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Artificial intelligence in the kitchen: Can humans be replaced in recipe creation and food production?

Abstract

Purpose – Artificial intelligence (AI) is increasingly involved in idea generation and production processes. To understand AI's pivotal roles in the back-of-house operations of restaurants, we examined the effects of AI involvement in recipe creation and food production on consumers' willingness to order food.

Design/methodology/approach – We conducted three experiments in the context of casual dining restaurants. We examined the main effect of AI involvement in recipe creation and food production on the willingness to order food in a hypothetical restaurant (Study 1) and a real restaurant (Study 2). In addition, we investigated the mediating role of uniqueness neglect. We explored whether the negative effect of AI involvement in recipe creation is attenuated in the presence of cues of uniqueness consideration (Study 3).

Findings – We demonstrate that AI involvement in food production does not elicit negative responses to a menu but that consumers show unfavorable responses when AI is involved in recipe creation. We also identify the mediating role of uniqueness neglect. Furthermore, we reveal a way to mitigate the negative perceptions of AI involvement in tasks requiring intuition and instinctive decision-making (i.e., recipe creation) by incorporating cues that emphasize uniqueness considerations.

Originality/value – We deliver causal evidence for the significant impacts of AI involvement in recipe creation and food production, utilizing multiple experimental designs involving both hypothetical and real restaurants. Our findings thus can tackle an ongoing challenge in the tourism and hospitality industry—the deficit of human resources in back-of-house operations.

Keywords Artificial intelligence, recipe creation, food production, subjective task, objective task, restaurant

1. Introduction

Artificial intelligence (AI), defined as "any kind of algorithm or statistical model [that] perform[s] perceptual, cognitive, and conversational functions typical of the human mind" (Longoni *et al.,* 2019, p. 5), has significantly transformed the restaurant industry by revolutionizing their back-of-house operations (Song *et al.,* 2022; Tussyadiah, 2020). As demonstrated by Capterra's survey (Burke, 2022), 76% of restaurant owners, managers, and executive chefs have incorporated cutting-edge technologies in various operational areas, including day-to-day kitchen operations, such as food preparation, recipe development, and inventory management. For example, CaliExpress has adopted an AI-powered robot, Flippy, to prepare burgers, and robots are cooking the patties and providing customized foods for their guests (Ewing-Chow, 2024). Chipotle has been experimenting with various AI-powered robotic chefs preparing its salads and bowls (Snider, 2023). Furthermore, Velvet Taco has introduced Chat GPTaco, the new taco menu developed by its AI-generated recipe, capturing customers' attention and redefining their AI experiences (Krysik *et al.,* 2023). Thus, AI is playing a pivotal role in reshaping the operational landscape of restaurants as well as customer experience (Lu *et al.,* 2021).

While a growing number of restaurants have recently incorporated AI into their back-of-house operations, limited attention has been directed toward consumers' perceptions of AI involvement in various tasks in kitchens, such as recipe creation and food production. Past empirical research has mainly focused on its applications in their front-of-house operations, particularly service encounters, to investigate direct interactions between humans and AI (e.g., Kim *et al.,* 2022; Yang *et al*., 2024). Understanding how consumers perceive a restaurant's kitchen operation is crucial as it influences perceived value, food quality, and purchase intention (Buell *et al*., 2017; Leung *et al*., 2024). With AI playing a growing role in the kitchen, learning how consumers evaluate AI applications and make decisions can offer useful insights for restaurant managers. This may help them to find the optimal balance between AI and human involvement in their kitchens.

To that end, we examine the differential impacts of AI involvement in kitchens—recipe creation and food production—on consumers' willingness to order food compared to the traditional restaurant scenario where humans are responsible for both tasks. Based on cognitive continuum theory (Hammond, 1996), we categorize recipe creation as a subjective task and food production as an objective task. We then adopted the notion of algorithm aversion (Dietvorst *et al.,* 2015) to explain the varying impact of AI involvement in the two distinct tasks on consumer responses, driven by skepticism about AI's ability to replicate the intuitive qualities of humans. Through three experiments, we demonstrate that consumers are less likely to order food when AI performs the recipe creation process, while such negative responses are mitigated when AI is involved in the food production process. We also demonstrate the role of perceived uniqueness neglect as a psychological mechanism underlying the impacts of AI involvement in the kitchen on consumers' reactions. Finally, we show that incorporating uniqueness consideration cues (i.e., signals of AI's ability to recognize individuals' distinct attributes; Yalcin *et al.,* 2021) into AI's functions reduces its likelihood of evoking negative responses.

Accordingly, our research enriches the literature on consumer decision-making by delineating the impacts of AI involvement in two tasks in kitchens. We fill this gap by revealing the distinct impacts of AI involvement in recipe creation and food production on consumers' willingness to

order food, compared to the conventional restaurant scenario where humans manage both tasks. Furthermore, our findings provide theoretical and practical insights into how algorithm aversion can be mitigated, highlighting the conditions under which consumers may be more receptive to AI involvement in subjective and intuitive tasks. Ultimately, our study underscores a particular circumstance (i.e., the presence of uniqueness consideration cues) in which consumers' resistance to AI can be mitigated.

2. Literature Review

2.1. The Era of Autonomy in the Kitchen

AI technologies have made remarkable strides forward, diminishing consumers' reliance on human intervention and facilitating AI's autonomous decision-making (Choi *et al.,* 2023; Kim *et al.,* 2024). These technological advances in AI have spurred scholars to identify a shift from the age of automation to the era of autonomy (e.g., Cohen and Hopkins, 2019; De Bellis and Johar, 2020). Artificial autonomy empowers systems to execute tasks by learning and adopting the environment without direct human participation (Hu *et al.,* 2021). For example, cutting-edge artificial autonomous machines, such as the Tefal Cuisine Companion, have the capability to autonomously oversee the entire cooking process without human involvement (De Bellis *et al.,* 2023).

Given the benefits of autonomous kitchen products, a growing number of restaurants are integrating AI into kitchens for tasks ranging from cooking and preparation to dishwashing. Accordingly, a line of literature explores how consumers perceive and evaluate services and/or products that are processed by AI applications in the kitchen. For example, Huang *et al*. (2023) identified inflexibility, concerns about tastiness, and the authenticity barrier as key reasons against accepting robot chefs, while expected enjoyment, efficiency, and trend affinity were highlighted as the main reasons in favor of robot chefs. In general, researchers have shown favorable consumer responses toward AI applications in the kitchen via sensory stimuli (Hwang *et al*., 2021), educational experience (Ma *et al*., 2022), and service expertise (Zheng *et al*., 2023).

With the rapid development AI, creative AI has emerged. Accordingly, it became possible for AI to create recipes (GE Pressroom, 2023; Surya, 2023), as demonstrated by a number of AI-driven recipe generators, such as DishGen and Mr. Cook. In the realm of recipe creation, however, the tourism and hospitality literature has not yet conducted a thorough empirical investigation of the potential roles of AI. In computer science and mechanical engineering research, scholars have developed systems for autonomously generating culinary recipes (e.g., Andres, 2023) and demonstrated AI's capability to generate both flavorful and creative recipes (Antô *et al.,* 2020).

Yet, consumers' responses to such tasks in kitchens carried out by AI remain unclear in the tourism and hospitality context. Hence, our objective is to explore the distinct impacts of AI involvement in recipe creation and food production on customers' responses, compared to the traditional restaurant scenario where humans are responsible for both tasks.

2.2. AI Involvement in Recipe Creation and Food Production

In this research, we argue that consumers show more negative responses to AI involvement in the recipe creation process than in the food production process due to the distinct nature of the two tasks. Recipe creation and food production can be theoretically categorized and explained by

cognitive continuum theory (Hammond, 1996). This theory elucidates that achieving optimal performance in problem-solving requires an approach aligned with the inherent properties of the focal task. According to the theory, tasks can be categorized as either surface features or depth features. Surface feature tasks are most effectively addressed through analytical and objective approaches, whereas depth feature tasks are better suited to intuitive and subjective strategies (Dhami and Mumpower, 2018; Hammond, 1996; Mathwick *et al.,* 2002). Guided by cognitive continuum theory (Hammond, 1996) and previous literature (e.g., Castelo *et al*., 2019), we identify food production as an objective task as tasks for food production, including food preparation (e.g., washing, cutting, and portioning ingredients) are rather quantifiable and measurable than require interpretation or intuition. For example, when preparing one ounce of garlic powder to marinate half a pound of chicken breast, accurate measurement is not required for human intuition. However, as recipe creation heavily relies on intuition and is open to creativity and personal interpretation, we consider it a subjective task.

According to algorithm aversion (Dietvorst *et al.,* 2015), individuals often avoid relying on technologies, even when they outperform the available alternatives, mainly due to their prevailing skepticism regarding AI's ability to replicate the subjective and intuitive qualities of humans. Research has shown that people tend to view machines as lacking emotional abilities but not cognitive abilities (Haslam *et al*., 2008). Therefore, consumers are less likely to rely on AI for subjective (vs. objective) tasks and prefer AI recommenders to human recommenders for hedonic (vs. utilitarian) consumption, due to AI's limited human characteristics (Castelo *et al*., 2019; Longoni and Cian, 2022). Following this line of reasoning, we posit that the incorporation of AI into the recipe creation process, which is subjective in nature, is likely to elicit unfavorable consumer reactions.

On the other hand, the food production process (e.g., food preparation for slicing vegetables and spreading sauce) requires minimal subjective judgment, adhering to established recipes and procedures to produce consistent food quality (Vu *et al*., 2019). Past research has shown that people expect similar levels of competence in objective tasks between AI and humans (Castelo *et al*., 2019; Haslam *et al*., 2008; Yalcin *et al.,* 2021). Hence, we predict that the AI-involved food production process will not produce negative responses from consumers. In terms of the outcome variable, we therefore focus on the willingness to order due to its theoretical implications and practical significance within the literature on consumer decision-making in the context of AI involvement (e.g., Park, 2020; Shi *et al.,* 2021; Tussyadiah, 2020). Overall, we hypothesize the following:

H1. Compared to the traditional restaurant scenario (i.e., humans perform all tasks), consumers are likely to show a more negative willingness to order food when AI is involved in the recipe creation process. However, such effects are diminished when AI is employed in the food production process.

2.3. The Mediating Role of Uniqueness Neglect

According to the "broken leg" hypothesis, people distrust statistical judgments because they fear that a statistical model could fail to account for rare or unexpected situations, leading to inaccurate predictions (Grove and Meehl, 1996; Longoni *et al*., 2019). Uniqueness neglect, therefore, represents consumers' concerns about AI's lack of ability to readily consider their distinct characteristics and circumstances (Kim *et al.,* 2022; Yalcin *et al.,* 2021). According to

the previous literature, AI's uniqueness neglect can stand out in consumers' minds as a key factor negatively leading to resistance to AI (Longoni et al., 2022; Mou et al., 2023) and the adoption of service robots (Kim *et al*., 2022). Following this notion, we posit that uniqueness neglect explains, at least partially, how AI is involved in kitchens and influences consumers' menu responses.

For recipe creation, consumers tend to expect their individual needs and preferences to be incorporated into the process (Chatzopoulou *et al*., 2019). Also, a growing number of consumers expect a restaurant to prepare dishes that account for specific dietary requirements (e.g., allergen-free) or personal tastes by adjusting from formal recipes (Filimonau and Krivcova, 2017; Rejikumar *et al*., 2022). However, AI is perceived to be capable of operating in a standardized, rigid manner following programmed procedures (Montagu and Watson, 1983). Since being appreciated for one's uniqueness is a fundamental human need, the perceived inability of AI to identify their distinctive traits may impact consumers' sense of individuality, consequently influencing their perception of uniqueness neglect (Kan *et al.,* 2023; Yan *et al.,* 2023). Therefore, consumers are likely to respond negatively to AI involvement in the recipe creation process due to the uniqueness neglect concern. Conversely, food production is viewed as a standardized and objective task (Vu *et al*., 2019) in which uniqueness neglect is less relevant. Thus, we predict that uniqueness neglect does not explain the effect of AI involvement in food production on consumer responses. Accordingly, we have developed the following hypothesis:

H2. Uniqueness neglect mediates the relationship between AI involvement and willingness to order.

2.4. How to Mitigate the Negative Effects of AI Involvement in Recipe Creation

It follows from H1 and H2 that one way of mitigating the negative consumer responses toward AI involvement in the recipe creation process is to increase the degree to which AI is capable of capturing consumer's distinct attributes. As noted earlier, consumers believe their distinctive characteristics could be disregarded by AI because it relies on standardized procedures recognizing objective data patterns (Castelo *et al.,* 2019; Longoni *et al*., 2022). Accordingly, we argue that signaling AI's ability to recognize individuals' distinct attributes by external cues (i.e., uniqueness consideration cues) can help reduce the negative effects of AI involvement in recipe creation. For example, providing a cue that an algorithm is highly adaptive can significantly enhance the perceived creativity and flexibility of the algorithm (Clegg *et al*., 2024). In this research, we operationalize uniqueness consideration cues as disclosing human involvement (e.g., training by human chefs) in AI development. As AI's limited ability to consider customers' distinct characteristics and needs is complemented by human involvement, such uniqueness consideration cues can be viewed as elements of human input and touch, which drive consumers to feel a greater sense of understanding and connection to AI operations (Zhang *et al*., 2024). We, therefore, posit that uniqueness consideration cues mitigate the negative impact of AI's task subjectivity in the recipe creation process. Thus, we hypothesize the following:

H3. The negative effect of AI involvement in recipe creation is likely to be attenuated when a uniqueness consideration cue is present.

3. Methodology

3.1. Overview of Studies

To test our hypotheses, we conducted three experiments in the casual dining restaurant context for several reasons. First, the market size of casual dining is considerable (i.e., USD 485 billion in 2023), and it is expected to continuously grow at a CAGR of 4.9% (Future Data Stats, 2023). Second, casual dining restaurants have actively leveraged technologies in their kitchens (e.g., Chillis' Kitchen of the Future) (Ruggless, 2023). Last but not least, we selected this casual restaurant context to avoid potential confounding effects, including the significant impacts of varying expectations of human involvement in recipe creation and food production within both fine-dining and fast-food restaurants (Wang and Papastathopoulos, 2023; Yu and Egger, 2021). As shown in the conceptual model in Figure 1, we examined the main effect (H1) of AI involvement in recipe creation and food production on the willingness to order food in a hypothetical restaurant (Study 1) and a real restaurant (Study 2). In addition, we investigated the mediating role of uniqueness neglect (H2) in Studies 1 and 2. Drawing on the consistent findings in these studies, Study 3 mainly evaluated the impacts of AI involvement in recipe creation by incorporating a new cue signifying AI's uniqueness consideration. Therefore, in Study 3, we explored whether the negative effect of AI involvement in recipe creation is attenuated in the presence of cues of uniqueness consideration (H3).

[Figure 1]

3.2. Study 1: Can humans be replaced in recipe creation or food production in a hypothetical restaurant?

3.2.1. Method

We used a single factor (AI involvement: recipe creation vs. food production vs. control) between-subjects design. Two hundred ninety-four participants (45.2% male, 46.6% ages between 29–43) recruited from the Prolific online consumer panel were randomly assigned to one of three conditions. Participants are largely representative of U.S. adults in terms of age, gender, income, and education level. All participants were introduced to a scenario in which they planned to dine at a casual dining restaurant. The scenario was developed based on the previous literature related to casual dining restaurants (e.g., Han *et al*., 2022; Song *et al*., 2022) to ensure generalizability and objectivity. Specifically, we developed a fictional and hypothetical restaurant name, Wing Wing Wing, to enhance internal validity as well as to eliminate any potential brand effects, such as preexisting preferences for and attitudes toward actual restaurants (Cai *et al*., 2022). In the recipe creation condition, participants read that an AI-powered robot had created a unique sauce recipe but that chefs were cooking their food (i.e., wings). In the food production condition, participants observed that chefs had created the unique recipe but that an AI-powered robot followed it to cook their food. In the control condition, participants were informed that chefs had devised a unique recipe for a new sauce and were cooking their food (see Appendix 1).

Participants also reported their willingness to order ("The probability/likelihood/chance that I would consider the new menu is…"; 1 = *very low*, 7 = *very high*; $\alpha = 0.98$; adapted from Grewal *et al.,* 1998). Then, they rated a 3-item measure of uniqueness neglect ("[An AI-power

robot/Chefs] would not recognize the unique needs of customers," "[An AI-power robot/Chefs] would not consider customers' unique preferences," and "[An AI-power robot/Chefs] would not tailor the menu to meet customers' unique needs"; 1 = *strongly disagree*, 7 = *strongly agree*; α = 0.94; adapted from Longoni *et al.,* 2019). As a manipulation check, we asked the participants to indicate who had designed their food with response options, including "the AI-powered robot" and "human chefs" as well as to specify who had cooked their food with these same response options. We also asked the participants to indicate how realistic the scenario was (1 = *highly unrealistic*, 7 = *highly realistic*). Finally, they responded to demographic questions and noted their dining frequency for the focal food (i.e., wings) using a single item ("How often do you go out to eat your wings?"); these served as the potential control variables. Based on previous literature (e.g., Kim and Kim, 2021; Moon *et al*., 2020), the frequency of dining out is a key component of dining-out patterns and can potentially affect the evaluation of AI adoption in recipe creation and food production.

3.2.2. Results

3.2.2.1. Manipulation and Realism Check. First, among the 294 participants who completed the survey, four participants who failed an attention check (i.e., Please select "Disagree") were excluded from further analyses. All participants in the recipe creation condition (i.e., 101 out of 101) accurately responded to the recipe creation manipulation check, while 91.7% (i.e., 88 out of 96) correctly completed the food production manipulation check. In addition, 96.8% (i.e., 90 out of 93) correctly completed the control manipulation check. In accordance with previous research (e.g., Chu and Lowery, 2023; Longoni and Cian, 2022), hypothesis tests were conducted with and without participants who provided incorrect responses to a manipulation check; these did not influence the observed patterns or significance levels. Thus, for further analysis, 279 participants (52% male, 47% ages between 29 and 43) who passed the manipulation and attention check questions were used ($N_{recipe\ creation}$ = 101, $N_{food\ production}$ = 88, $N_{control}$ = 90). The participants also found the scenario to be highly realistic compared to the scale midpoint of 4 (t (278) = 10.52, p < 0.001)). Therefore, the manipulation in Study 1 proved to be successful.

3.2.2.2. Willingness to Order. A one-way ANOVA on the willingness to order showed a significant effect of AI involvement (F(2, 276) = 10.01, p < 0.001). The post hoc analysis results indicated that the participants exhibited a higher level of willingness to order in the control condition than in the recipe creation condition ($M_{control}$ = 5.23, SD = 1.33 vs. $M_{recipe\ creation}$ = 4.23, SD = 1.85; *diff* = 1.00, adjusted-p < 0.001). However, there was no significant difference between the control and food production conditions in terms of the participants' willingness to order ($M_{control}$ = 5.23, SD = 1.33 vs. $M_{food\ production}$ = 4.95, SD = 1.54; *diff* = 0.28, adjusted-p > 0.05). These results remained the same when controlling for the frequency of wing consumption and demographics (gender and age) (F(2, 273) = 11.24, p < 0.001). Therefore, H1 is supported.

3.2.2.3. Uniqueness Neglect. A one-way ANOVA on uniqueness neglect showed a significant effect of AI involvement (F(2, 276) = 8.28, p < 0.001). The results of the post hoc analysis indicated that the participants in the control condition exhibited significantly lower perception of uniqueness neglect than those in the recipe creation condition ($M_{control}$ = 3.27, SD = 1.38 vs. $M_{recipe\ creation}$ = 4.11, SD = 1.57; *diff* = -0.84, adjusted-p < 0.01). However, there was no significant difference between the participants in the control and food production conditions in terms of their perception of uniqueness neglect ($M_{control}$ = 3.27, SD = 1.38 vs. $M_{food\ production}$ = 3.45, SD = 1.56; *diff* = -0.18, adjusted-p > 0.05; see Figure 2). These results held when

controlling for the frequency of wing consumption and demographics (gender and age) ($F(2, 273) = 8.30$, $p < 0.001$).

3.2.2.4. Mediation Analysis. A mediation analysis (Model 4; Hayes, 2017) using the bootstrapping approach (bootstrapping samples = 5,000) was conducted to test the indirect effect of AI involvement (0 = control, 1 = food production, 2 = recipe creation) on the willingness to order via uniqueness neglect. As the independent variable was multi-categorical, we adopted indicator coding (reference group: control; pair 1: control vs. recipe creation; pair 2: control vs. food production). The participants' willingness to order as a result of the negative impact of uniqueness neglect significantly differed between the control and recipe creation conditions (a x b = -0.23, 95% CI = [-0.42, -0.08]). In contrast, compared to the participants in the control condition, the participants in the food production condition exhibited no significantly lower willingness to order due to the negative effect of uniqueness neglect (a x b = -0.05, 95% CI = [-0.18, 0.07]). Therefore, H2 is supported.

[Figure 2]

3.2.3. Discussion

In Study 1, the participants exhibited a decreased likelihood of ordering food when AI was incorporated into the recipe creation process compared to the traditional setting where humans were responsible for both tasks. However, no significant differences were observed between the situations where AI was utilized in the food production process and where humans were responsible for both tasks. Hence, these findings suggest that AI involvement in food production does not elicit a negative response, aligning with our expectation that food production represents an inherently objective task well suited to proficient AI execution. Conversely, AI involvement in recipe creation yielded adverse outcomes. These are likely attributable to the perceived need for intuitive decision-making in such tasks—an ability often considered lacking in AI. Moreover, Study 1 revealed that uniqueness neglect mediates the observed effect of AI involvement. Last, the results showed consistent outcomes, with or without control variables.

3.3. Study 2: Can humans be replaced in recipe creation or food production in a real restaurant?

3.3.1. Method

In Study 2, we adopted the same scenarios and measurement items as in Study 1, but we used a real restaurant (Buffalo Wild Wings) to increase the external validity of the revealed effects of AI involvement. Thus, we used a single factor (AI involvement: recipe creation vs. food production vs. control) between-subjects design. Three hundred and three participants (52.1% female, 40.0% ages between 29–43) recruited from the Prolific online consumer panel were randomly assigned to one of the three conditions. They are mostly representative of U.S. adults. Participants were also asked to evaluate the same measurement items utilized in Study 1.

3.3.2. Results

3.3.2.1. Manipulation and Realism Checks. Among the 303 participants completing the survey, only one participant who failed an attention check item (i.e., Please select "Disagree") was excluded from further analyses. All participants in the recipe creation condition (i.e., 98 out

of 98) provided accurate responses to the recipe creation manipulation check, and 90.3% (i.e., 93/103) correctly completed the food production manipulation check. In addition, 96.0% (i.e., 97 out of 101) correctly completed the control manipulation check. Hypothesis tests were conducted that both included and excluded the participants who had provided inaccurate responses to a manipulation check; these had no impact on the observed patterns and significance levels. In further analyses, 288 participants (53% female, 43% ages between 29–43) who passed manipulation and attention checks were used ($N_{recipe\ creation} = 98$, $N_{food\ production} = 93$, $N_{control} = 97$). Additionally, participants perceived the scenario to be highly realistic compared to the scale midpoint of 4 (t (287) = 10.23, $p < 0.001$). Thus, the manipulation in Study 2 demonstrated its effectiveness.

3.3.2.2. Willingness to Order. A one-way ANOVA on the willingness to order showed a significant effect of AI involvement ($F(2, 285) = 3.47$, $p < 0.05$). The post hoc analysis results indicated that the participants exhibited a higher level of willingness to order in the control condition than in the recipe creation condition ($M_{control} = 4.76$, SD = 1.43 vs. $M_{recipe\ creation} = 4.14$, SD = 1.89; *diff* = 0.62, adjusted-$p < 0.01$). However, there was no significant difference between the control and food production conditions in terms of the participants' willingness to order ($M_{control} = 4.76$, SD = 1.43 vs. $M_{food\ production} = 4.38$, SD = 1.62; *diff* = 0.38, adjusted-$p > 0.05$). These results held when controlling for wing dining frequency and demographics (gender and age) ($F(2, 282) = 3.62$, $p < 0.05$). Therefore, H1 is supported.

3.3.2.3. Uniqueness Neglect. A one-way ANOVA on uniqueness neglect showed a significant effect of AI involvement ($F(2, 285) = 8.15$, $p < 0.001$). The results of post hoc analysis indicated that the participants in the control condition exhibited a significantly lower perception of uniqueness neglect than those in the recipe creation condition ($M_{control} = 3.31$, SD = 1.33 vs. $M_{recipe\ creation} = 4.09$, SD = 1.48; *diff* = -0.78, adjusted-$p < 0.01$). However, there was no significant difference between the participants in the control and food production conditions in terms of their perception of uniqueness neglect ($M_{control} = 3.31$, SD = 1.33 vs. $M_{food\ production} = 3.39$, SD = 1.65; *diff* = -0.18, adjusted-$p > 0.05$; see Figure 3). These results were consistent when controlling for wing dining frequency and demographics (gender and age) ($F(2, 282) = 8.10$, $p < 0.001$).

3.3.2.4. Mediation Analysis. A mediation analysis (Model 4; Hayes, 2017) using the bootstrapping approach (bootstrapping samples = 5,000) was conducted to test the indirect effect of AI involvement (0 = control, 1 = food production, 2 = recipe creation) on the willingness to order via uniqueness neglect. Similar to Study 1, we adopted indicator coding (reference group: control; pair 1: control vs. recipe creation; pair 2: control vs. food production). These results showed a significant indirect effect of A involvement on the willingness to order via uniqueness neglect regarding the control condition versus recipe creation condition comparison ($a \times b = -0.25$, 95% CI [-0.44, -0.09]). However, there was no significant indirect relationship between the control and food production conditions (95% CI [-0.18, 0.10]). Therefore, H2 is supported.

[Figure 3]

3.3.3. Discussion

In line with our predictions, in Study 2, we successfully replicated the impacts of AI involvement in both recipe creation and food production within the context of a real restaurant, which enhanced the external validity of our results. Specifically, the participants exhibited a decreased inclination to order food when AI was integrated into the recipe creation process, while no

significant differences were observed when AI was employed in the food production process or humans were responsible for both tasks. Additionally, we confirmed the consistent mediating role of uniqueness neglect. These results thereby reinforced our arguments by demonstrating consistent outcomes across both hypothetical and real restaurants, with or without control variables. Thus, the consistent findings in both Studies 1 and 2 underscore the robustness of the proposed effect of AI involvement on the willingness to order, enhancing the theoretical and practical implications of this research for restaurants.

Building upon the findings of Studies 1 and 2, Study 3 incorporated a uniqueness consideration cue indicating AI's capacity to recognize the distinct attributes of individuals (Yalcin *et al.,* 2021) to mitigate customers' negative perceptions of AI involvement in recipe creation.

3.4. Study 3: Can the negative effects of AI involvement in recipe creation be reduced?

3.4.1. Method

We used a single factor (AI involvement: recipe creation vs. recipe creation with a uniqueness consideration cue vs. control) between-subjects design. Two hundred and ninety-five participants (48.5% female, 40.3% ages between 29–43) recruited from the Prolific online consumer panel were randomly assigned to one of three conditions. Participants are largely representative of U.S. adults. All participants were introduced to a scenario in which they planned to dine at a casual dining restaurant, Applebee's Grill + Bar. In the control condition, participants read that the chefs had created a unique recipe for the dish and were cooking their food (i.e., burgers); in the recipe creation condition, an AI-powered robot had created a unique recipe for the focal dish, but chefs were cooking it. The recipe creation with a uniqueness consideration cue condition was identical to the recipe creation condition except the participants learned that the AI-powered robot had been trained by observing and learning from human chefs' cooking demonstrations and cooking videos (see Appendix 2).

As a manipulation check, we asked the participants to indicate who had designed their food with response options including "the AI-powered robot," "human chefs," and "the AI-powered robot with training" as well as to specify who was cooking their food with the same response options. All other measurement items were directly adopted from Studies 1 and 2.

3.4.2. Results

3.4.2.1. Manipulation and Realism Check. Among the 295 participants completing the survey, four participants who failed an attention check item (i.e., Please select "Disagree") were excluded from further analyses. All the participants in the recipe creation condition (i.e., 97 out of 97) provided accurate responses to the recipe creation manipulation check, and 96.9% (i.e., 94 out of 97) correctly completed the recipe creation with a uniqueness consideration cue manipulation check. In addition, 97.9% (i.e., 95 out of 97) correctly completed the control manipulation check. The statistical results remained consistent even when hypothesis tests were performed, comprising both the inclusion and exclusion of participants who had provided inaccurate responses to a manipulation check. Therefore, 286 participants (50% female, 40% ages between 29–43) who passed the manipulation and attention checks were used for further analyses ($N_{\text{recipe creation}} = 97$, $N_{\text{recipe creation with a uniqueness consideration cue}} = 94$, $N_{\text{control}} = 95$). Additionally, the participants perceived the scenario to be highly realistic compared to the scale

midpoint of 4 (t (285) = 7.69, p < 0.001)). Therefore, the manipulation in Study 2 proved to be successful.

3.4.2.2. Willingness to Order. A one-way ANOVA on the willingness to order showed a significant effect of AI involvement (F(2, 283) = 15.99, p < 0.001). The post hoc analysis results indicated that the participants exhibited a higher level of willingness to order in the control condition than in the recipe creation condition ($M_{control}$ = 4.99, SD = 1.58 vs. $M_{recipe\ creation}$ = 3.65, SD = 1.65; *diff* = 1.34, adjusted-p < 0.001). However, there was no significant difference between the control and the recipe creation with a uniqueness consideration cue conditions in terms of participants' willingness to order ($M_{control}$ = 4.99, SD = 1.58 vs. $M_{recipe\ creation\ with\ a\ uniqueness\ consideration\ cue}$ = 4.56, SD = 1.81; *diff* = 0.43, adjusted-p > 0.05). Notably, the participants in the recipe creation with a uniqueness consideration cue showed a significantly higher willingness to order than those in the recipe creation condition ($M_{recipe\ creation\ with\ a\ uniqueness\ consideration\ cue}$ = 4.56, SD = 1.81 vs. $M_{recipe\ creation}$ = 3.65, SD = 1.65; *diff* = 0.91, adjusted-p < 0.001). These results held when controlling for burger ordering frequency and demographics (gender and age) (F(2, 280) = 17.37, p < 0.001). Therefore, H3 is supported.

3.4.2.3. Uniqueness Neglect. A one-way ANOVA on uniqueness neglect showed a significant effect of AI involvement (F(2, 283) = 14.69, p < 0.001). The results of post hoc analysis indicated that the participants in the control condition had a significantly lower perception of uniqueness neglect than those in the recipe creation condition ($M_{control}$ = 3.07, SD = 1.43 vs. $M_{recipe\ creation}$ = 4.28, SD = 1.64; *diff* = -0.64, adjusted-p < 0.001) or the recipe creation with a uniqueness consideration cue condition (M = 3.63, SD = 1.54; *diff* = -0.56, adjusted-p < 0.05). Notably, the participants in the recipe creation with a uniqueness consideration cue condition exhibited a significantly lower perception of uniqueness neglect than those in the recipe creation condition ($M_{recipe\ creation\ with\ a\ uniqueness\ consideration\ cue}$ = 3.63, SD = 1.54 vs. $M_{recipe\ creation}$ = 4.28, SD = 1.64; *diff* = -0.64, adjusted-p < 0.05; see Figure 4.). These results held when controlling for burger ordering frequency and demographics (gender and age) (F(2, 280) = 14.59 p < 0.001).

3.4.2.4. Mediation Analysis. Consistent with Studies 1 and 2, a mediation analysis (Model 4; Hayes, 2017) with a multi-categorical independent variable was conducted (bootstrapping sample = 5,000) to examine the indirect effect of AI involvement (0 = control, 1 = recipe creation with a uniqueness consideration cue, 2 = recipe creation) on the willingness to order, mediated by uniqueness neglect. These mediation results indicated that uniqueness neglect mediated the effect of AI involvement on the willingness to order concerning control versus recipe creation with a uniqueness consideration cue in Pair 1 (a × b = -0.21, 95% CI [-0.41, -0.05]) and regarding control versus recipe creation in Pair 2 (a × b = -0.45, 95% CI [-0.72, -0.23]; see Figure 5).

To further compare the conditions in which AI was involved, Helmert coding was performed (Hayes, 2017). These results indicated that uniqueness neglect mediated the relationship between A involvement and willingness to order for recipe creation with a uniqueness consideration cue versus recipe creation in Pair 3 (a × b = -0.24, 95% CI [-0.46, -0.06]; see Figure 5). Thus, when an AI with a uniqueness consideration cue is involved in the recipe creation process (vs. AI involvement in recipe creation), this is likely to decrease the perception of uniqueness neglect and, in turn, foster a higher willingness to order the focal food. Therefore, H2 is supported.

[Figures 4 and 5]

3.4.3. Discussion

Study 3 demonstrated that consumers' responses to AI involvement in recipe creation can be influenced by uniqueness consideration cues, which signify AI's ability to recognize consumers' distinct attributes. Customers are thus less likely to display a negative willingness to order food when AI with uniqueness consideration cues is employed in the recipe creation process than in the traditional restaurant scenario where humans perform two focal tasks (i.e., recipe creation and food production). Hence, our findings suggest that the negative effect of AI involvement in recipe creation is attenuated when uniqueness consideration cues are present.

4. General Discussion and Implications

4.1. General Discussion

AI has demonstrated a strong potential for idea generation and product production. Recognizing the crucial roles of AI in various tasks, this research conducts a novel empirical investigation of the impacts of AI involvement on consumers' menu responses. Specifically, we illustrate that AI involvement in food production does not elicit negative responses to a menu, affirming the expectation that such a task is inherently objective and well-suited to proficient AI execution. Conversely, AI involvement in recipe creation leads to unfavorable outcomes, likely stemming from the demand for intuitive decision-making in such tasks—an ability often perceived to be lacking in AI. The findings suggest that a balanced approach, where AI handles objective, repetitive tasks and humans focus on creative, intuitive tasks, can lead to positive outcomes, underscoring the importance of defining clear roles in human-AI collaboration (Khoa *et al*., 2023). Additionally, we have shown that uniqueness neglect acts as a mediating factor in the observed impact of AI involvement on consumers' willingness to order. Moreover, our study underscores that consumers' reactions to AI involvement in recipe creation can be significantly influenced by uniqueness consideration cues. Thus, informing customers about the specific roles of AI and humans in recipe creation and food production can help manage expectations. Marketing communications should highlight the benefits of AI's ability to understand individuals' distinct attributes in the culinary process. In addition, transparency about AI involvement and its benefits can alleviate concerns and enhance customers' willingness to order from the menu. While relying solely on uniqueness consideration cues in AI is not entirely sufficient for establishing a genuine preference for AI over humans, specifically, in subjective tasks (e.g., recipe creation), presenting uniqueness consideration cues can mitigate the negative responses to a menu associated with AI involvement in such tasks.

4.2. Theoretical Implications

Our research provides several important theoretical contributions. First, we extend the literature on consumer decision-making amid AI involvement (Liu *et al.,* 2022; Tussyadiah, 2020; Shi *et al.,* 2021) by addressing whether AI can fulfill human roles in restaurants' back-of-house tasks. This question is novel, as prior research has mainly focused on applications in front-of-house operations, particularly, service encounters, to explore the direct interactions between humans and AI (e.g., Shin and Jeong, 2020; Park, 2020). Based on cognitive continuum theory (Hammond, 1996), our findings theoretically contribute to the literature by demonstrating the impacts of AI involvement in two relatively underexplored tasks in kitchens. Traditionally, tasks such as recipe creation have been regarded as intuitive and subjective, largely relying on human

creativity and expertise. However, the integration of AI into these tasks challenges this distinction by demonstrating that AI, typically aligned with analytical processes, can also contribute to more subjective, creative endeavors. Also, we provide causal evidence for the significant impacts of AI involvement in recipe creation and food production, employing multiple experimental designs involving both hypothetical and real restaurants to ensure our results' internal and external validity. We demonstrate that these tasks, even in the absence of direct customer interaction, exert a substantial influence on consumers' menu responses. Thus, our findings can expand the theoretical understanding of task classification and the potential scope of AI.

Second, we contribute to the emerging body of research on the factors of algorithm aversion (Dietvorst *et al.,* 2015). In particular, our findings bridge this gap by examining the differential impacts of AI involvement in recipe creation and food production on consumers' willingness to order food, specifically, compared to the traditional restaurant scenario where humans are responsible for both tasks. Our research therefore reveals that AI involvement in food production does not evoke a negative response, affirming our expectation that food production is an inherently objective task well suited to proficient AI execution. In contrast, AI involvement in recipe creation yields adverse outcomes, likely due to the demand for intuitive decision-making in such tasks—an ability often perceived to be lacking in AI. This first empirical investigation can contribute to the literature on consumer decision-making by delineating the impacts of AI involvement in two comparatively underexplored tasks in kitchens, namely food production and recipe creation. Furthermore, our research theoretically extends the discussion from algorithm aversion by demonstrating that customer appreciation or aversion toward AI can vary depending on the specific nature of the task (e.g., objective and analytics vs. subjective and intuitive), particularly in kitchens.

Third, we pinpoint a novel psychological factor that contributes to consumer hesitancy toward trusting AI's ability: uniqueness neglect. Our findings can thus contribute to reducing resistance to AI across different domains where consumers deem their own uniqueness crucial in their decision-making (Longoni *et al.,* 2019) due to the thus far limited understanding of the factors influencing the reluctance to trust AI in kitchens. We offer empirical support for and insights into the broken leg hypothesis (Longoni and Cian, 2022; Grove and Meehl, 1996), empirically demonstrating how a previously unexplored psychological mechanism can influence decisions concerning back-of-house operations.

Fourth, our findings elucidate the circumstances in which consumers are receptive to AI involvement in recipe creation. Importantly, building on prior findings (e.g., Kan *et al.,* 2023; Yan *et al.,* 2023), consumers' responses to AI involvement in recipe creation can be influenced by uniqueness consideration cues, which indicate AI's capacity to recognize consumers' distinct attributes. Hence, our findings have theoretical significance, as this research constitutes the first empirical investigation of the impact of AI with uniqueness consideration cues, which can mitigate the potential negative perceptions of AI's role in recipe creation. By identifying uniqueness consideration cues as a mitigating factor for algorithm aversion, our findings contribute to a more nuanced understanding of when consumers may be more receptive to AI's role in subjective and intuitive tasks such as recipe creation overcoming customers' existing perceptions of AI's limited ability to detect customers' distinct characteristics. Ultimately, our research highlights particular circumstances, such as the presence of uniqueness consideration

cues, in which consumers' resistance to AI can be attenuated by addressing the timely and important topic of AI's roles in back-of-house operations.

4.3. Practical Implications

Our findings contribute timely insights to the ongoing debate on whether AI can replace humans in subjective and/or objective tasks. This discussion is particularly relevant in light of the current technological advancements that are reshaping the restaurant landscape. Our findings provide actionable guidance to managers in the tourism and hospitality industry, specifically, in contexts whose tasks require intuition and instinctive decision-making (i.e., recipe creation) or quantified and logical approaches (i.e., food production).

Our results suggest that the involvement of AI in the food production process, including food preparation (e.g., slicing vegetables and spreading sauce) and cooking, does not adversely affect customers' menu responses. Unlike human employees, who may experience emotional fluctuations and physical fatigue, AI is impervious to toxic emotions or bad days, consistently operating in a predictable and accurate manner. Additionally, AI's contribution to food production can alleviate a longstanding challenge in the restaurant industry—the scarcity of human resources in kitchens. This is especially beneficial for quantifiable, measurable tasks and conducive to logical, rule-based analysis, as AI can be seamlessly incorporated into the food production process. By automating various back-of-house operations, restaurants can create more attractive job roles focused on creativity and customer interaction, potentially attracting higher-quality talent. Potentially, AI also enables the standardization of food preparation and cooking processes, making it easier for restaurant chains to maintain consistency across multiple locations. The reliability and efficiency provided by AI can support business expansion and the opening of new locations with confidence in maintaining high standards.

Nevertheless, our results suggest that AI's impacts on consumers' menu responses are less favorable when AI is involved in the recipe creation process. Our findings thus align with a common belief held by several restaurant experts: the role of a chef or cook cannot be easily automated with today's technology (Burke, 2022). Surprisingly, however, our studies involving two real brands reveal that this may not always be the case in regard to AI's impacts on brand loyalty. Our additional analyses on brand-related evaluations in Study 2 (Buffalo Wild Wings) and Study 3 (Applebee's Grill + Bar) show that AI involvement has no significant impact on brand loyalty ($F(2, 285) < 1$ and $F(2, 283) < 1$, respectively). Notably, AI involvement in food production and recipe creation does not adversely affect brand-related evaluations; emphasizing such outcomes could therefore allow leveraging the advantages of AI without compromising brand loyalty.

We also propose several managerial strategies that restaurant managers can adopt to mitigate the negative perceptions of AI involvement in recipe creation by incorporating uniqueness consideration cues. AI may be less proficient in considering consumers' unique circumstances and characteristics, given its limited capability compared to humans in recognizing human emotions and providing appropriate responses. Thus, our findings have implications for various tactical decisions, including marketing communications (e.g., personalized email campaigns, interactive website features, staff training and communication, press releases and media outreach) to showcase AI's ability. For instance, managers could present uniqueness consideration cues by communicating to their customers how AI can deliver personalized and tailored services through advanced technologies. Servers should be trained to effectively

communicate how AI can recognize and adapt to individuals' unique characteristics by learning from human chefs' cooking demonstrations and videos. They can also highlight how AI considers factors like dietary restrictions, flavor preferences, and ingredient choices. In this way, customers' skepticism toward AI's ability to perform intuitive and subjective tasks would be well addressed, thereby increasing their acceptance of AI-created recipes. Additionally, hosting themed nights or events featuring AI-generated dishes on a personalized menu would allow customers to experience how AI-created recipes cater to their tastes and needs. Offering limited-time AI chef specials, customized to individual preferences, can also attract curious diners and demonstrate AI's role in enhancing the dining experience. Combined, these strategies can showcase how AI can understand personal preferences, unique considerations, and behavioral patterns, signaling its ability to recognize and adapt to individual differences. In doing so, restaurants can ultimately alleviate concerns and increase customers' willingness to order from an AI-generated recipe and meals.

Our findings can contribute practical insights into human-AI collaboration, highlighting that human staff maintain a personal touch in customer interactions, balancing technological aspects with genuine human engagement. Thus, human-AI collaboration can reassure customers about the quality and uniqueness of the food.

5. Limitations and Future Directions

We must recognize some limitations in our research. First, we conducted online experiments to assess the impact of AI involvement on consumers' responses. While these variables (i.e., willingness to order and uniqueness neglect) are robust predictors of actual behavior, further exploration of the practical effects of AI involvement is warranted. Thus, future studies could conduct field or lab-based experiments or use archival data, secondary data. Additionally, while the current study did not use pictures in the scenario to control for other potential effects (e.g., physical features, gaze, gesture; Blut *et al*., 2021), future investigations should explore whether different visual cues could affect the findings of our study. In addition, although we demonstrated that involving AI with uniqueness consideration cues in the process of recipe creation can significantly attenuate consumers' negative responses, there could be some potential moderators (e.g., identity threat or sensory ability cues) that could enhance the impacts of AI involvement in recipe creation, enabling it to potentially outperform humans. For example, some participants left salient comments at the end of their surveys, such as, "*I just don't want it to take humans out of human jobs.*" Drawing on social identity theory (Tajfel, 1988), which suggests that AI challenges the distinction between humans and machines, resulting in negative evaluations of AI, varying levels of identity threats among groups would likely cause them to evaluate AI involvement in recipe creation differently. Another representative comment is as follows: "*AI can't taste the food or add the nuances that enhance the development of recipes*." Thus, sensory cues, such as gustatory, haptic, and olfactory abilities, have the potential to act as moderators, positively enhancing the impacts of AI involvement in recipe creation. Some respondents also worried about whether AI-created food can symbolically provide love and passion, a concern widely examined under the concept of the handmade effect (Fuchs *et al*., 2015) with daily consumed products. Thus, future studies should focus on the handmade effect in the context of recipe creation and food production. Finally, while we chose the casual restaurant context to avoid potential confounding effects, exploring diverse expectations of human

involvement in the processes of recipe creation and food production across different types of restaurants, including fast-food and fine-dining establishments, would be an intriguing research direction. Furthermore, future investigations should examine the various types and spectrum of tasks, ranging from pure intuition, mostly intuition with some analysis, equally intuitive and analytical, primarily analytical with some intuition, to pure analysis in hospitality and tourism.

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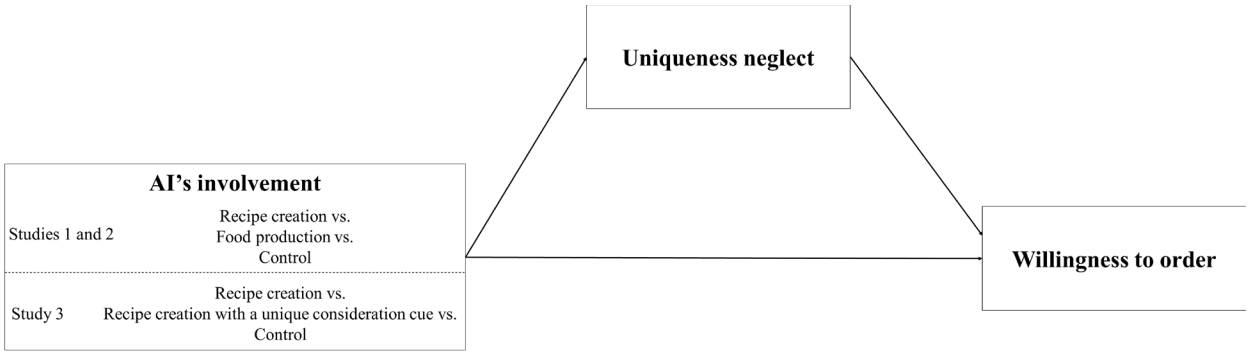


Study	Purpose	Context (Casual dining restaurant brand)	Hypothesis
Study 1	•Examine the effect of AI's involvement in recipe creation and food production on the willingness to order food •Investigate the mediating role of uniqueness neglect	Fictional and hypotheitcal brand (Wing Wing Wing)	H1, H2
Study 2		Real brand (Buffalo Wild Wings)	H1, H2
Study 3	•Examine the role of uniqueness consideration cues in attenuating the negative effect of AI's involvement in recipe creation	Real brand (Applebee's Grill + Bar)	H3

Figure 1. Conceptual model

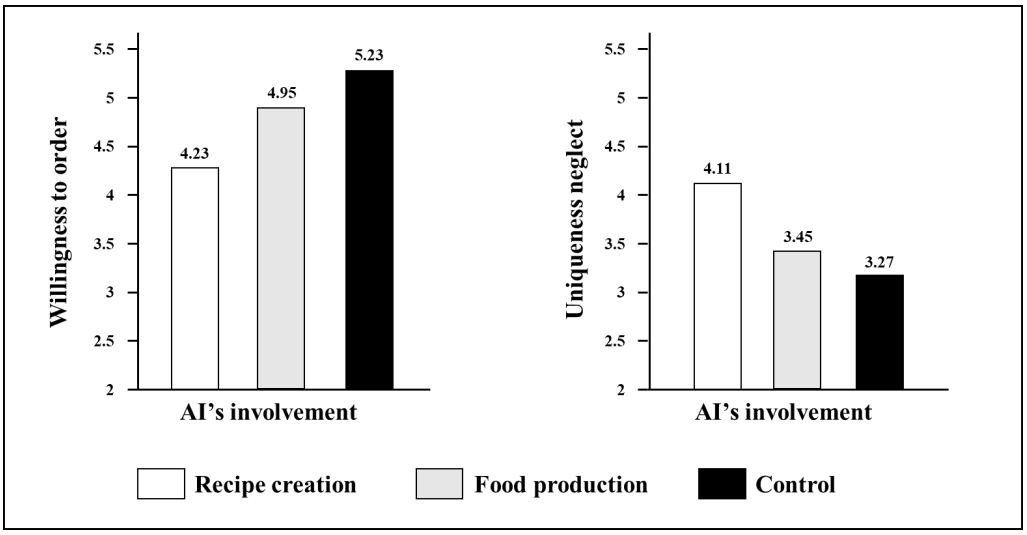


Figure 2. The impacts of AI's involvement on the willingness to order and uniqueness neglect

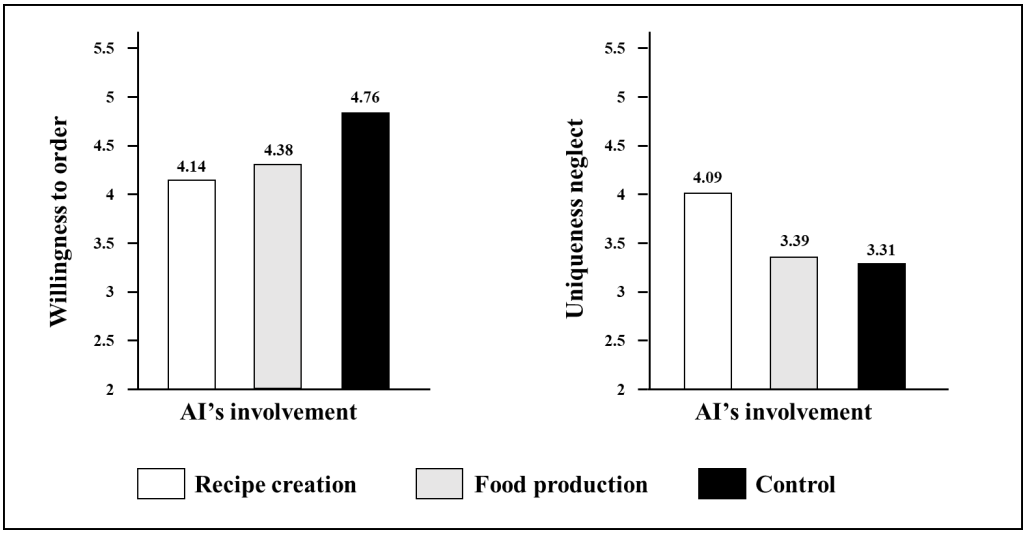


Figure 3. The impacts of AI's involvement on the willingness to order and uniqueness neglect

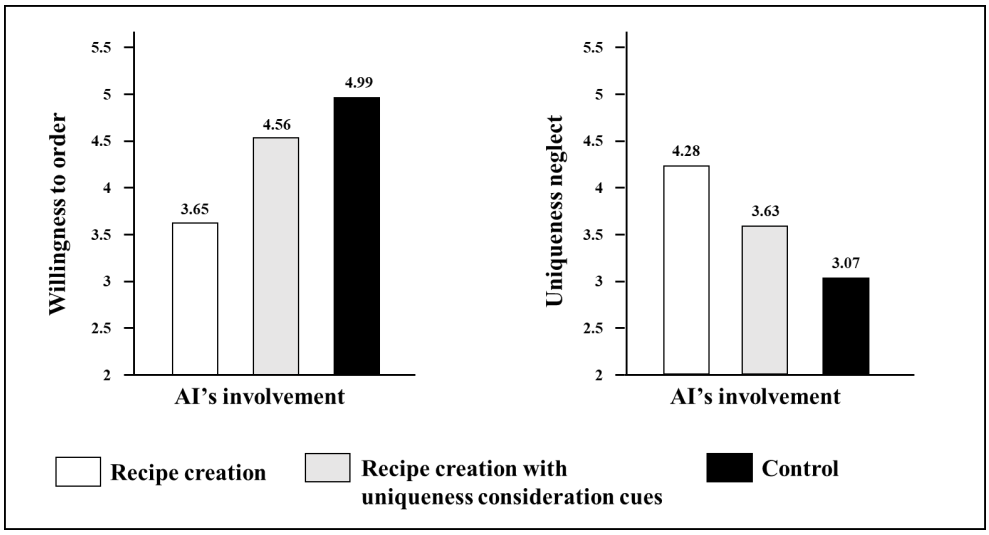


Figure 4. The impacts of AI's involvement on the willingness to order and uniqueness neglect

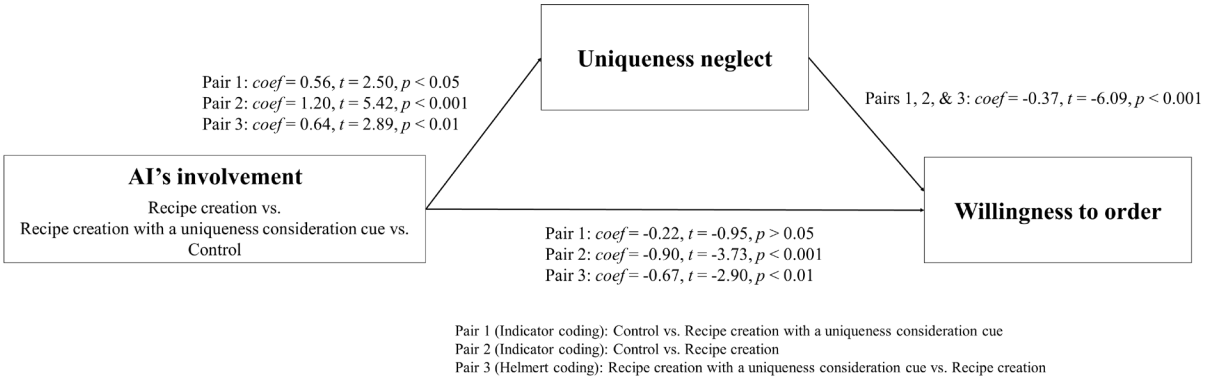
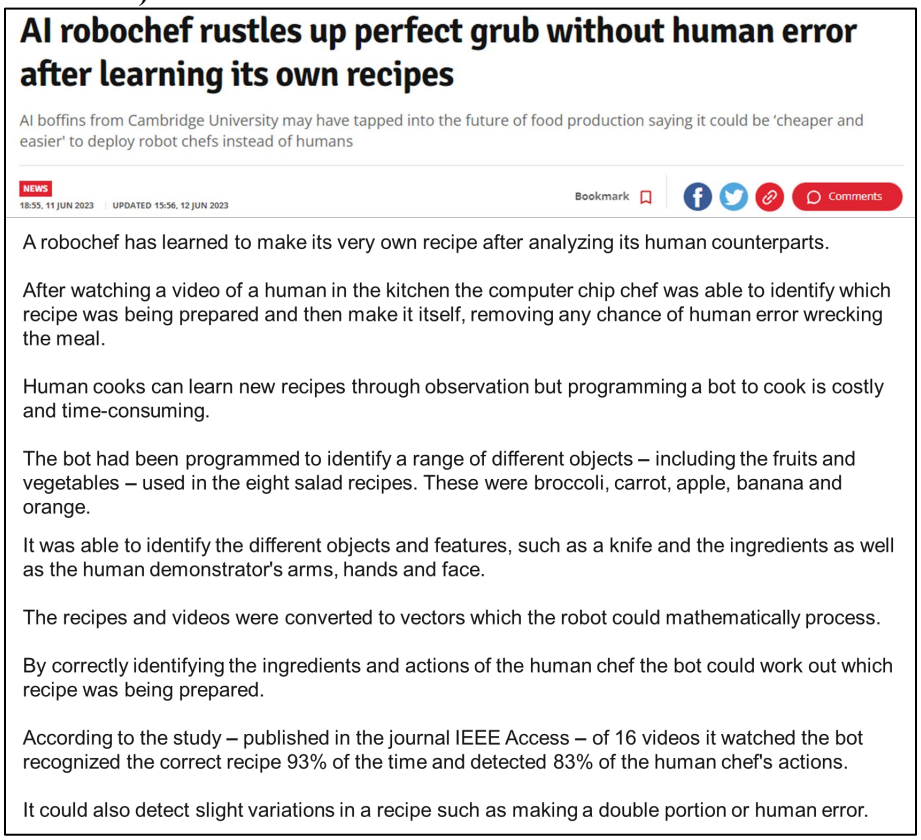


Figure 5. The results of mediation analysis

Appendix 1. Study 1 Sample Stimuli (Food Production Condition)

You are planning to dine out with your friends today. You visit Wing Wing Wing, a casual dining restaurant. A waitress (waiter) comes over to welcome you and recommends a new sauce. S/he explains that the chefs create a unique recipe for the new sauce, while an AI-powered robot cooks Buffalo wings by following the recipe for the new sauce created by the chefs. Thus, you consider ordering the Buffalo wings with the new sauce where the chefs formulate its core recipe for the new sauce while the AI robot cooks it.

Appendix 2. Study 3 Sample Stimuli (Recipe Creation with Uniqueness Consideration Cues Condition)



AI robochef rustles up perfect grub without human error after learning its own recipes

AI boffins from Cambridge University may have tapped into the future of food production saying it could be 'cheaper and easier' to deploy robot chefs instead of humans

NEWS
18:55, 11 JUN 2023 | UPDATED 15:56, 12 JUN 2023

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A robochef has learned to make its very own recipe after analyzing its human counterparts.

After watching a video of a human in the kitchen the computer chip chef was able to identify which recipe was being prepared and then make it itself, removing any chance of human error wrecking the meal.

Human cooks can learn new recipes through observation but programming a bot to cook is costly and time-consuming.

The bot had been programmed to identify a range of different objects – including the fruits and vegetables – used in the eight salad recipes. These were broccoli, carrot, apple, banana and orange.

It was able to identify the different objects and features, such as a knife and the ingredients as well as the human demonstrator's arms, hands and face.

The recipes and videos were converted to vectors which the robot could mathematically process.

By correctly identifying the ingredients and actions of the human chef the bot could work out which recipe was being prepared.

According to the study – published in the journal IEEE Access – of 16 videos it watched the bot recognized the correct recipe 93% of the time and detected 83% of the human chef's actions.

It could also detect slight variations in a recipe such as making a double portion or human error.

Please imagine that you are planning to dine out with your friends today. You visit Applebee's Grill + Bar, a casual dining restaurant. A waitress (waiter) comes over to welcome you and recommends a new burger menu. S/he explains that it uses its own AI-powered robot to create a unique recipe for the dish, while the chefs cook the dish by following the AI robot-created recipe. S/he further describes that its own AI-powered robot has been trained through observing and learning from human chefs' cooking demonstrations and chefs' cooking videos.

So, Applebee's Grill + Bar's AI-powered robot has developed an ability to understand customers' unique needs and tastes comparable to that of a human chef while performing various cooking tasks, such as creating recipes. Thus, you consider ordering the burger menu where the AI robot formulates its core recipe while the chefs cook.