and more agency than traditional automatic machines.

Study 2 and Study 3 aimed to show that the higher agency attributed to SSTs that have been anthropomorphically framed leads to more positive evaluations of the machine in case of service failure compared to SSTs that have been framed as traditional automatic machines. Our findings provide evidence for this relationship and show that this holds across different interactions with the machine and different contexts. We also show that in case of service failure, consumers are also more likely to engage in positive WOM, and be less dissatisfied if they interact with a SST framed as a robot rather than as an automatic machine.

7.1. Theoretical contributions

Overall, our study makes several theoretical contributions. First, we contribute to the understanding of consumers' responses to anthropomorphic self-service technologies (e.g., Cao et al., 2022; Fan et al., 2016; Fan et al., 2020). Specifically, we focus on a driver that has been neglected by prior research, namely the way the SST is linguistically framed (robot vs. automatic machine). In this sense, we extend prior research showing that giving a humanlike name to technology has important consequences in terms of how consumers respond to machines (Darling, 2015; Darling et al., 2015). More importantly, we show that the association held by consumers about technology and agency is an unconscious one that is triggered regardless of whether individuals are exposed to the physical appearance of the machine.

Second, our work contributes to recent literature investigating consumers' reactions to the failure of SSTs in a service context (e.g., Fan et al., 2016; Zhu et al., 2013; Chen et al., 2021). We add to this literature by underlying the positive downstream effects of SST failure, such that presenting the technology as a robot mitigates the negative effect that the failure of the machine can have on consumers' reactions. Indeed, we provide evidence that in case of service failure, the higher agency attributed to machines framed as a robot rather than as an automatic machine leads to higher service evaluations, but also to higher satisfaction and positive word of mouth.

Third, our work contributes to the literature on linguistic framing (e.g., Cheema & Patrick, 2008; Kopp et al., 2022; Mayer & Tormala, 2010; Su et al., 2023). In particular, we develop and test a simpler way to anthropomorphically frame SSTs, and show that merely framing the technology using a humanlike frame (i.e., robot) has important consequences on consumers' responses to service failure. More importantly, our results provide evidence that, even in the absence of objective information about the characteristics and functionalities of the technology, consumers attribute more agency to the SST if this is presented as a robot rather than as a traditional automatic machine.

Finally, our research is in line and extends the literature on attribution theory (Weiner, 1985; Harris et al., 2006) to the context of SSTs. In particular, our findings show that people react to a service failure based on how the SST machine is framed (robot vs. automatic machine). As such, we show that the attribution of failure and the extent to which people would blame themselves can be influenced by how the technology is framed. These findings are also in line with recent research that acknowledges the evolution of technologies as social entities (van Doorn et al., 2017). Overall, the paper shows how negative consequences of service failure can be mitigated using linguistic framing.

7.2. *Managerial implications*

Our work provides useful insights for hospitality businesses interested in integrating technology into their services. Indeed, managers who are planning to invest in automation should work on increasing the perceived agency of the technology as that might mitigate the negative consequences of service failure on consumers' evaluations. Our results suggest that one way to do that is to increase the extent to which technology is perceived as humanlike and similar to humans. We recommend companies implementing technological solutions in their services to use robot-related labels (e.g., robotic) rather than labelling machines as "automatic" or "self-service" as this can increase the perceived intelligence of the machine, and therefore improve consumers' evaluations in case of service failure.

Furthermore, our results about the effect that agency attributions have on consumers' likelihood to engage in positive word of mouth in case of service failure are particularly relevant for small-medium companies faced with the decision of choosing how to best invest their limited resources in automated services. In particular, this finding suggests that investing in less expensive machines presented using robot-related labels or investing in costly machines with a humanlike appearance could have similar image and reputation returns in case of service failure.

Therefore, our work provides useful insights that could be leveraged by companies in case of service failure. As consumers evaluate a service more positively in case of failure if it involves a self-service machine that has been anthropomorphically framed because of higher perceived agency, companies should underline the machine's capacity to do and exert self-control when mistakes occur. For example, self-service machines could be programmed to verbally say or display messages highlighting their agency and abilities in case of faulty

behavior or when consumers report mistakes; this could help prime perceptions of humanness and trigger more positive reactions to the failure.

7.3. Limitations and future research

Our research has its own set of limitations that can be suitably addressed in future studies. First, we focus on the service outcome (failure vs. success) as a moderator, but there could be several other interesting moderators that future research could explore. For example, future research could investigate the influence of individual traits (e.g., anthropomorphic tendency, openness to innovation) that could make consumers respond especially well to anthropomorphic SSTs. Similarly, future research could explore whether the severity of the service failure (high vs. low) affects the way consumers respond to different types of SSTs.

Second, we do not test for the effect that anthropomorphically framing SSTs has over time. For example, it is possible that as consumers become more experienced with using machines that are framed as robots, their inferences about their agency and their capabilities might change. In this sense, future research could explore the hypothesised effects longitudinally and explore potential interventions that could be enacted to ensure that anthropomorphic framing is effective over several service encounters.

Third, our studies are conducted with Western samples. Future studies could explore the findings in other cultures and test how different cultural dimensions could affect the influence that perceived threat to human identity posed by service robots has on service evaluation.

Fourth, in this paper, we argue that anthropomorphic framing and framing an SST as a robot rather than an as automatic machine is effective in triggering perceptions of agency because individuals make unconscious associations that robots are autonomous (Scheutz, 2011) and novel (Wang et al., 2022), and therefore must also be intelligent machines. However, in our studies, we only control for familiarity and we do not empirically test for the

effect of these variables. Therefore, future research could extend our findings by investigating the effect that perceptions of novelty and autonomy have on consumers' responses to anthropomorphic self-service machines.

Fifth, in this research, we only investigate the effect that anthropomorphic framing in terms of framing SSTs as robots versus automatic machines has on consumers' perceptions. However, we do not explore this intervention in the context of other technologies. Future research could investigate the role of anthropomorphic framing for technologies such as chatbots and voice assistants and explore whether our findings on agency attribution and evaluation extend to these automatic machines too.

Sixth, in Study 3 we found that compared to males females are less sensitive to technology perceived agency. This result is quite interesting and future research can further explore the relationship between gender, perceived agency and attribution theory, both in the context of SSTs and that of other technologies (e.g., artificial intelligence).

Finally, in our study, we focus on the effect that automation has on customers' service evaluation. However, it is quite plausible that in the future automation and humans will collaborate to support one another in case of failure or to exploit the strengths of both human workers and technology at the same time. For example, front-line employees can be employed alongside SSTs to add warmth and empathy to the interaction, while technology can free employees' valuable time by taking over repetitive, time-consuming tasks (van Doorn et al., 2023). Future studies could investigate how the interactions between humans and robots influence the customers' experience. For example, what happens when the anthropomorphised SST fails, but a human worker is present as part of the recovery process? Future research could explore the role that agency plays in these circumstances and uncover

other potential psychological mechanisms that could explain consumers' reactions to service failure in the context of human-machine collaboration.

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Figure 1. Conceptual Model with Hypotheses and Studies.

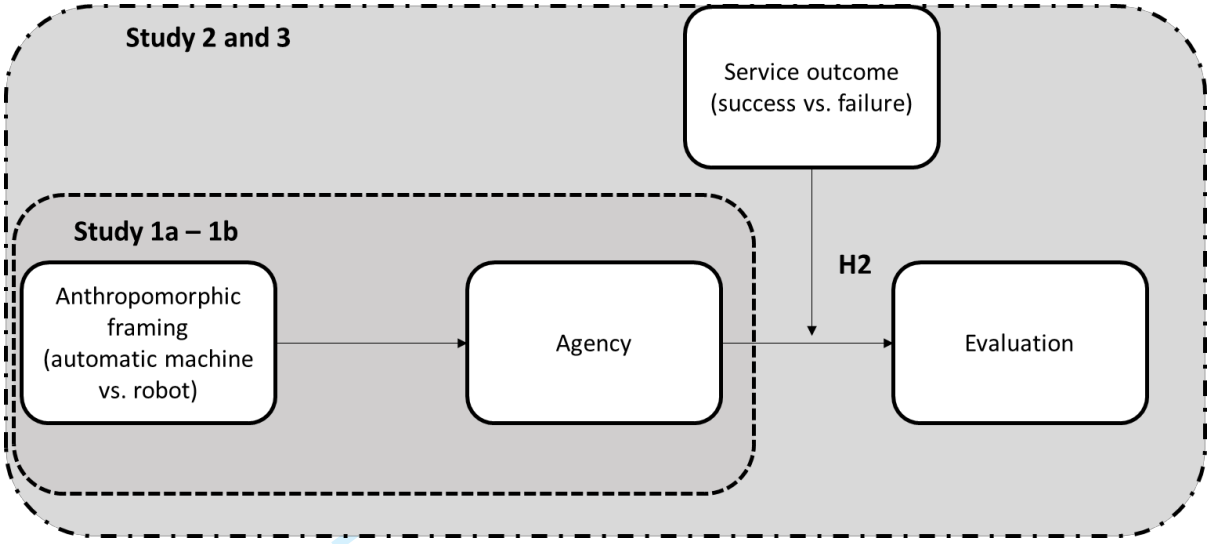
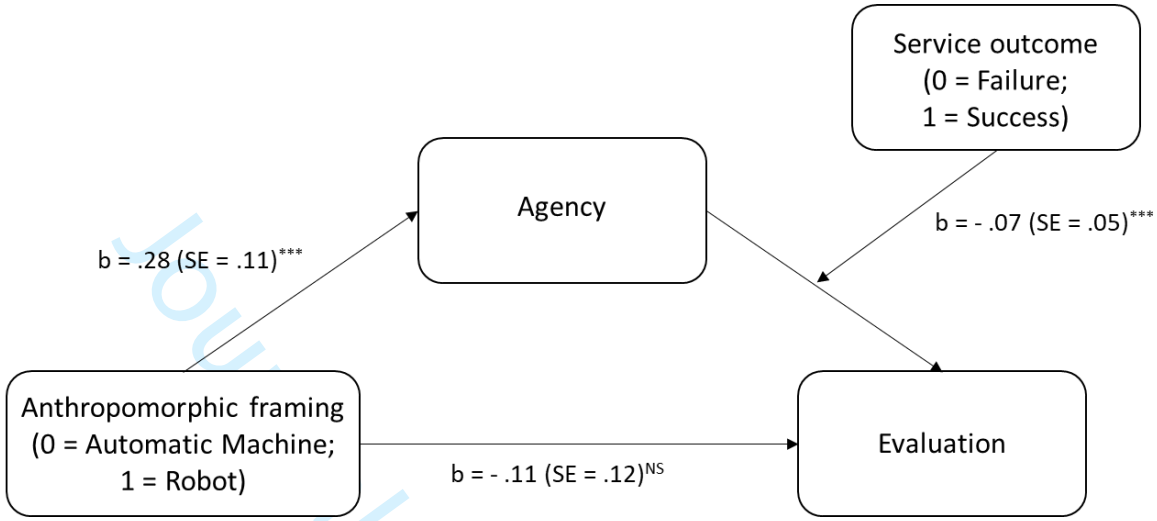
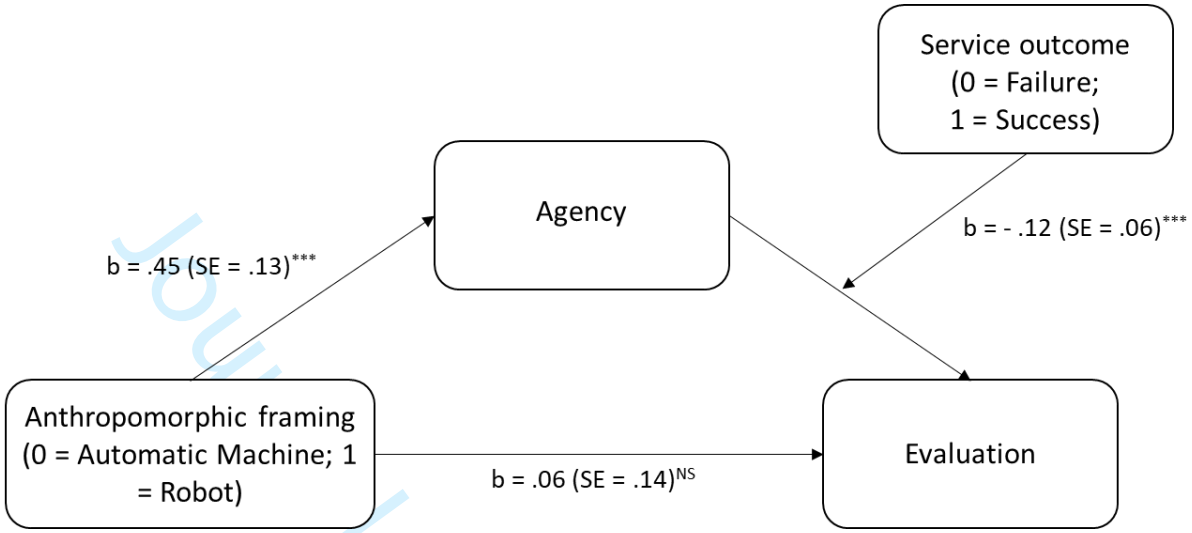


Figure 2. Results from Study 2.



Note: 95% CI Bootstrap 10000; *** p < .001; ** p < .05

Figure 3. Results from Study 3.



Note: 95% CI Bootstrap 10000; *** $p < .001$; ** $p < .05$

Table 1. The 7 Blocks of the IAT Test.

Block	Left assignment	Right assignment	Note
1	Robot	Automatic Machine	Target
2	Intelligent	Unintelligent	Category
3	Robot Intelligent	Automatic Machine Unintelligent	Combination Practice
4	Robot Intelligent	Automatic Machine Unintelligent	Combination Critical
5	Automatic Machine	Robot	Target swap
6	Automatic Machine Intelligent	Robot Unintelligent	Combination Practice
7	Automatic Machine Intelligent	Robot Unintelligent	Combination Critical

Note: "Target" indicates the stimuli which belong to the target trials (robot vs. automatic machine). "Category" indicates the stimuli which belong to the category trials (intelligent vs. unintelligent).

Appendix A – Stimuli used in Study 1a
Robot:

Automatic machine:

Intelligent: Smart, clever, competent
Unintelligent: Dumb, stupid, incompetent

Appendix B – Stimuli used in Study 1b

Robot: Cyborg, Android, Humanoid
Automatic machine: Self-service machine, Self-ordering machine, automated machine
Intelligent: Smart, clever, competent
Unintelligent: Dumb, stupid, incompetent

Appendix C – Scenarios used in Study 2

	Service outcome	
Anthropomorphic Framing	**Success**	**Failure**
Self-check-in machine	You are traveling to a new city. You have booked several nights at a hotel where the check-in process has been completely automated. You arrive at the hotel and head towards the reception area to check-in. Indeed, you find that there is only a self-check-in machine and no employee to assist you with the check-in process. Hence, you go towards the **self-check-in machine**. **You tap on the self-check-in machine to activate it**. Self-check-in is done by providing your reservation number or your last name. After doing so, you will be given your room number and a five-digit password that you can use to enter your room. You type your reservation number in the **self-check-in machine**, and after a brief information verification process (approximately 15 seconds), you get the information you need to access your room. You go to the elevator and head towards your room. **You type your password and successfully enter your room.**	You are traveling to a new city. You have booked several nights at a hotel where the check-in process has been completely automated. You arrive at the hotel and head towards the reception area to check-in. Indeed, you find that there is only a self-check-in machine and no employee to assist you with the check-in process. Hence, you go towards **the self-check-in machine.** **You tap on the self-check-in machine to activate it**. Self-check-in is done by providing your reservation number or your last name. After doing so, you will be given your room number and a five-digit password that you can use to enter your room. You type your reservation number **in the self-check-in machine**, but after a long information verification process (approximately 5 minutes) you get an error message. You try again and, after another long information verification process, you get the information you need to access your room. You go to the elevator and head towards your room. **You type your password, but you are unable to access your room.**
Robot	You are traveling to a new city. You have booked several nights at a hotel where the check-in process has been completely automated. You arrive at the hotel and head towards the reception area to check-in. Indeed, you find that there is only a robot and no employee to assist you with the check-in process. Hence, you go towards the **robot.** **You tap on the robot to activate it.** Check-in with the robot is done by providing your reservation number or your last name. After doing so, you will be given your room number and a five-digit password that you can use to enter your room. You tell your reservation number to **the robot,** and after a brief information verification process (approximately 15 seconds), you get the information you	You are traveling to a new city. You have booked several nights at a hotel where the check-in process has been completely automated. You arrive at the hotel and head towards the reception area to check-in. Indeed, you find that there is only a robot and no employee to assist you with the check-in process. Hence, you go towards the **robot.** **You tap on the robot to activate it.** Check-in with the robot is done by providing your reservation number or your last name. After doing so, you will be given your room number and a five-digit password that you can use to enter your room. You tell your reservation number to the **robot**, but after a long information verification process (approximately 5 minutes) you are told there is an error. You try again and, after another long

	need to access your room. You go to the elevator and head towards your room. **You type your password and successfully enter your room.**	information verification process, you get the information you need to access your room. You go to the elevator and head towards your room. **You type your password, but you are unable to access your room.**

Appendix D – Scenarios used in Study 3

	Service outcome	
Anthropomorphic Framing	**Success**	**Failure**
iPad	It is Friday night and you go with a friend to a new restaurant for dinner. You read online that the process to make orders has been completely automated. You are very curious to see for yourself how this would work. When you get to the restaurant, you see that to make your order you can use one of the **i-pads that have been placed on the tables**. Once seated, you check the menu and order food and drinks by **ticking on the i-pad the items that you want.** About 10-15 minutes later, your food and drinks are served by an automatic cart. You check and see that all the food and drinks you ordered are on the table. You start eating and enjoy your dinner.	It is Friday night and you go with a friend to a new restaurant for dinner. You read online that the process to make orders has been completely automated. You are very curious to see for yourself how this would work. When you get to the restaurant, you see that to make your order you can use one of the **i-pads that have been placed on the tables**. Once seated, you check the menu and order food and drinks by **ticking on the i-pad the items that you want.** About 20-25 minutes later, your food and drinks are served by an automatic cart. You check and you realize that they delivered you the wrong order and that the food and drinks that have been served do not match with what you ticked on the i-pad.
Robot	It is Friday night and you go with a friend to a new restaurant for dinner. You read online that the process to make orders has been completely automated. You are very curious to see for yourself how this would work. When you get to the restaurant, you see that to make your order you can call one of the **robot servers available in the restaurant**. Once seated, you check the menu and order food and drinks **by ticking on the robot the items you want.** About 10-15 minutes later, your food and drinks are served by the robot server. You check and see that all the food and drinks you ordered are on the table. You start eating and enjoy your dinner.	It is Friday night and you go with a friend to a new restaurant for dinner. You read online that the process to make orders has been completely automated. You are very curious to see for yourself how this would work. When you get to the restaurant, you see that to make your order you can call one of the **robot servers available in the restaurant.** Once seated, you check the menu and order food and drinks **by ticking on the robot the items you want.** About 15-20 minutes later, your food and drinks are served by the robot server. You check and you realize that they delivered you the wrong order and that the food and drinks that have been served do not match what you asked the robot server.

Appendix E – Results of Study 2 and 3 controlling for gender

Study 2 – Results controlling for gender (N= 374)

	Agency	Evaluation
Agent (1= robot)	0.28**	-0.10
Gender (1 =Male)	-0.03	0.07
Frequency Traveling	0.04	-0.03
AI Familiarity	0.005	0.26*
Fear Covid	0.04	0.01
Agency		0.36***
Service outcome (1= success)		3.75***
Service Outcome*Agency		-0.23**
Index Mod-Med -0.07 IC [-0.1931, -0.0023]		
F-test	1.88*	99.52***
R-square	0.02	0.68

Notes. $^{*}p < .10$ $^{**}p < .05$ $^{***}p < .01$

Study 3 - Results controlling for gender (N= 374)

	Agency	Evaluation
Agent (1= robot)	0.49***	0.04
Gender (1 =Male)	-0.68***	0.20
Frequency Traveling	0.06	0.001
AI Familiarity	-0.26**	0.16
Fear Covid	0.27	0.04
Agency		0.39***
Service outcome (1= success)		3.65***
Service Outcome*Agency		-0.26**
Index Mod-Med -0.13 IC [-0.2983, -0.0236]		
F-test	9.06***	71.06***
R-square	0.11	0.61

Notes. $^{*}p < .10$ $^{**}p < .05$ $^{***}p < .01$