

Research Article

# Research on the Influence of Humor Response in the Context of Artificial Intelligence Service Failure: Moderating Effect Based on User Humor

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## Abstract

With the development of high and new technology, artificial intelligence technology has been widely used in all walks of life. However, limited by the technical development level and the complexity of the service environment, the failure of artificial intelligence robots is inevitable. How to make an effective remedy has become the focus of attention of enterprises and academia. Based on cognitive-affective system theory of personality, benign violation theory and personality trait congruence theory, this paper conducts three situational experiments. This paper explores the relationship between artificial intelligence humor response, perceived sincerity and user forgiveness in the context of artificial intelligence service failure, and discusses the moderating effect of user humor degree. It is found that artificial intelligence humor response has a positive effect on user forgiveness in the context of service failure, and perceived sincerity plays a part of mediating role. In addition, for users with different degrees of humor, the same humorous reply will cause users to perceive different sincerity, and then lead to different users' forgiveness. This study complements the research on consumer psychology and behavior theory and remedy strategies in the context of service failure by artificial intelligence robots. At the same time, it provides a reference for enterprises how to dynamically adjust the artificial intelligence humor response level according to the user portrait, and further provides practical enlightenment for enterprises to implement effective remedy strategies.

## Keywords

Artificial Intelligence, Service Robot, Service Recovery, User Forgiveness, Cognitive-affective System Theory of Personality, Benign Violation Theory

## 1. Introduction

In recent years, big data, artificial intelligence, biometrics and other high-tech has been developed rapidly. How to use high-tech to improve production and service has become the focus of society and enterprises. Among them, Artificial Intelligence (AI) service robots have gradually penetrated into various industries, bringing users a new experience. Overall,

the application of artificial intelligence plays a crucial role in improving customer service levels. However, due to the limitations of the current technical level and the complexity of the service environment, the application of artificial intelligence technology in service contact will inevitably produce some problems. The service failure is one of them. For example, a

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service robot at the Heinina Weird Hotel in Japan received numerous complaints from customers for interpreting customers' snoring as a signal for help and waking them up several times during the night [1]. Users' perception of service failure not only affects their willingness to purchase products or services again, but also negatively affects user satisfaction, brand loyalty and word-of-mouth communication. How to effectively reduce the user's perception of artificial intelligence service failure or how to effectively remedy the failure of artificial intelligence service has become the focus of enterprise attention.

At present, scholars have carried out a lot of research on consumers' willingness to accept service robots and service evaluation. However, the research on the result response and service recovery at the consumer level after the failure of service robots is relatively scarce, and it is still in the initial stage [2]. Nowadays, the research of artificial intelligence service failure remedy strategy is mainly reflected in changing the appearance design of robots. Through empirical analysis, scholars have verified that the cuteness of service robots and anthropomorphism can promote the remedy after the failure of AI services [3, 4].

In the aspect of language remedy of service robots, some scholars put forward the empathic response strategy of robots [5, 6]. It can embody the "emotional intelligence" of robots and enhance trust in robots and choose to re-accept the use of robots by reducing the psychological distance of consumers. Some scholars also believe that humorous robot responses after service failure can effectively obtain positive evaluation from consumers [7]. Existing literature has found that humorous language style, as a manifestation of emotional intelligence, can play a positive role in interpersonal communication, such as improving communication quality and reducing misunderstandings. The same humor effect plays a similar role in human-computer interaction [8]. But humor is not just positive. Facing different situations, cultures and users with different personalities, inappropriate humor is likely to lead to negative effects. For example, Kim et al. (2016) have verified the negative impact of humor in the service process [9]. So in the process of AI service recovery, will the humorous reply of the robot have the same double-edged sword effect? In what cases does the use of humorous replies lead to higher user forgiveness? The existing literature does not respond strongly to this question.

In order to make up for the lack of existing studies, based on cognitive-affective system theory of personality (CASTP), benign violation theory and personality trait congruence theory, combined with the characteristics of artificial intelligence service, this paper explores the influence of AI humor response on user forgiveness in the context of artificial intelligence service failure. We also examined the mediating effect of perceived sincerity and the moderating effect of user humor. This study explores how enterprises should adjust the level of AI humor response to reduce users' negative emotions about service failure and obtain higher user forgiveness when users

with different levels of humor face artificial intelligence service failure. In addition, this study complements and improves the theoretical research on consumer psychology and behavior and remedy strategies in the context of AI robot service failure, further expands the theoretical research on service marketing in the fields of hotel, catering and tourism, and promotes the sustainable development of AI service marketing. More importantly, this study provides practical implications for enterprises to implement effective remedial strategies.

## 2. Literature Review and Hypotheses Development

### 2.1. Humorous Responses

Humor is a form of emotional communication designed to please the target while also contributing to emotional regulation [10]. Martin et al. (2003) divided humor into four styles based on its function and consequences [11]. They are self-deprecating humor (building rapport with others in a benign way), self-enhancing humor (promoting oneself in a generally harmless way), subsidiary humor (developing harmonious relationships that are harmless to oneself and others), and aggressive humor (promoting oneself in a harmful way to others). Service recovery is to mitigate the negative impact of service failures on customers in order to meet customer needs [12]. Therefore, this paper mainly focuses on the study of self-deprecating humor.

Generally speaking, humor usually has a positive effect in interpersonal communication, but if used incorrectly, it can also backfire. In the field of robotics research, Tay et al. (2016) proposed that humor in service robots refers to the extent to which service robots use humor when interacting with customers [13]. If used properly, humor can be a good strategy to enrich human-machine interaction. Zhang et al. (2021) found that humor can improve customer acceptance of human-like and mascot-like service robots, but seems less applicable to machine-like service robots [8]. However, some studies have also found the potential role of humor in mitigating the negative effects of service failures and public crises [9, 10]. When customers are faced with service failures, humor may further irritate customers because it makes them feel like the robot isn't taking them seriously [14]. Therefore, it is very important to clarify the boundary conditions of humor's double-edged sword effect in service recovery.

### 2.2. The Impact of Artificial Intelligence Humor Responses on User Forgiveness

Due to the heterogeneity of customers and the variability of services, whether it is staff or artificial intelligence, service failures are inevitable. After the service failure, the enterprise is most concerned about easing the negative emotions of customers in order to achieve the desired remedial effect

[15-17]. In the face of service failure, customers will be dissatisfied and complain because their needs are not met or the service of the enterprise does not reach the expected level, and even spread negative word of mouth. At present, in the research on artificial intelligence service failure and remedy, scholars have verified through empirical analysis that cute, empathic response and apology of service robots can promote the remedy after artificial intelligence service failure [3, 18, 19]. There has been little research on artificial intelligence's humorous apologies.

Humor can enhance interactive fun, provide entertainment, and relieve tension in stressful situations [20]. And the relief of tension allows users to reevaluate the situation through a new perspective, often making them more tolerant of lapses. For example, Kobel et al. (2021) found through empirical research that humorous expressions are more likely to make customers feel relaxed and tolerant and have a positive attitude toward service providers after service failures [10]. Moreover, Zhang et al. (2021) have demonstrated that the positive effects of such humor play a similar role in human-computer interaction [8]. Therefore, when the AI robot service fails, the AI humor response can bring users more positive perceptions of relaxation, tolerance and personalization, thus suppressing the negative emotions caused by the service failure and generating a higher willingness to forgive. Accordingly, the following hypothesis is proposed:

H1. AI humor response positively affects user forgiveness.

### 2.3. Mediating Effects of Perceived Sincerity

In the context of interpersonal interaction, existing studies usually define perceived sincerity as people's perception of individual information that can be perceived, is sincere, and conveys authenticity [21]. For example, according to the research of Si (2017), perceived sincerity refers to consumers' sincere knowledge about the motivation of a certain behavior [22]. Cui et al. (2019) believe that perceived sincerity is an extra-role behavior of employees, and sincerity is the true essence of service providers [23]. In the context of human-computer interaction, sincerity is considered to be one of the most critical characteristics of service robots. Poushneh (2021) shows that perceived sincerity is the degree to which the information provided by the robot is true, sincere, and trustworthy [7]. Therefore, this study defines perceived sincerity as the true feelings people feel in the process of interacting with artificial intelligence service robots.

Previous studies have explored the impact of perceived sincerity on consumers from different perspectives. Research by Darby & Schlenker (1981) explored the role of perceived sincerity in apologies and showed that the role of perceived sincerity can be cumulative for the recipient of a company's apology [24]. Gonghe et al. (2020) discussed the impact of perceived sincerity on consumers' attitudes from the perspective of crisis response [25]. She believed that service providers could "show weakness" and ask the injured party for for-

giveness by revealing regret or sadness. From the perspective of service recovery, Cui Zhanfeng and Chen Yitao (2019) explored the positive role of perceived sincerity in recovery satisfaction [23]. Yaou Hu (2021) also discusses different service entities (bot text vs. Robot voice vs. Human employee) on the effect of perceived sincerity on remedy satisfaction, and concluded that human service remediation improves remedy satisfaction by making customers perceive higher sincerity [26]. It can be seen that in both interpersonal and human-computer interaction situations, when users perceive more sincerity, the higher the satisfaction and forgiveness of service failure remediation.

Based on the theory of cognitive emotion system, perceived sincerity is essentially a follow-up behavior that users process external information from the emotional path to influence [27]. When the AI service fails, the self-deprecating reply of the service robot to its service failure behavior can make the user perceive that the AI is on the same side as itself, which reduces the sense of position and distance between the AI and the user, and the user has certain trust in the AI. On the other hand, the humility expressed by self-deprecation makes users feel that artificial intelligence has the courage to admit mistakes and the determination to remedy them, thus reflecting the sincerity of the individual. To sum up, AI's high humor response in the event of service failure can improve user forgiveness by improving user's perceived sincerity. Accordingly, the following hypothesis is proposed:

H2. Perceived sincerity plays a mediating role between AI humor response and user forgiveness.

### 2.4. Moderating Effect of User Humor

User humor refers to the degree of difficulty for users to feel humor and fun. In this study, the stable difference in users' tendency to perceive other individuals' language styles is called humor [28]. Compared to low humorous users, high humorous users are more likely to recognize humorous intentions from a wink, a sentence, or other change in others, and are more likely to find something funny, witty, or humorous. Whether the AI humor response is appropriate in the context of AI service failure largely depends on the user's own sense of humor.

According to the benign violation theory, humor can be produced only when benign conflict occurs. And humor may or may not be appropriate, depending on the violation (any irritant that may threaten an individual's well-being, identity, or normative belief structure) [29]. Therefore, humorous responses in the context of AI service failure also depend on how users define the violation. Users with different levels of humor perceive humorous apology responses differently. When faced with AI's humorous apology reply, users with a high degree of humor will think that AI's humorous reply is effective and reasonable, and does not belong to the violation, and tend to forgive. For low humor users, they will perceive the AI humorous response as inappropriate and unappreciated,

and therefore view the remedial action as a violation, leading to lower user forgiveness.

In addition, from another perspective, the personality trait congruence theory provides theoretical support for the effect of user humor degree on the difference in user responses to different levels of AI humor. This theory holds that individuals with different personality traits will have different cognitive biases when processing emotional information, which is specifically reflected in that individuals prefer to process information consistent with their personality traits and have processing advantages [30]. Specifically, when facing artificial intelligence services, users with a high degree of humor are more inclined to accept highly humorous AI responses, because they believe that the AI with a high degree of humor response is more compatible with their own personality traits, and will have higher processing advantages and social tendencies for them, which also reduces the sense of position and distance between artificial intelligence and users. Resulting in more perceived sincerity, which in turn leads to a higher willingness to forgive. When users with low humor are faced with the failure of artificial intelligence service, the use of AI to respond with high humor will lead to the mismatch between their own characteristics and the characteristics of artificial intelligence, further increasing the contradiction between users and artificial intelligence, making users perceive the insincerity of artificial intelligence, and then reduce the willingness to forgive. Accordingly, the following hypothesis is proposed:

H3. User humor moderates the mediating effect of AI humor response on user forgiveness through perceived sincerity. When the customer is high humor, the AI high humor re-

sponse can produce higher perceived sincerity than the AI low humor response. When the customer is low humor, the AI low humor response can produce a higher perception of sincerity.

### 3. Methods

Based on the cognitive-affective system theory of personality, the benign violation theory and the personality trait congruence theory, and combined with the service characteristics of artificial intelligence, this paper conducts three situational experiments (Table 1). Study 1 examined the main effect of humorous reply on user forgiveness in the context of AI service failure. Study 2 examined the main effect and the mediating effect of perceived sincerity between the robot's humorous response and the user's forgiveness. Study 3 investigated the moderating effect of user humor degree by designing an inter-group control experiment (user humor  $\times$  AI humor response). To ensure the robustness of the experimental results, the studies were conducted under different situations and failure severity. This includes navigation services (study 1 and study 3) and wake-up services (study 2), as well as different severity levels of failure, including low severity (study 1 and study 2) and high severity (study 3). The contextual material was adapted from the study of Hongyan Y (2022) [7].

We collected a total of 498 questionnaires through self-forwarding and paid services on professional online platforms WJX and Credamo. Then, the samples with filling time (less than 60s), ip (repeated answers) and the same options were processed.

**Table 1.** Overview of studies.

Hypotheses	Studies	Experimental design	Scenarios/failure severity
Main effect: H1	Study 1	AI humor response (High vs. low)	Navigation service/low
Mediating effects: H2	Study 2	AI humor response (High vs. low)	Wake-up service/low
Moderating effects: H3	Study 3	2 (AI humor response: High vs. low) $\times$ 2 (User humor: High vs. low)	Navigation service/high

## 4. Study 1

Study 1 tested the effect of different AI humor responses on user forgiveness after AI service failure.

### 4.1. Pretest

A total of 71 subjects were recruited for the preliminary experiment. Participants were asked to rate humorous re-

sponses based on two different scenarios in which an AI robot interacts with a user (Appendix 1). Different humorous responses were recorded as R1a, R1b and R2a, R2b, respectively (Table 2). The measure of humor level refers to the study of Ye (2021) and modifies appropriately "You think that the reply content of the robot is humorous" (1 = not at all, 7 = completely consistent) [31]. The results showed that in the first scenario, the score of R1a ( $M1a = 5.22$ ,  $SD = 2.144$ ) was significantly higher than that of R1b ( $M1b = 1.74$ ,  $SD = 1.133$ ). In the second scenario, the score of R2a ( $M2a = 4.98$ ,  $SD = 2.212$ ) was significantly higher than that of R2b ( $M2b =$

1.79, SD = 1.151), so the experiment took R1a and R2a as the AI high humor response group, and R1b and R2b as the AI

low humor response group.

**Table 2.** AI humor response.

Label	Content
R1a	Oh, my God! I'm so sorry! I must have remembered the wrong way. Dear God, please forgive me, do not give me "a red". I will summon my boss for you immediately!
R1b	I took the wrong way, I am very sorry for the inconvenience, please forgive me! Call human service for you immediately, please wait for a moment!
R2a	That's too bad! I'm terribly sorry, but I must have got it wrong in my head. Dear God, do not give me "a red", please forgive me.
R2b	I'm sorry, I misheard the time. I'm very sorry for the inconvenience. Please forgive me!

## 4.2. Design and Samples

A single-factor (AI humor response: high vs. low) between-subject design was adopted. We randomly assigned 140 participants to one of two scenarios. They were asked to read the material and complete a questionnaire. The final valid samples were 112 (58.0% women).

The design of the items in the questionnaire is based on the mature scale. Control variables were measured in the following parts: Situational involvement measures ("Can you imagine yourself as the protagonist in the situation?", 1 = completely unable, 7 = completely able); Service failure severity measurement ("How serious do you think this service failure is?", 1 = very not serious, 7 = very serious) [32]. The measurement of the independent variable AI humorous response ( $\alpha = 0.902$ ) was adapted according to the maturity scale proposed by Amitava (1990), including three items such as "Do you think the robot's reply content is humorous" [33]. The question of dependent variable user forgiveness ( $\alpha = 0.913$ ) was adapted from the research of Paul et al. (2018), including three questions such as "Do you think the robot's apology is acceptable" [34]. Both AI humor response and user forgiveness measures were measured using a Likert 7-level scale (1 = completely inconsistent, 7 = completely consistent).

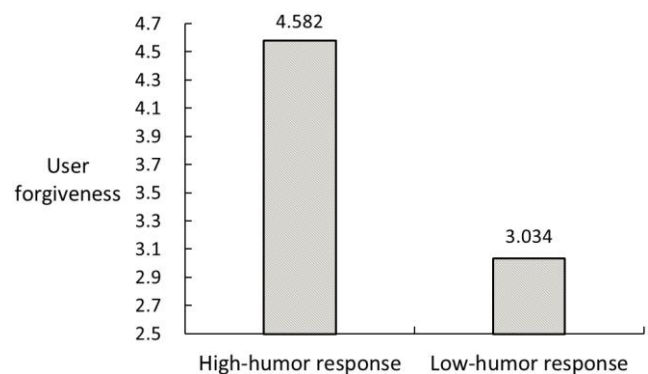
## 4.3. Results

The results of single sample T test (with the median value 4 of the 7-point scale as the critical value) and independent sample T test showed that the level of situation involvement ( $M = 5.25$ ,  $p < 0.001$ ) was high and the difference between groups was not significant ( $ps > 0.05$ ). There was no significant difference in the severity of failure between groups ( $ps > 0.05$ ). The potential influence of the above variables on the experiment was excluded.

As for the control of AI humor response, the independent

sample T-test results showed that the humor level of AI high humor response group ( $M_{\text{high}} = 4.87$ ,  $SD = 1.248$ ) was significantly higher than that of AI low humor response group ( $M_{\text{low}} = 2.65$ ,  $SD = 1.314$ ). That is, the AI humorous response manipulation was successful ( $t(100.630) = 9.044$ ,  $p < 0.001$ ).

The results of independent sample T-test showed that the user forgiveness of AI high humor response group was significantly higher than that of AI low humor response group ( $M_{\text{high}} = 4.58$ ,  $SD = 0.998$ ;  $M_{\text{low}} = 3.03$ ,  $SD = 1.750$ ;  $t(71.813) = 5.532$ ,  $p < 0.001$ ), H1 was verified. Figure 1 shows user forgiveness at different levels of AI humor response.



**Figure 1.** User forgiveness at different AI humor response.

## 5. Study 2

Study 2 examined the mediating effect of perceived sincerity on the AI humor response and the forgiveness of users.

### 5.1. Design and Samples

The control of AI humor response was the same as in experiment 1. A total of 132 subjects participated in this experiment, and 116 valid samples were recovered (60.24%

women). Participants were randomly assigned to one of two situations and asked to fill out questionnaires (Appendix 2).

On the basis of study 1, the questionnaire of study 2 added the measurement of perceived sincerity ( $\alpha = 0.912$ ) of the intermediary variable. Referring to Langsley's research, the question included a total of 4 items such as "Do you think the other party's apology is sincere", and Likert 7-level scale was used (1 = completely inconsistent, 7 = completely consistent) [35].

## 5.2. Results

The results of single sample T test (with the median value 4 of the 7-point scale as the critical value) and independent sample T test showed that the score of situation involvement ( $M = 5.36$ ,  $p < 0.001$ ) was higher and the difference between groups was not significant ( $ps > 0.05$ ). There was no significant difference in the severity of failure between groups ( $ps > 0.05$ ), that is, the potential influence of the above variables on the experiment was excluded.

As for the control of AI humor response, the independent sample T-test results showed that the humor level of AI high humor response group ( $M_{\text{high}} = 5.41$ ,  $SD = 1.519$ ) was significantly higher than that of AI low humor response group ( $M_{\text{low}} = 3.07$ ,  $SD = 1.693$ ). The AI humor response manipulation was successful ( $t(111) = 7.835$ ,  $p < 0.001$ ).

The results of independent sample T-test showed that the user forgiveness of AI high humor response group was significantly higher than that of AI low humor response group ( $M_{\text{high}} = 5.22$ ,  $SD = 1.449$ ;  $M_{\text{low}} = 3.32$ ,  $SD = 1.665$ ;  $t(114) = 6.590$ ,  $p < 0.001$ ), H1 was verified again. Figure 2 shows user

forgiveness for users at different levels of AI humor response.

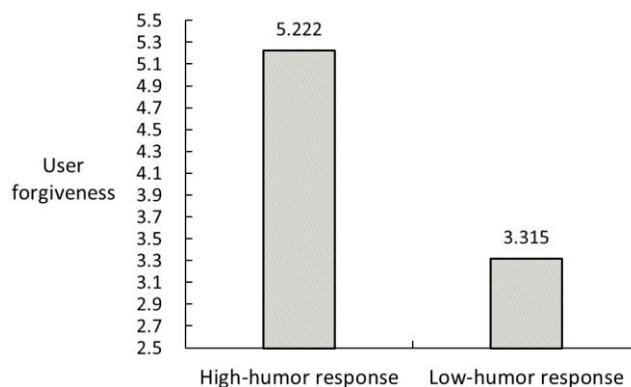


Figure 2. User forgiveness at different AI humor response.

Finally, we examined the mediating effect of perceived sincerity.

Verification was conducted according to the mediation effect test procedure of Zhao X et al. (2010) (Process4.1, Model 4, sample size 5000, confidence interval 95%) [36]. The results showed that perceived sincerity had a significant mediating effect ( $LLCI = 0.298$ ,  $ULCI = 0.641$ , excluding 0), and the mediating effect value was 0.443, which proved that perceived sincerity played a partial mediating role between AI humor response and user forgiveness. In summary, H2 was verified. The specific data are shown in Table 3.

Table 3. Mediating effect model testing of perceived sincerity.

Category	Effect	SE	t	p	95%CI	
					LLCI	ULCI
Total effect	0.802	0.042	19.171	0.000	0.719	0.885
Direct effect	0.359	0.055	6.525	0.000	0.250	0.468
Mediating effect	0.443	0.088	—	Not include 0	0.298	0.641

## 6. Study 3

Study 3 tested the moderating effect of user humor.

### 6.1. Design and Samples

Study 3 used 2 (AI humor response: high VS. low)  $\times$  2 (user humor level: high vs. low). Low) intergroup experimental design. A total of 155 subjects participated in this experiment,

and 144 effective samples (52.1% women) were finally recovered. The participants were randomly assigned to the AI high/low humor response group, and the experimental procedure was the same as in study 1, except that the user's humor was measured at the beginning of the experiment (Appendix 3).

On the basis of study 2, the questionnaire of study 3 added the measure of user humor degree ( $\alpha = 0.912$ ) of the moderating variable, referring to Svebak's (1996) research, including 2 items such as "You can easily recognize a slight hint of other people's humorous intention, such as a wink, a sentence,

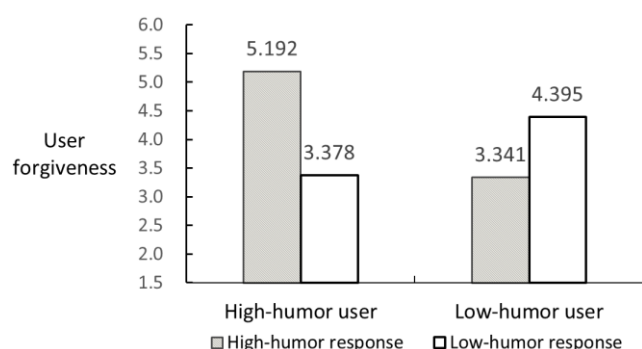
or other change” [37]. Likert 7-level scale (1 = completely inconsistent, 7 = completely consistent) was used.

## 6.2. Results

The results of single sample T test (with the median value 4 of the 7-point scale as the critical value) and independent sample T test showed that the subjects could be well substituted into the experimental situation ( $M = 4.80$ ,  $p < 0.001$ ), and the difference between groups was not significant ( $ps > 0.05$ ). There was no significant difference in the severity of failure between groups ( $ps > 0.05$ ). The potential influence of the above variables on the experiment was excluded.

Referring to the relevant research of Deng Wei (2020) and Zhang Depeng (2019), the samples with a user humor score of no less than 4 were divided into the high user humor group, and the remaining samples were divided into the low user humor group [38, 39]. The results of independent sample T-test for moderating user humor showed that high user humor score was significantly higher than low user humor score ( $M_{\text{high}} = 5.61$ ,  $SD = 0.882$ ;  $M_{\text{low}} = 2.06$ ,  $SD = 0.741$ ;  $t(141.650) = 26.300$ ,  $p < 0.001$ ). The independent sample T-test of AI humor response level showed that AI high humor response score was significantly higher than AI low humor response score ( $M_{\text{high}} = 4.38$ ,  $SD = 1.861$ ;  $M_{\text{low}} = 3.40$ ,  $SD = 1.946$ ;  $t(141.718) = 3.093$ ,  $p = 0.002$ ). This indicates that this experiment is effective for the manipulation of the moderating and independent variables.

Since both AI humor response and user humor are categorical variables, a two-factor analysis of variance was used. The results showed that there was a significant interaction between AI humor response and user humor on perceived sincerity ( $F(1,143) = 24.838$ ,  $p < 0.001$ ).



**Figure 3.** The impact of the interaction between AI humor response and user humor degree on perceived sincerity.

The independent sample T test was conducted for the two groups of data respectively, and the moderating effect analysis was conducted to compare the differences between the groups. The results of the high user humor group showed that the perceived sincerity of AI's high humor response was higher than that of AI's low humor response ( $M_{\text{high}} = 5.19$ ,  $SD =$

$1.378$ ;  $M_{\text{low}} = 3.38$ ,  $SD = 1.505$ ;  $t(77.891) = 5.626$ ,  $p < 0.001$ ). The results of the low user humor group showed that there was no significant difference in the effect of AI humor response on perceived sincerity ( $M_{\text{high}} = 3.34$ ,  $SD = 2.168$ ;  $M_{\text{low}} = 4.40$ ,  $SD = 2.199$ ;  $t(61.625) = -1.930$ ,  $p = 0.058$ ). Therefore, the H3 hypothesis was partially true. The interaction between AI humor response and user humor has an impact on perceived sincerity, as shown in Figure 3.

## 7. Discussion

### 7.1. Conclusions

Based on the cognitive affective system theory, the benign conflict theory and the personality trait consistency theory, this paper, starting from AI emotional intelligence and combining with the characteristics of artificial intelligence service, examines the direct impact of robot humor response on user forgiveness, the mediating role of perceived sincerity and the moderating role of user humor degree after artificial intelligence service failure through three situational experiments. The main conclusions are as follows: First, in the context of AI service failure, AI humorous reply has a positive impact on user forgiveness. Compared with AI low humorous reply, AI high humorous reply is more likely to cause user forgiveness. Second, perceived sincerity plays a partial mediating role between AI humorous response and user forgiveness. According to the cognitive emotion system theory, AI's self-deprecating high-humor response reduces the sense of distance between artificial intelligence and users, making them feel more sincere, and thus improving forgiveness. Third, the above effect will be different according to the characteristics of the user, that is, the user's humor plays a moderating role. According to benign conflict theory and personality trait consistency theory, people's judgment of violation behavior in service failure and cognitive tendency to humor are related to their own characteristics. For users with high humor, AI's high humor response can improve the perceived sincerity more than AI's low humor response. For users with low humor, the level of AI humor response no longer affects the perceived sincerity.

### 7.2. Theoretical Contributions

First, this study explores the influence of artificial intelligence humor response on user forgiveness and the mediating role of perceived sincerity, which enriches the service marketing theory from the perspective of artificial intelligence. Previous studies paid much attention to the effect of artificial intelligence's appearance design, perception dimension and language style on the use intention of service robots, but ignored the continuous use intention of customers and the remedy strategy in the case of service failure. From the perspective of AI emotional intelligence, this study proves that after service failure, AI can remedy it in a humorous way, which can better improve users' perceived sincerity, and then

make a choice to forgive AI service failure. The above conclusions provide a new digital perspective for the study of relationship marketing derived from artificial intelligence services, and help to understand the important role of remedial language style on artificial intelligence services more comprehensively.

Second, this study verifies that the user's humor degree can influence the user's forgiveness behavior by adjusting the effect of AI humor response on the perception of sincerity, which is conducive to promoting the combination of artificial intelligence and consumer psychology and behavior-related theories. Most previous studies focused on the role of customers' personal traits (such as gender, implicit personality, etc.) or situations (consumption situations, social situations, etc.), but did not carry out matching analysis on the characteristics of user humor. By matching the level of user humor with the level of AI humor response, this study proves that for users with different humor levels, only when the level of humor response is consistent with it, the service recovery effect is the best. This study clarified the remedial strategy that different humor levels should be used to respond to different users, which is helpful to promote the research on the relationship between users and businesses in human-computer interaction.

### 7.3. Managerial Implications

First, businesses should recognize the positive role of AI humor response on the application of artificial intelligence, and pay attention to not only the improvement of AI intelligence level, but also the development of AI emotional intelligence, and appropriately improve its humor response level. As an intelligent technology product, AI's IQ level is the basis for its promotion in the service market, while emotional intelligence level is the lubricant to slow down its promotion resistance and promote customer acceptance. Artificial intelligence is favored by a large number of users because of its advantages such as accuracy and speed, but it is subject to its own technical level and whether it can provide sincerity, warmth and other human-like attributes, making some users do not have high hopes for artificial intelligence. By reasonably setting the level of humor response, businesses can effectively improve users' perception of artificial intelligence sincerity, and help businesses better carry out relationship marketing.

Second, businesses can consider other aspects (such as improving the level of robot anthropomorphism) to improve users' perceived sincerity towards AI, and thus improve user forgiveness in the face of service failures. This study concludes that the effect of AI humor response on user forgiveness is partly achieved through the path of perceived sincerity. Therefore, if you can directly improve the user's perception of artificial intelligence sincerity, forgiveness will have the same positive effect on the user. Studies have confirmed that AI personification level can have a positive impact on users' willingness to continue using and user dissatisfaction by shortening psychological distance. Therefore, in the design

of artificial intelligence, the anthropomorphic level of the robot can be appropriately improved to achieve a similar role to the humorous reply of AI, and improve the user's willingness to forgive and continue to use.

Third, when the service failure occurs, the merchant can evaluate the humor degree of the customer, and dynamically match the AI humor response remedy strategy according to the evaluation results. User heterogeneity requires merchants to have a deep understanding of the characteristics and needs of different user groups. Enterprises need to subdivide and position users through market research, user portraits and other means in order to better meet the needs of different user groups. Combined with the relevant conclusions on the user's humor degree, this paper gives the following suggestions: Businesses can evaluate the user's humor degree, and accurately match the artificial intelligence humor response level with the user's humor degree. Technicians can train the AI to dynamically adjust the level of humor response based on customer portraits. This study is helpful for businesses to broaden the application field and optimize the use of artificial intelligence service technology.

### 7.4. Limitations and Future Research

First of all, the experimental situation of this paper focuses on the service scene of the hotel, and the experiment adopts the method of online scene description and illustration, which has certain limitations. In the future, we can focus on users' perception and decision-making of artificial intelligence services in offline real scenes. Second, this study only considers the impact of self-deprecating humor responses in negative service situations, while the impact of other types of language styles (such as cuteness and empathy) on user experience in positive service situations needs to be further explored. Finally, with the development of new technologies and the emergence of new remedial forms and methods, more dimensions of artificial intelligence services can be explored in the future, and factors such as service context, attribution theory, and other personal characteristics can be introduced for exploration.

### Abbreviations

AI	Artificial Intelligence
CASTP	Cognitive-Affective System Theory of Personality
WJX	A Platform for Collecting Questionnaires
IQ	Intelligence Quotient

### Author Contributions

**Yunxia Shi:** Model construction, Funding acquisition, Methodology, Writing – original draft, Writing – review & editing

**Bu Zhang:** Data curation, Software, Validation, Investigation, Visualization, Writing – original draft, Writing – review & editing

**Rumeng Zhang:** Resources, Data curation, Supervision, Investigation

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## Data Availability Statement

The data is available from the corresponding author upon reasonable request.

## Conflicts of Interest

The authors declare no conflicts of interest.

## Appendix

### Appendix I. Scenarios and Stimuli of Study 1

Experimental materials: Suppose you travel to another city and stay in a hotel serviced by a robot. After returning from your trip, you feel hungry and want to have a meal at your hotel's Chinese restaurant. You don't know the exact location of the Chinese restaurant. The staff are busy helping other customers. Then, you see a service robot nearby. You just walk up and say, "Take me to the Chinese restaurant." The robot replied, "Yes, please follow me." Three minutes later, the robot stopped in front of a dessert shop not far from the Chinese restaurant and said, "You have reached your destination." Enjoy your meal." You tell the robot, "This is not a Chinese restaurant," and the robot apologizes.

AI high-humor response: Oh, my God! I'm so sorry! I must have remembered the wrong way. Dear God, please forgive me, do not give me "a red". I will summon my boss for you immediately!

AI low-humor response: I took the wrong way, I am very sorry for the inconvenience, please forgive me! Call human service for you immediately, please wait for a moment!

### Appendix II. Scenarios and Stimuli of Study 2

Experimental materials: Suppose you live in a hotel that is serviced by robots. You plan to get up early the next morning and do some exercise. Before you go to bed, you give the service robot in your room a command: "Wake me up at 6:10 a.m. tomorrow." However, the service robot misinterpreted it as "wake me up at 6.40am tomorrow" and replied: "OK, the alarm has been set for you." The next morning, when the

service robot wakes you up, it's 6:40 a.m. You miss exercise time, but it doesn't affect your overall plan. You tell the robot, "You've got the time wrong!" The robot then apologizes.

AI high-humor response: That's too bad! I'm terribly sorry, but I must have got it wrong in my head. Dear God, do not give me "a red", please forgive me.

AI low-humor response: I'm sorry, I misheard the time. I'm very sorry for the inconvenience. Please forgive me!

### Appendix III. Scenarios and Stimuli of Study 3

Experimental materials: Suppose you travel to another city and stay in a hotel serviced by a robot. After returning from your trip, you feel hungry and want to eat at the hotel's Chinese restaurant. You don't know the exact location of the Chinese restaurant and the staff is busy helping other customers. Then, you see a service robot nearby. You just walk up and say, "Take me to the Chinese restaurant." The robot replied, "Yes, please follow me." Three minutes later, the robot stopped in front of the restaurant and said, "You have arrived at your destination." Enjoy your meal." However, the Chinese restaurant is far away from you and you don't like Western food. You tell the robot, "This is not a Chinese restaurant!" The robot then apologizes.

AI responded with the same content as Study 2.

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