ABSTRACT

Title of Dissertation:	WHEN THE FUTURE COMES: ESSAYS ON CONSUMER ATTITUDE TOWARD ARTIFICIAL PRODUCTS
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This dissertation consists of two essays that investigate how consumers react to artificial products. Specifically, each essay focuses on one type of artificial product: robots and lab-grown meat, respectively. The first essay investigates the interaction effect of personal control and the potential for negative judgment on consumers' robot preferences. Across five studies, I find that when the consumption context enables the high potential for negative judgment, consumers with low (vs. high) personal control have stronger preferences for service robots because they are less confident in leaving a positive impression on others and thereby experience stronger social anxiety. However, when the consumption context enables the low potential for negative judgment, consumers feel confident in leaving a positive impression on

others, so personal control affects neither social anxiety nor robot preference. The second essay studies why consumers resist lab-grown meat and proposes a novel theory to explain it: the life-creation perception theory. Across six studies, I demonstrate that consumers have more negative attitudes toward lab-grown meat than lab-grown dairy products because they associate lab-grown meat (vs. dairy products) with artificially creating life and thereby violating the laws of nature to a greater degree. In addition, theory-based interventions are shown to increase consumer acceptance of lab-grown meat by disassociating lab-grown meat from creating life. Across these two essays, I intend to provide insights into how consumers interact with artificial products in the marketplace and how marketers can increase consumers' adoption of these innovations accordingly.

WHEN THE FUTURE COMES: ESSAYS ON CONSUMER ATTITUDE TOWARD ARTIFICIAL PRODUCTS

by

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Dissertation submitted to the Faculty of the Graduate School of the
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Chapter 1: Introduction

The marketplace has evolved into a new stage when consumers are faced with numerous artificially created products. Unprecedentedly, services can be provided by robots rather than human staff, and food, such as meat and dairy products, can be created in the lab rather than being harvested from nature. In contrast to the huge advancement of artificial technologies, consumers seem to be reluctant to adopt them due to many psychological reasons. This begs a series of questions on the topic of consumer acceptance (or resistance) toward artificially made products: What factors will influence it? What is the underlying psychological process? How can marketers improve consumer acceptance of them? Two essays in this dissertation aim to answer these questions in different marketing contexts.

Essay 1 Overview

Essay 1 (Chapter 2) examines conditions under which consumers will be more accepting of service robots. Specifically, I investigate how personal control triggered by factors external to robots and the potential for negative judgment enabled by the shopping context together affect consumers' robot preferences. I find that when the potential for negative judgment is high, consumers with low (vs. high) personal control have stronger preferences for robots because they are less confident in leaving a positive impression on others and thereby experience stronger social anxiety. In other words, consumers use service robots as safety nets in this circumstance. However, when the potential for negative judgment is low, consumers feel confident

in leaving a positive impression on others, so personal control does not influence social anxiety or preference for robots. To my knowledge, this research is the first to study the interaction effect between two psychological factors that have been demonstrated to significantly impact robot adoption: personal control and concern about negative judgment. Managerially, this research provides important insights into when and how marketers can gain a higher level of consumer acceptance when introducing robots into their businesses.

Essay 2 Overview

Essay 2 (Chapter 3) examines why consumers resist lab-grown meat. Lab-grown meat produced using cellular biotechnology has been proposed as a promising solution to the environmental and food security issues associated with meat consumption. I find that consumers have negative attitudes toward lab-grown meat because they associate lab-grown meat with the process of creating life artificially and violating the laws of nature. In addition, I demonstrate the effectiveness of three theory-based interventions, and the uniform logic behind them is to dissociate producing meat in the lab from creating life from scratch. These interventions include displaying food (rather than animal) images on product packaging, deconstructing the concept of meat into simpler biological components (i.e., water, protein, and fat), and drawing an analogy with growing plants from plant cuttings. This research proposes a novel life-creation perception theory to explain consumers' resistance to lab-grown meat and extends it to providing useful suggestions for marketers to promote lab-grown meat.

Chapter 2: Robots as Safety Nets: When Low Personal Control Increases Consumer Preference for Service Robots[1]

Introduction

It is fairly well-established that consumers prefer to interact with human service providers. A major reason for this is that consumers experience a lack of personal control in the presence of robots (Andre et al., 2018; de Bellis & Johar, 2020; Dietvorst et al., 2018; Jorling et al., 2019; Lee & Allaway, 2002; Mende et al., 2019; Puntoni et al., 2021; Zlotowski et al., 2017). For example, Puntoni et al. (2021) propose that data capturing by artificial intelligence threatens consumers' feelings of control, leading consumers to complain about being invaded and exploited. A survey conducted by Pew Research Center among five hundred and forty technology experts suggests that even experts predict control threat caused by robots, such that 56% of them did not think that technologies, including robots, would allow humans to easily be in control of tech-aided decision-making (Anderson & Rainie, 2023). However, recent research demonstrates that preference for robots increases when consumers are acquiring embarrassing products because they view robots as less agentic and thereby less capable of forming a judgment of them (Holthower & van Doorn, 2022; Pitardi et al., 2021; Sun et al., 2022). For instance, Holthower and van Doorn (2022) find that consumers have an increased preference for robots when engaging in embarrassing conversations with service providers, such as seeking medication to treat a sexually

[1] Amna Kirmani is my co-author on this essay. This essay is under review at the *Journal of Consumer Psychology*.

transmitted disease. In these situations, concern about the lack of personal control over robots appears to be overwhelmed by the fear of negative judgment.

In this paper, we focus on the interplay between personal control and the potential for negative judgment and propose that the lack of personal control can *increase* the desire to interact with robots when consumers fear negative judgment from the service provider. Personal control refers to consumers' beliefs about whether they can obtain desired outcomes, avoid undesired outcomes, and achieve their goals (Beck et al., 2020). We make a distinction between personal control that is external vs. internal to the service context. In contrast to prior research, which asserts that robots themselves reduce consumers' sense of personal control (e.g., Lee & Allaway, 2002; Mende et al., 2019; Puntoni et al., 2021; Zlotowski et al., 2017), we examine situations in which personal control is threatened by the environment, such as shopping at an unfamiliar mall, recalling a life experience that makes one experience low control, and traveling to a country for the first time.

Based on the impression management literature (Leary & Kowalski, 1990; Schlenker, 1980), we propose that the impact of personal control on robot preference depends on the potential for negative judgment. Specifically, when the potential for negative judgment is high, consumers with low (vs. high) personal control feel that they may make a negative impression on others, leading to greater social anxiety and thus stronger preference for service robots. In contrast, when the potential for negative judgment is low, consumers have a lower expectation of leaving a negative impression, regardless of their personal control. In this case, social anxiety and robot preference are unaffected by personal control.

This research contributes to the literature on consumer attitudes toward robots and artificial intelligence by being the first to investigate the interaction effect of two critical factors that affect consumer preference for service robots: personal control and the potential for negative judgment enabled by the consumption context. Unlike prior literature on robots (e.g., Lee & Allaway, 2002; Zlotowski et al., 2017), we focus on personal control external to the environment rather than caused by the robot. More broadly, we extend work on technology and consumer welfare by studying how consumers apply technologies (e.g., smartphones, social media, robots) to avoid mental discomfort and improve social well-being (e.g., Duvenage et al., 2020; Harwood et al., 2014; Melumad & Pham, 2020). In this sense, robots provide safety nets for consumers with low personal control. Finally, our findings provide important practical implications by identifying market segments that are more receptive to service robot application and marketing contexts where the application of service robots is more beneficial.

Theoretical Development

Prior Research: Preference for Robots over Humans in Embarrassing Interactions

Prior research demonstrates that consumers prefer services from humans over robots for multiple reasons, and those reasons concern consumers' perceptions of robots' relative weaknesses in many domains (Castelo et al., 2019; Dietvorst &

Bartels, 2021; Granulo et al., 2021; Longoni et al., 2019; Longoni & Cian, 2020; Mende et al., 2019). For example, in symbolic consumption and medical services, consumers dislike robots because they view robots as ignorant of consumer uniqueness (Granulo et al., 2021; Longoni et al., 2019). In hedonic consumption, consumers resist recommendations from artificial intelligence because they believe that artificial intelligence is less capable of conducting emotion-based tasks (Castelo et al., 2019; Longoni & Cian, 2020). Together, this research suggests that consumers disfavor robots compared to humans in many circumstances.

However, recent research demonstrates that consumers prefer robots over humans when the service context is embarrassing or socially uncomfortable (Holthower & van Doorn, 2022; Pitardi et al., 2021; Sun et al., 2022). Consumers prefer to interact with robots rather than humans when purchasing condoms or sanitary napkins (Sun et al., 2022), using a dry-cleaning service to remove an embarrassing stain (Sun et al., 2022), and asking for medical advice for treating embarrassing diseases (Holthower & van Doorn, 2022; Pitardi et al., 2021; Sun et al., 2022). Furthermore, in such contexts, consumers even tend to dehumanize human service providers when service robots or self-service are unavailable, such as viewing humans as devoid of emotion and interpersonal abilities (Sun et al., 2022).

Embarrassing service contexts raise concerns about the potential for negative judgment (Fenigstein et al., 1984; Miller, 2007; Sun et al., 2022), i.e., the extent the service context enables the possibility of a consumer being negatively judged by the service provider. In order to avoid negative judgment by a human provider, consumers may prefer to interact with a service robot. We argue that besides

embarrassment, consumers' assessment of a high potential for negative judgment can also be triggered by other factors. For instance, consumers may assess a high potential for negative judgment when the service context threatens their self-worth, i.e., that shows that they do not live up to a standard. Specific examples include inquiring about discounts in a fancy store, asking a waiter about the meaning of a word on the menu, or talking to a hotel receptionist with a heavy accent. In these situations, the likelihood of consumers being judged to be cheap, ignorant, or unsophisticated is high.

Prior research demonstrates that the underlying reason for the heightened preference for robots in highly judgmental contexts is lower perceived agency (Pitardi et al., 2021), i.e., the capacity to act, plan and exert self-control (Gray et al., 2011), and emotionality of robots (Sun et al., 2022). To be specific, consumers believe that robots are less capable of forming negative judgments about them and acting upon the judgment (Holthower & van Doorn, 2022), such as despising them or spreading negative comments about them. However, when robots are anthropomorphized, consumers view them as more humanlike, and their preference for robots in embarrassing contexts decreases (Holthower & van Doorn, 2022).

In short, this stream of research shows that the potential for negative judgment increases consumer preference for service robots. However, we explore how personal control will interplay with the potential for negative judgment and affects consumer preference for service robots.

The Present Research: The Interaction of Personal Control and Potential for Negative Judgment

Personal control is theoretically critical to the literature on consumer attitudes toward automated, algorithm-based, and artificial intelligence-powered technologies (Dietvorst et al., 2018; Faraji-Rad et al., 2017; Lee & Allaway, 2002; Lin et al., 2020; Min & Schwarz, 2022; Puntoni et al., 2021; Zlotowski et al., 2017). This literature suggests that low personal control is a major barrier for consumers to trust and adopt robotic technologies (e.g., Andre et al., 2018; de Bellis & Johar, 2020; Puntoni et al., 2021). For instance, the desire for control leads consumers to rely on their own forecasts rather than the forecasts by advanced algorithms (Dietvorst et al., 2018). Similarly, low personal control leads to the avoidance of using self-service technologies due to greater perceived risk (Lee & Allaway, 2002). In addition, the higher autonomy of service robots results in even stronger consumer resistance because consumers feel lower control over the robots (Zlotowski et al., 2017).

In contrast to this stream of literature, we propose that lack of control may actually increase preference for robots when the potential for negative judgment is high. Importantly, we make a distinction between personal control that is external to the interaction with the robot vs. personal control that results from the robot. While prior research examines the latter, we focus on the personal control that is external to the interaction with the robot and triggered by other factors, such as when shopping in an unfamiliar mall and traveling to a country for the first time.

Human beings have a fundamental need for personal control (Averill, 1973; Haidt & Rodin, 1999), and personal control refers to a belief that one can achieve

desired outcomes (Beck et al., 2020; Whitson & Galinsky, 2008). With high personal control, consumers feel more optimistic when faced with uncertainties (Mittal & Griskevicius, 2014) and more capable of effectively coping with stressors (Compas et al., 1991; Frazier et al., 2011). With low personal control, however, consumers have more negative prospects for the future (Mittal & Griskevicius, 2014) and feel eager to resolve their mental discomfort (Fiske et al., 1996; Kay et al., 2008).

Lack of personal control can be triggered by multiple antecedents and can have a critical impact on consumer behavior. Personal control may be low when the shopping environment is crowded (Consiglio et al., 2018), when consumers lack choice (Hui & Bateson, 1991), when consumers do not feel shopping savvy (Cutright & Samper, 2014), and when consumers encounter unfamiliar retail environments (Baronas & Louis, 1988). Importantly, low personal control is psychologically stressful and will lead to actions to regain a sense of control (e.g., Kay et al., 2010; Landau et al., 2015; Shepherd et al., 2011). Prior marketing literature has demonstrated that personal control shapes consumers' preferences and choices in a significant way (Chen et al., 2017; Cutright & Samper, 2014). For example, when experiencing low control, consumers seek structure and order (e.g., displaying higher preferences for boundaries in product design; Cutright, 2012), have lower acceptance of brand extensions (Cutright et al., 2013), and desire accuracy and predictability (e.g., valuing numerical information; Lembregts & Pandelaere, 2019).

We theorize that personal control influences the way that consumers respond to the potential for negative judgment, and this is through social anxiety. Social anxiety is the apprehension resulting from the prospect or presence of personal

evaluation in real or imagined social situations (Leary & Kowalski, 1990; Schlenker & Leary, 1982). By definition, consumers with low (vs. high) personal control tend to anticipate a lower chance of achieving a desired outcome. On this basis, we predict that, when the potential for negative judgment is high, consumers with low (vs. high) personal control will be more anxious that they will be unable to make a positive impression. This will lead them to experience stronger social anxiety. However, when the potential for negative judgment is low, personal control will not influence consumers' social anxiety because the context does not lend itself to negative social judgment.

Furthermore, we reason that when consumers experience a heightened level of social anxiety, they will have an increased preference for service robots because 1) they perceive robots to be less judgmental than humans; and 2) they care less about negative judgment from robots than from humans. The first reason can be systematically explained by mind perception theory (Gray et al., 2011). Compared to humans, robots are seen as having lower agency (Lee et al., 2021; Pitardi et al., 2021; Srinivasan & Sarial-Abi, 2021) as well as experience, i.e., the capacity to feel pain, pleasure, and emotions (Sun et al., 2022). This means that robots will be perceived as having weaker abilities to form a judgment about others and generate evaluative emotions towards others. The second reason is that consumers see robots as outgroups and humans as ingroups; therefore, they care more about the opinions of ingroup members than outgroup members (Tajfei & Turner, 1986). As a result, negative judgment from robots would be less detrimental to their self-esteem. Prior work supports the notion that consumers feel less closely related to robots than other

humans. For example, individuals prefer human workers to be replaced by other human workers rather than robots (Granulo et al., 2019); and the rise of robot workers reduces intergroup prejudice among humans because the existence of robots, a more salient outgroup, highlights commonalities between all humans (Jackson et al., 2020).

Together, we propose that not every consumer will react to the potential for negative judgment equally; instead, when the potential for negative judgment is high, consumers with low (vs. high) personal control will have a stronger preference for robots due to stronger social anxiety, whereas when the potential for negative judgment is low, personal control does not influence consumer preference for robots. Formally, we hypothesize:

H_{1A}: When the potential for negative judgment is high, low (vs. high) personal control leads consumers to have a stronger preference for service robots.

H_{1B}: When the potential for negative judgment is low, personal control does not affect consumer preference for service robots.

H_2: The proposed effect in H1 is mediated by social anxiety.

Empirical Overview

We conducted five studies to examine the interaction effect of personal control and the potential for negative judgment on consumer preference for service robots. We utilized different operationalizations of personal control and potential for negative judgment; diverse service contexts (i.e., shopping mall, online drugstore,

hotel); both hypothetical measures and real behavioral choices; and both a field survey and controlled experiments. Study 1 demonstrates H_1 in an actual shopping mall where service robots were in use. Studies 2A and 2B examine H_1 with consumers' real or hypothetical choice of chatting with a robot or human service provider. Study 3 adds a baseline personal control condition to show that the low, rather than high, personal control condition drives the effects and tests the mediational role of social anxiety (H_2). Finally, study 4 explores the potential moderation effect of the agency of service robots and suggests that in a service context with high potential for negative judgment, the promoting effect of low personal control on preferences for service robots is stronger when the robots have low (vs. high) agency. Across experimental studies, we had some additional measures, including perceptions of warmth and competence of service robots, technology literacy, and general attitude towards innovative technologies. We report the results of these measures in the web appendices. In addition, we examined the effectiveness of our manipulations of potential for negative judgment across studies in a pretest and report the results in Appendix A.

Study 1: Preference for Robots in the Field

Study 1 examines the relationship among personal control, potential for negative judgment, and preference for service robots (H_{1A} and H_{1B}) in a real-world setting – a shopping mall. The study had a 2 (personal control: low vs. high, between-

subjects) x 2 (potential for negative judgment: low vs. high, within-subjects) mixed design.

Method

Participants and Design. The study used a mall intercept methodology at a high-end shopping mall in a large Asian city. Most of the stores on the first floor were luxury brands (e.g., Tiffany, Prada, Burberry), with service robots stationed in various places. We invited consumers who passed by a service robot near the Tiffany store to participate in a consumer survey. The rolling screen on the robot displayed signs with suggested inquiries, such as "asking me about what to eat," "finding a store," and "watching a video." A total of 157 consumers (M_{age} = 30.51, SD = 7.13, 47.8% male) completed the survey on site using an 11-inch iPad Pro.

We used two measures of personal control. The first was an objective measure that was actionable by companies: shopping frequency at the mall (1 = "zero" to 5 = "above 20 times"). We reasoned that compared to participants who had shopped there before, those who had never shopped at the mall would be less familiar with the environment and would feel less likely to attain desired shopping outcomes. Thus, the 44.6% of participants who had never visited the mall were classified as having low personal control, while the rest were classified as having high personal control. In addition, we measured personal control directly using three items (1 = "not at all; 5 = "very much;" α = .70): "I am in control of what I purchase/I can purchase what I desire/I am capable of attaining the shopping outcome I want in the stores on the first

floor of this mall." Participants who had never shopped in the mall indicated significantly lower personal control (M = 2.63 vs. 3.67, SD_{lowPC} = 1.01, SD_{highPC} = .80, $F(1, 155) = 51.65$, $p < .001$, $\eta_P^2 = .250$), confirming the effectiveness of using shopping frequency as an objective proxy of personal control.

Potential for negative judgment was a within-subjects variable. High potential for negative judgment was captured by the consumer's asking the service provider about promotions and discounts, while low potential for negative judgment was captured by asking about the location of a store. As shown in the pretest (see Appendix A), asking about discounts leads to higher potential for negative judgment than does asking for store location (M = 4.14 vs. 2.91, $SD_{discounts}$ = 1.86, $SD_{location}$ = 1.84, $F(1, 232) = 61.78$, $p < .001$, $\eta_p^2 = .210$).

Measures. Participants answered the key measures in the following order: shopping frequency, perceived control, preference for the robot vs. human, and demographic variables. Preference for robots versus humans was measured for both the high and low potential for negative judgment contexts (1 = "definitely the staff;" 5 = "definitely the service robot"). In addition, there were some exploratory measures, including the extent to which participants felt welcomed in the store and whether they had noticed the service robot in the mall (see Appendix B). We concluded with demographic measures, including age, gender, and annual income range.

Results and Discussion

A 2 (personal control: low vs. high) x 2 (potential for negative judgment: low vs. high) repeated measure ANOVA revealed significant main effects of personal control ($F(1, 155) = 42.99$, $p < .001$, $\eta_P^2 = .211$) and potential for negative judgment ($F(1, 155) = 41.44$, $p < .001$, $\eta_P^2 = .211$) as well as a significant interaction ($F(1, 155) = 43.04$, $p < .001$, $\eta_P^2 = .217$, figure 1). Consistent with H_{1A}, when the potential for negative judgment was high (asking about discounts), participants with low (vs. high) personal control indicated a significantly higher preference for service robots (M = 3.81 vs. 2.03, $SD_{lowPC} = 1.32$, $SD_{highPC} = 1.15$, $F(1, 155) = 81.57$, $p < .001$, $\eta_P^2 = .345$). Consistent with H_{1B}, when the potential for negative judgment was low (asking about location), participants with low (vs. high) personal control did not significantly differ in their preferences for service robots (M = 3.80 vs. 3.54, $SD_{lowPC} = 1.12$, $SD_{highPC} = 1.24$, $F(1, 155) = 1.85$, $p = .175$, $\eta_P^2 = .012$). These results supported H_1[2].

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INSERT FIGURE 1 HERE

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In short, the results of study 1 provide initial support for H_1. However, this study has two limitations. First, due to the correlational nature of this study, we cannot assess causality. Second, the nature of our operationalization of low potential

[2] The continuous measure of perceived control yielded similar results. As expected, when the potential for negative judgment was high (i.e., discounts item), personal control was significantly negatively correlated with preference for the service robot ($r = -.39$, $p < .001$), whereas when the potential for negative judgment was low (i.e., location item), personal control was not correlated with preference for the service robot ($r = -.02$, $p = .830$).

for negative judgment (i.e., "asking the location of a store") and the fact that the screen of robots in this mall displayed ad slogans including "ask me about store locations" caused that consumers in the low potential for negative judgment condition overall had high preferences for robots. This uncontrollable confounding factor interfered with our results. Therefore, the remaining studies use controlled experiments with manipulated personal control and potential for negative judgment.

Study 2: Choices of Chatbots

Studies 2A and 2B involved participants' seeking medical advice from a pharmacist at an online drugstore. In study 2A, we created a chatbot platform in which participants chose between consulting a human pharmacist or a chatbot pharmacist. In study 2B, we measured consumers' hypothetical choice between pharmacists and varied the manipulation of potential for negative judgment for greater realism.

Study 2A Method

Participants and Design. The study was a 2 (personal control: low vs. high) x 2 (potential for negative judgment: low vs. high) between-subjects design. We opted for a larger sample size because the dependent variable was choice, which typically decreases the effect size (Ferguson, 2016). A total of 709 participants (M_{age} = 41.41,

SD = 13.23, 41.7% male) from Amazon Mechanical Turk (MTurk) completed the study.

Procedure. Participants learned that the study included two unrelated parts. Part one manipulated perceived control (adapted from Han & Broniarczyk, 2021). In the low (high) personal control condition, participants recalled a shopping experience that made them experience low (high) control. The specific instructions were: "It could be either you attained something, or you missed something, (not) because of what you did. You felt that your shopping outcome completely depended on (had nothing to do with) the direction you were striving for and the amount of effort you put into." Across two conditions, participants were asked to write about what they thought of and felt in that shopping experience.

Part two manipulated the potential for negative judgment and measured the choice of service robots. Potential for negative judgment was manipulated by the embarrassing nature of the medical problem. We attempted to make the problems deal with the same part of the body, i.e., the nose. In the high (low) potential for negative judgment condition, participants imagined that they had a snoring problem (nasal allergies). According to the pretest (see Appendix A), seeking treatment for snoring creates higher potential for negative judgment than does seeking treatment for nasal allergies (M = 3.04 vs. 2.64, $SD_{snoring}$ = 1.86, $SD_{allergies}$ = 1.87, F (1, 232) = 17.96, $p < .001$, $\eta_p^2 = .072$).

Participants read that they were looking for medical recommendations about their ailment and that the online drugstore provided both human and robot pharmacists. They could choose one of the two to have an actual interaction.

Participants saw profiles of a sample robot pharmacist, "Alex," and a sample human pharmacist, "Fabian," and the screenshots of their conversations with previous customers (see Appendix C). The major dependent variable was the choice of pharmacist (1 = "robot pharmacist;" 0 = "human pharmacist").

Before engaging in the interaction with the online pharmacist, participants indicated their attitude toward the online drugstore compared to a store that provided only human pharmacists (1 = "much more negative/unfavorable/unappealing;" 7 = "much more positive/favorable/appealing") and the firm's customer orientation (1 = "completely motivated by making money/completely profit-driven;" 7 = "completely motivated by helping customers/completely customer-driven). These measures were exploratory to assess whether consumers view firms investing in service robots as profit-driven and sacrificing consumer experience for saving costs (Grewal et al. 2020). Because a factor analysis revealed that the five items loaded on one factor, we averaged them into an overall firm evaluation index (α = .93).

After answering these measures, participants moved on to chat with their chosen pharmacist. In fact, the pharmacist was a chatbot we developed by using Flow OX. For the cover story, we told participants that we were collecting their feedback for the pharmacist and asked them to rate their satisfaction with their interaction with the pharmacist and the extent they believed the pharmacist to be either a robot or a human (see Appendix C for detailed results). Finally, we had additional measures of their knowledge of chatbots, their general attitude toward technological innovation, and demographic measures. We report the results of additional measures in Appendix C.

Study 2A Results

Choice of Service Robots. We ran a logistic regression with choice of pharmacist as the outcome (1 = robot pharmacist; 0 = human pharmacist) and personal control, potential for negative judgment, and their interaction term as predictors. The results showed a significant main effect of potential for negative judgment (B = .56, SE = .23, $Wald\chi^2_{(1)}$= 5.95, p = .015, OR = 1.746), with high (vs. low) potential for negative judgment leading to a higher likelihood of choosing the robot pharmacist. There was also a significant interaction (B = -.80, SE = .32, $Wald\chi^2_{(1)}$= 6.33, p = .012, OR = .450; figure 2). The main effect of personal control was non-significant (p = .294). Decomposing the interaction effect, when the potential for negative judgment was high, a higher proportion of participants chose to interact with the robot pharmacist in the low (vs. high) personal control condition (43.40% vs. 30.41%, $\chi^2_{(1)}$= 6.37, p = .012). In contrast, when the potential for negative judgment was low, personal control did not significantly influence the choice of the robot pharmacist (low vs. high: 30.51% vs. 35.75%, $\chi^2_{(1)}$= 1.11, p = .293). These results are consistent with H_1.

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INSERT FIGURE 2 HERE

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Firm Evaluation. We also explored how personal control and potential for negative judgment influence consumers' evaluation of firms that provide both robot and human service providers. Theoretically, this is important because prior literature suggests that introducing service robots can negatively impact firm reputation because consumers view it as an attempt to save costs while sacrificing consumer experience (Grewal et al., 2020); on the contrary, we infer that when consumers desire to interact with robots due to strong social anxiety, they will view firms that provide robot options more positively. Practically, this inquiry can provide critical insights for firms about how incorporating novel technologies into their interface with consumers affects their brand image (Kunz et al., 2011; Wallace, 2017). A 2 (personal control: low vs. high) x 2 (potential for negative judgment: high vs. low) between-subjects ANOVA on firm evaluation revealed a significant interaction effect ($F(1, 705) = 8.48$, $p = .004$, $\eta_P^2 = .012$; figure 3). Neither the main effect of personal control nor the main effect of potential for negative judgment (p's > .108) was significant. Decomposing the interaction effect, we found that when the potential for negative judgment was high, low (vs. high) personal control led to significantly higher firm evaluation ($M = 4.99$ vs. 4.55, $SD_{low} = 1.17$, $SD_{high} = 1.33$, $F(1, 705) = 10.13$, $p = .002$, $\eta_P^2 = .014$), whereas when the potential for negative judgment was low, personal control did not cause this effect ($M = 4.59$ vs. 4.72, $SD_{low} = 1.38$, $SD_{high} = 1.29$, $F(1, 705) = .86$, $p = .355$, $\eta_P^2 = .001$). These results parallel the choice results, demonstrating that when the potential for negative judgment is high, consumers may be more positively inclined toward firms that offer a choice between robot and human service providers.

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INSERT FIGURE 3 HERE

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Study 2B Method

Participants and Design. The study used the same design and procedure with a different manipulation of the potential for negative judgment. A total of 706 participants (M_{age} = 41.48, *SD* = 15.80, 37.8% male) from MTurk completed the study.

Manipulation of Potential for Negative Judgment. To increase the realism of the task, we asked participants to recall an ailment that they had experienced that they felt comfortable or uncomfortable talking about to a pharmacist. In the low potential for negative judgment condition, the specific instruction was "you wanted to learn more about how to treat it and were comfortable asking questions to a pharmacist or doctor." We provided examples including "a respiratory infection," "a nasal allergy," and "a sore throat." In the high potential for negative judgment condition, the instruction was "you wanted to learn more about how to treat it and were uncomfortable asking questions to a pharmacist or doctor." Examples provided included "a urinary tract infection," "body odor," and "constipation." According to the pretest (see Appendix A), seeking treatment for an ailment that someone feels uncomfortable (vs. comfortable) talking about creates higher potential for negative

judgment (M = 3.67 vs. 2.97, $SD_{high\ potential}$ = 1.87, $SD_{low\ potential}$ = 1.88, F (1, 232) = 37.17, $p < .001$, $\eta_p^2 = .138$).

Next, participants read that they were looking for medical recommendations about their ailment and could choose either a human or robot pharmacist. Participants then read the same profiles and conversation screenshots as in study 2A and made a choice (1 = "robot pharmacist;" 0 = "human pharmacist"). Unlike study 2A, however, they did not actually talk to the pharmacist, and we did not measure firm evaluation. Finally, we had additional measures of their knowledge of chatbots, their general attitude toward technological innovation, and demographic measures. We report the results of additional measures in Appendix C.

Study 2B Results

We ran a logistic regression with choice of the pharmacist as the outcome (1 = robot pharmacist; 0 = human pharmacist) and personal control, potential for negative judgment, and their interaction term as predictors. Consistent with study 2A, the results showed a significant main effect of potential for negative judgment (B = .96, SE = .23, $Wald\chi^2_{(1)}$= 17.49, $p < .001$, OR = 2.602), with high (vs. low) potential for negative judgment leading to a higher likelihood of choosing the robot pharmacist. The interaction was also significant (B = .65, SE = .33, $Wald\chi^2_{(1)}$= 3.99, p = .046, OR = .523; figure 4). The main effect of personal control was non-significant (p = .447). Decomposing the interaction effect, when the potential for negative judgment was high, a higher proportion of participants chose to interact with the robot pharmacist in

the low (vs. high) personal control condition (46.63% vs. 35.43%, $\chi^2_{(1)}$= 4.57, p = .032). In contrast, when the potential for negative judgment was low, personal control did not significantly influence the choice of the robot pharmacist (low vs. high: 25.14% vs. 28.74%, $\chi^2_{(1)}$= .58, p = .446). These results are consistent with H_1.

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INSERT FIGURE 4 HERE

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Discussion

Studies 2A and 2B replicate the results of study 1, demonstrating in a controlled context an interaction effect of personal control and potential for negative judgment on preference for robots. As expected, when potential for negative judgment was high, higher personal control led to higher preference for a service robot. When potential for negative judgment was low, however, personal control did not affect preference.

The exploratory analysis of firm evaluations in Study 2A shows that consumer preference for service robots carries over to their evaluation of firms. According to Grewal et al. (2020), the adoption of technologies influences consumer satisfaction and loyalty and further impacts firm profitability. Therefore, assessing how consumers' evaluation of the firm may change with the firm's adoption of the technology is critical for the firm to make decisions about adopting the technology or

not. Our finding suggests that firms that provide services that may enhance the potential for negative judgment should consider introducing service robots because this will lead consumers with low personal control to have more positive attitudes toward them.

Study 3: Does Low or High Personal Control Drive the Effect?

Study 3 assesses whether the low or high personal control condition drives the results by including a baseline personal control condition. In addition, it tests H_2, that social anxiety mediates the effects of personal control and potential for negative judgment on robot preference. The context was asking for information at a shopping mall.

Method

Participants and Design. The study was a 3 (personal control: low vs. high vs. baseline) x 2 (potential for negative judgment: low vs. high) between-subjects design. Although 605 MTurk participants completed the study, 28 failed the attention check (see Appendix D), leaving 577 participants (M_{age} = 41.57, SD = 12.72, 42.3% male).

Procedure. The procedure was similar to that of studies 2A and 2B, with the same manipulation of personal control. In the baseline personal control condition, participants reflected on the last book that they had read or the last movie they had watched (Cutright, 2012; Han & Broniarczyk, 2021). The manipulation check for

personal control immediately followed, using three items: "I was in control of the situation," "I could achieve the desired outcome," and "I was capable of attaining what I wanted" (α = .95).

As before, the second part of the study contained the manipulation of the potential for negative judgment. Whereas study 1 varied the nature of the information that consumers would inquire about in a high-end mall, here we kept the information the same but varied the context that consumers imagined asking for this information in. Specifically, potential for negative judgment was manipulated through the self-threatening level of the context. We reasoned that MTurk respondents might perceive a larger discrepancy between their actual self and a prototype of consumers of luxury malls than between their actual self and a prototype of consumers of average-priced malls (Goor et al., 2020; Higgins, 1987). Therefore, they may infer higher potential for negative judgment when being in a luxury (vs. average-priced) mall. Accordingly, in the high potential for negative judgment condition, participants imagined visiting a high-end shopping mall (i.e., "home to who's who list of designer brands, including Louis Vuitton, Cartier, Chanel, Jimmy Choo, and Ralph Lauren, among many others"). In the low potential for negative judgment condition, they imagined visiting an average shopping mall (i.e., "home to a who's who list of regular and affordable brands, including Urban Outfitters, Zara, Gap, Uniqlo, and Banana Republic, among many others"). According to the pretest (see Appendix A), being at a luxury (vs. averaged-priced) mall creates higher potential for negative judgment (M = 3.07 vs. 2.74, SD_{high} = 1.77, SD_{low} = 1.78, F (1, 232) = 20.39, $p < .001$, $\eta_p^2 = .081$).

Next, we assessed the preference for interacting with the robot or human provider. Specifically, participants were asked to imagine walking into a store and wanting some information about one of the display racks. They were informed that the store offered both human and robot service providers who were rated as "*equally knowledgeable and efficient*." This was to ensure that they did not draw different inferences about the competence of the service providers. Then, participants watched a 20-second video about a robot service provider (see Appendix D). Next, they indicated from which type of service provider they would like to learn information (1 = "definitely the human service provider;" 7 = "definitely the service robot"). To assess the mediation, social anxiety was measured by three items asking participants the extent to which they experienced apprehension when deciding with which service provider to interact: "I was worried that the service provider would find fault with me;" "I was nervous about leaving a negative impression on the service provider;" and "I was concerned that the service provider would disapprove of me" (α = .96). Finally, participants answered measures of their perceptions and knowledge of service robots and their general attitude towards technological innovation along with demographic measures. We report analyses of the additional measures in Appendix D.

Results

Personal Control Manipulation Check. A 3 (personal control: low vs. high vs. baseline) x 2 (potential for negative judgment: high vs. low) between-subjects

ANOVA on the personal control manipulation check revealed a significant main effect of personal control ($F(2, 571) = 308.94$, $p < .001$, $\eta_P^2 = .520$) and no other significant treatment effects (all p's > .10). Compared to participants in the baseline condition ($M = 5.43$, $SD = 1.31$), those in the low personal control condition had a significantly lower sense of control ($M = 3.12$, $SD = 1.53$, $p < .001$), while those in the high personal control condition had a significantly higher sense of control ($M = 6.29$, $SD = .96$, $p < .001$). Thus, the personal control manipulation was effective.

Preference for Service Robots. A 3 (personal control: low vs. high vs. baseline) x 2 (potential for negative judgment: high vs. low) between-subjects ANOVA revealed a significant main effect of personal control ($F(2, 571) = 4.80$, $p = .008$, $\eta_P^2 = .017$) as well as the predicted significant interaction ($F(2, 571) = 3.77$, $p = .024$, $\eta_P^2 = .013$, figure 5A). The main effect of potential for negative judgment was not significant ($p > .181$). Consistent with H_{1A}, when the potential for negative judgment was high, personal control significantly influenced preference for service robots ($F(2, 571) = 8.13$, $p < .001$, $\eta_P^2 = .028$). Low personal control ($M = 4.64$, $SD = 1.74$) led to higher preference for service robots than both high personal control ($M = 3.66$, $SD = 2.12$, $p = .001$) and the baseline condition ($M = 3.55$, $SD = 1.94$, $p < .001$). The latter two did not significantly differ ($p = .709$). Consistent with H_{1B}, when the potential for negative judgment was low, personal control did not significantly affect preference for service robots ($F(2, 571) = .25$, $p = .777$, $\eta_P^2 = .001$). Because the patterns of the high personal control and baseline conditions were similar, it appears that the low personal control condition was driving the effects.

Social Anxiety. A 3 (personal control: low vs. high vs. baseline) x 2 (potential for negative judgment: high vs. low) between-subjects ANOVA revealed significant main effects of personal control ($F(2, 571) = 11.37$, $p < .001$, $\eta_P^2 = .038$) and potential for negative judgment ($F(1, 571) = 12.04$, $p = .001$, $\eta_P^2 = .021$), as well as a significant interaction ($F(2, 571) = 6.29$, $p = .002$, $\eta_P^2 = .022$, figure 5B). Decomposing the interaction, when the potential for negative judgment was high, personal control significantly influenced social anxiety ($F(2, 571) = 16.25$, $p < .001$, $\eta_P^2 = .054$). Low personal control ($M = 3.19$, $SD = 1.93$) led to higher social anxiety than both high personal control ($M = 2.00$, $SD = 1.52$, $p < .001$) and the baseline condition ($M = 2.08$, $SD = 1.66$, $p < .001$). The latter two did not significantly differ ($p = .707$). However, when the potential for negative judgment was low, personal control did not significantly affect social anxiety ($F(2, 571) = 1.29$, $p = .276$, $\eta_P^2 = .004$). These results replicated the patterns for preference.

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INSERT FIGURE 5 HERE

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Moderated Mediation. We used Process Model 7 (Hayes 2017) to analyze the mediation effect of social anxiety and the moderation effect of potential for negative judgment (see figure 6). Notably, because personal control was a three-level factor, the analysis included two levels of this factor each time. When the two levels were low vs high personal control, the moderated mediation effect was significant ($B = .41$,

SE = .16, *95%CI* = [.104, .724]), and the mediation effect was non-significant when potential for negative judgment was low (*B* = .15, *SE* = .10, *95%CI* = [-.036, .359]) and was significant when potential for negative judgment was high (*B* = .56, *SE* = .13, *95%CI* = [.323, .830]). Confirming H_1-H_2, the results suggested that low (vs. high) personal control led to a stronger preference for service robots due to stronger social anxiety only when potential for negative judgment was high, but not when the same potential was low.

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INSERT FIGURE 6 HERE

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In addition, when the two levels were low personal control vs. baseline, the moderated mediation effect was significant (*B* = .52, *SE* = .17, *95%CI* = [.189, .877]), and the mediation effect was non-significant when potential for negative judgment was low (*B* = -.002, *SE* = .10, *95%CI* = [-.207, .206]) and was significant when potential for negative judgment was high (*B* = .52, *SE* = .14, *95%CI* = [.256, .805]). Consistently, the results implied that low (vs. baseline) personal control led to a stronger preference for service robots due to greater social anxiety only when potential for negative judgment was high, but not when the same potential was low. Finally, when the two levels were high personal control vs. baseline, the moderated mediation effect was non-significant (*B* = .11, *SE* = .15, *95%CI* = [-.170, .401]). Together, these results fully supported our theoretical model in one statistical model

and demonstrated that it was the low, rather than high, personal control condition driving the effects.

Discussion

Study 3 supports our predictions that when the potential for negative judgment is high, consumers with low (vs. high) personal control are more willing to adopt service robots due to stronger social anxiety. Notably, this effect is driven mainly by the low, rather than high, personal control condition, which suggests that consumers choose robots to cope with the mental discomfort caused by low personal control. In addition, the results show that when the potential for negative judgment is low, consumers with low (vs. high) personal control have a similar level of social anxiety, leading to the same preference for service robots.

Study 4: Does the Agency of Service Robots Matter?

In this study, we examine a theoretically derived moderator of our predicted effects. One of the reasons that consumers perceive robots to be less capable of forming social judgment is because robots have low agency. On this basis, H_1 predicts that, in a service context with high potential for negative judgment, if the service robots have low agency, consumers with low (vs. high) personal control will have stronger preferences for service robots. However, if the service robots have high agency, meaning that the service robots will be perceived as more capable of forming

social judgment, the effect of personal control on consumer preference for service robots will diminish. Study 4 tests this prediction.

Method

Participant and Design. The study was a 2 (personal control: low vs. high vs. baseline) x 2 (agency of robots: low vs. high) between-subjects design. Potential for negative judgment was high in all conditions. A total of 436 undergraduate students (M_{age} = 20.18, *SD* = 1.47, 48.9% male) from a large public university participated in this study for partial credits.

Procedure. As in earlier studies, the study had two separate parts. Part one was the manipulation of personal control, in which participants were asked to recall a life experience in which they felt low (high) control, immerse themselves in visualizing it, and write about it. Part two contained the manipulation of agency of robots. Part two was ostensibly about visualizing a hotel experience. To activate high potential for negative judgment, we asked all participants to imagine that they were traveling to France to take a holiday break and anticipating many cultural differences between France and the US. They imagined arriving at the hotel they booked and checking in with a receptionist. We told them that the hotel provided both human and robot service providers powered by artificial intelligence, and prior guests were equally satisfied with the high-quality services that both types of service providers provided, to control for the effect of anticipated service quality. In the low agency condition, we said that "the robot service providers have limited agency; for example,

their service quality is stable and consistent unless engineers update them; they have a fixed range of automatic functions and cannot respond to consumers' requests beyond this range without human intervention." However, in the high agency condition, we said that "the robot service providers have very high agency; for example, they can learn from their previous service experience to improve service quality; they can respond to consumers' instant requests without human intervention."

The dependent measure was relative preference for interacting with a human or robot receptionist (1 = "definitely the human receptionist;" 7 = "definitely the robot receptionist.)" Next, as manipulation checks, we measured their perceptions of the agency (and experience) of the robot service providers using the scale from Gray et al. (2007) (see Appendix E) as well as personal control (as in study 3). Finally, we measured perceptions and knowledge of service robots along with demographic measures. We report the analyses of the additional measures in Appendix E.

Results

Personal Control Manipulation Check. A 2 (personal control: low vs. high) x 2 (agency of robots: low vs. high) between-subjects ANOVA revealed a significant main effect of personal control, suggesting that participants in the low personal control condition indeed experienced a lower sense of control (M = 2.57 vs. 6.27, SD_{low} = 1.38, SD_{high} = .93, F (1, 432) = 1085.79, $p < .001$, $\eta_p^2 = .715$), and our manipulation of personal control was effective. This analysis also revealed a marginally significant main effect of agency of robots (M = 4.33 vs. 4.50, SD_{low} =

2.18, SD_{high} = 2.21, F (1, 432) = 2.83, p = .093, η_p^2 = .007). However, the interaction effect was non-significant (F (1, 432) = .24, p = .628, η_p^2 = .001).

Agency of Robots Manipulation Check. A 2 (personal control: low vs. high) x 2 (agency of robots: low vs. high) between-subjects ANOVA showed a significant main effect of agency of robots. Indeed, participants in the low (vs. high) agency condition perceived a lower level of agency of robot service providers (M = 3.68 vs. 4.20, SD_{low} = 1.42, SD_{high} = 1.32, F (1, 432) = 15.36, p < .001, η_p^2 = .034), demonstrating the manipulation to be effective. Neither the main effect of personal control (F (1, 432) = .83, p = .364, η_p^2 = .002) nor the interaction effect (F (1, 432) = 2.15, p = .144, η_p^2 = .005) was significant. In addition, we ran the same analysis with perception of experience of robots as the dependent variable. We found none of the effects to be significant (all p's > .110), suggesting that the manipulation of agency of robots did not affect participants' perception of experience of robots.

Preference for Service Robots. A 2 (personal control: low vs. high) x 2 (agency of robots: low vs. high) between-subjects ANOVA showed a marginally significant main effect of personal control (F(1, 432) = 2.94, p = .087, η_P^2 = .007) as well as a significant interaction (F(1, 432) = 6.17, p = .013, η_P^2 = .014, figure 7). The main effect of agency of robots was non-significant (F(1, 432) = 1.36, p = .245, η_P^2 = .003). Consistent with our earlier findings, when the service robot had low agency, low (vs. high) personal control led to a stronger preference for service robots (M = 3.28 vs. 2.55, SD_{low} = 1.77, SD_{high} = 1.78, F (1, 432) = 8.85, p = .003, η_p^2 = .020). When the service robot had high agency, however, personal control did not significantly influence preferences for service robots (M = 2.64 vs. 2.78, SD_{low} = 1.85,

SD_{high} = 1.94, F (1, 432) = .30, p = .587, η_p^2 = .001). These results confirmed our prediction that only when consumers believe that the service robots lack agency (and thus the ability to judge), those with low (vs. high) personal control have a higher tendency to choose robots over humans in service contexts with high potential for negative judgment.

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Discussion

Study 4 sheds light on a theoretical moderator of our focal effect: the effect of personal control on preferences for service robots in high-potential-for-negative-judgment contexts is moderated by the agency of robots. Our results suggest that robots with high agency can no longer serve as safety nets for consumers – when the robots have high agency, consumers with low (vs. high) personal control stop preferring robots over humans because they assume highly agentic robots to be as capable of forming negative judgments of them as humans.

General Discussion

The objective of the paper was to identify the interaction effect of personal control triggered by external factors unrelated to robots and potential for negative judgment enabled by service contexts on consumer robot preference. Across five studies, we provide robust evidence for the focal hypothesis that in social contexts where the potential for negative judgment is high, consumers with low (vs. high) personal control have a heightened preference for a robot versus a human service provider. When the potential for negative judgment is low, however, personal control does not impact consumer robot preference. Importantly, we demonstrate that social anxiety underlies this effect. Finally, this effect only occurs when the robot has low rather than high agency. Next, we discuss the theoretical and practical contributions of these findings.

Theoretical Contribution

The research provides a more nuanced view of the role of personal control in the adoption of service robots, or novel technologies in general. Prior literature shows that consumers display low acceptance of novel technologies (Dietvorst et al., 2018; Faraji-Rad et al., 2017; Lin et al., 2020; Min & Schwarz, 2022), including robots (Dietvorst et al., 2018; Lee & Allaway, 2002; Puntoni et al., 2021). This is because the existence of these technological innovations causes a low sense of control. In contrast, we concentrate on personal control triggered by external factors other than the robots and investigate the interaction effect of personal control with potential for negative judgment, another critical contextual factor that has been consistently

demonstrated to affect robot preference (e.g., Holthower & van Doorn, 2022; Sun et al., 2022). We demonstrate that not everybody will be threatened by the high potential for negative judgment to the same degree; instead, only those with a low sense of control tend to experience stronger social anxiety and switch to service robots. In addition, not every type of robots can help consumers alleviate social anxiety, but only those with low agency serve as effective safety nets for consumers with low personal control.

More broadly, this research adds to the literature on human-computer interaction, specifically the stream of work on how consumers apply innovative technologies to solve mental discomfort and improve their psychological well-being (e.g., Harwood et al., 2014; Khosravi et al., 2016; McDaniel & Drouin, 2019). In line with prior findings that consumers are inclined to use technologies when faced with mental challenges (e.g., smartphones as pacifiers for adults to reduce stress, Melumad & Pham, 2020; technologies for older adults to deal with social isolation, Khosravi et al., 2016), our research shows that consumers utilize service robots as a means of coping with social anxiety. Thus, our research expands this inquiry to a new technological domain (i.e., robotic technologies) and a new type of mental discomfort (i.e., social anxiety).

Practical Implications

An important question for practitioners is how to increase adoption of robots in service contexts as robots are more capable of providing high-quality or even better

service than human service providers (Huang & Rust, 2018; 2021). Our results suggest that the use of robots may be more effective in situations where consumers experience lack of personal control and high potential for negative judgment simultaneously. Lack of personal control can be triggered by unfamiliar consumption contexts, such as visiting tourist attractions or high-end malls for the first time, whereas high potential for negative judgment can occur when the service context is embarrassing or threatening to one's self-worth. Moreover, though robots are often positioned about their functional features (e.g., robots used to provide information about what to eat or where to find a store in a shopping mall as in study 1), our research suggests that robots may be better used to answer questions that consumers may find emotionally draining, such as "which stores have deep discounts?" or "is there any cheap food in this mall?". Similarly, along with using chatbots to provide information online, managers could use chatbots to answer questions that raise social discomfort, such as sensitive medical problems. Perhaps in schools and colleges, chatbots could be in use to answer students' questions about cheating, disability accommodation, student loans, psychological counseling, and other sensitive issues as well.

In terms of personal control, online marketers could use existing individual difference scales to assess which customer groups might be more inclined to use robots and target them. Some consumers are more susceptive to lack of control and more worried about social judgment than are others. For instance, the *Desirability of Control Scale* (people with a stronger desire for control tend to be more easily feel low control; Burger & Cooper, 1979) and the *Fear of Negative Evaluation Scale*

(Leary & Kowalski, 1993) may be used to assess customers' tendencies on this aspect. In addition, some measurable or observable proxies can provide a close enough estimation of personal control, such as previous shopping experience (as shown in study 1) and ownership of premium membership. We encourage marketing practitioners to use the proxies to assess consumer personal control and enable the robot option when most needed.

Finally, we extend the marketing implications from technology acceptance to firm evaluation in our empirical study (study 2A). We show that when consumers experience low personal control and feel anxious about the high potential for negative judgment, they have more favorable reactions to companies that provide service robots in addition to human service providers. Contrary to prior research (Grewal et al., 2020), we find that they view these companies as more consumer-centered rather than profit-driven. This extension is critical given that companies do care about brand image management when incorporating novel technologies into their interface with consumers (Kunz et al., 2011; Wallace, 2017). Our findings imply that companies benefit from embracing service robots when their services or marketing messages arouse low personal control and high potential for negative judgment.

Limitations and Opportunities for Future Research

Traits of Robots. The present research only studies the effect of the agency of robots. However, there are other traits of robots that are worth consideration. For example, an interesting avenue for future research is whether the robot's

anthropomorphism level or humanoid traits, such as emotionality and conversational ability, will affect whether consumers see robots as safety nets. It could be that as the robot becomes more humanlike, consumers perceive it as more agentic and thus more judgmental, thereby negating robots' effectiveness in alleviating social anxiety. Therefore, consumers may prefer less humanlike robots when threatened by social anxiety because these robots are viewed as less judgmental. On the other hand, consumers may have a conflicted thinking process when experiencing social anxiety: they are afraid of social interactions; but meanwhile, they desire a certain degree of sociality as social animals. For instance, prior research suggests that more socially anxious consumers are more active on social media (O' Day & Heimberg, 2021). Along this logic, consumers with stronger social anxiety may prefer more humanlike robots because they strike a perfect balance between humanity and mechanicalness. In summary, this would be an interesting question for future research.

Short-Term versus Long-Term Interaction. The current research only examines consumers' preference to interact with service robots in a one-time situation. Yet, consumers, especially loyal consumers, have interactions with service providers from time to time. Will this short-term versus long-term orientation influence how consumers choose between service robots and human service providers when faced with social anxiety? A possible comparison is the distinction between company website chatbots that communicate with consumers on a one-time basis and social media robot influencers that maintain connections with consumers. (e.g., *Miquela* is a robot influencer with over 3.1 million followers on Instagram, and she posts about fashion styles, social life, and fancy cuisines to keep interacting with her

fans.) Robot influencers develop themselves into personal brands and build connections with consumers in the long run. Will social anxiety increase consumers' willingness to interact with robots that could potentially have a long-term relationship with them? Again, the answer is unclear. It is possible that consumers will view these long-term-oriented robots as more humanlike and have the same pressure to be judged by them as by humans; thus, they avoid having interactions with these robots when having strong social anxiety. However, consumers may also have a stronger desire to build up long-term relationships with these robots because this can be a more psychologically rewarding experience for them. Therefore, they are even more inclined to choose robots to cope with social anxiety given the long-term benefits. Future research is encouraged to investigate the specifics of the relationships between consumers and robots and compare how this short-term versus long-term relationship plays a role in consumer preference.

Appendices

Appendix A: Pretest of Manipulations of Potential for Negative Judgment

In this pretest, we intend to examine the effectiveness of our manipulations of potential for negative judgment across studies.

Method

Participants and Design. A total of 233 University students (M_{age} = 20.15, *SD* = 2.63, 39.7% male) from a large public university in the US participated in the pretest for partial credits. The study adopted the repeated measure design, and participants evaluated ten service contexts sequentially about their potential for negative judgment.

Procedure. We informed participants that the study was about their evaluation of different service contexts. Then, participants evaluated ten service contexts (summarized in Appendix Table 1) sequentially on potential for negative judgment (i.e., "the likelihood that people will form negative judgment about you") on 7-point scales (1 = "very low;" 7 = "very high").

Results and Discussion

Appendix Table 1 summarizes the service contexts and findings. The results suggested that our manipulations of potential for negative judgment were successful.

Appendix Table 1: Pretest Results of Operationalizations of Potential for Negative Judgment

Service Context	Study	Item	Potential for Negative Judgment	
			Mean (SD)	Significant Test Results
Mall	1	At a high-end mall, you ask a concierge about promotions and discounts.	4.14 (1.86)	F (1, 232) = 61.78, p < .001, η_p^2 = .210
		At a high-end mall, you ask a concierge about the location of a store.	2.91 (1.84)	
Online Drugstore	2A	At an online drugstore, you ask a pharmacist about medical recommendations to stop snoring.	3.04 (1.86)	F (1, 232) = 17.96, p < .001, η_p^2 = .072
		At an online drugstore, you ask a pharmacist about medical recommendations to cure nasal allergies.	2.64 (1.87)	
Online Drugstore	2B	At an online drugstore, you ask a pharmacist about medical recommendations to cure an ailment that you feel uncomfortable talking about.	3.67 (1.87)	F (1, 232) = 37.17, p < .001, η_p^2 = .138
		At an online drugstore, you ask a pharmacist about medical recommendations to cure an ailment that you feel comfortable talking about.	2.97 (1.88)	
Mall	3	At a high-end mall, you ask for information about one of the display racks in a store.	3.07 (1.77)	F (1, 232) = 20.39, p < .001, η_p^2 = .081
		At an average-priced mall, you ask for information about one of the display racks in a store.	2.74 (1.78)	
Hotel	Supple -mental study	At a hotel in another country, you check in with a receptionist.	3.66 (2.12)	F (1, 232) = 20.52, p < .001, η_p^2 = .081
		At a hotel in another country, you drop off the key with a receptionist.	3.31 (2.10)	

Appendix B: Additional Measures and Analyses in Study 1

1. **Do you feel welcomed by the stores on the first floor of this mall? (1 = not at all; 5 = very much)**

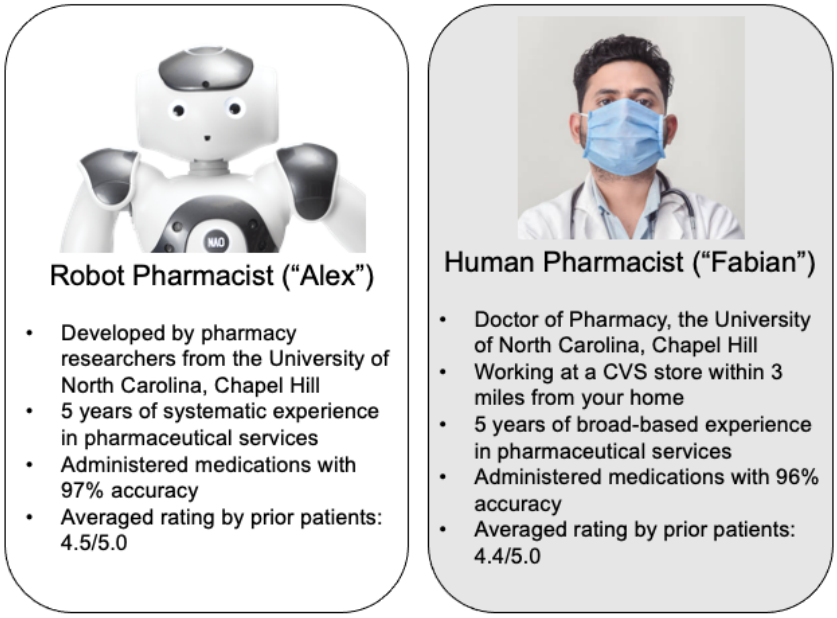
   Result: We found that participants in the low (vs. high) personal control condition felt significantly more welcomed by the stores on the first floor (M_{low} = 3.07, SD_{low} = 1.26 vs. M_{high} = 4.05, SD_{high} = .79, $F(1, 155) = 35.15$, $p < .001$, $\eta_P^2 =$ .185).

2. Have you noticed the service robots in the mall? (yes/no)

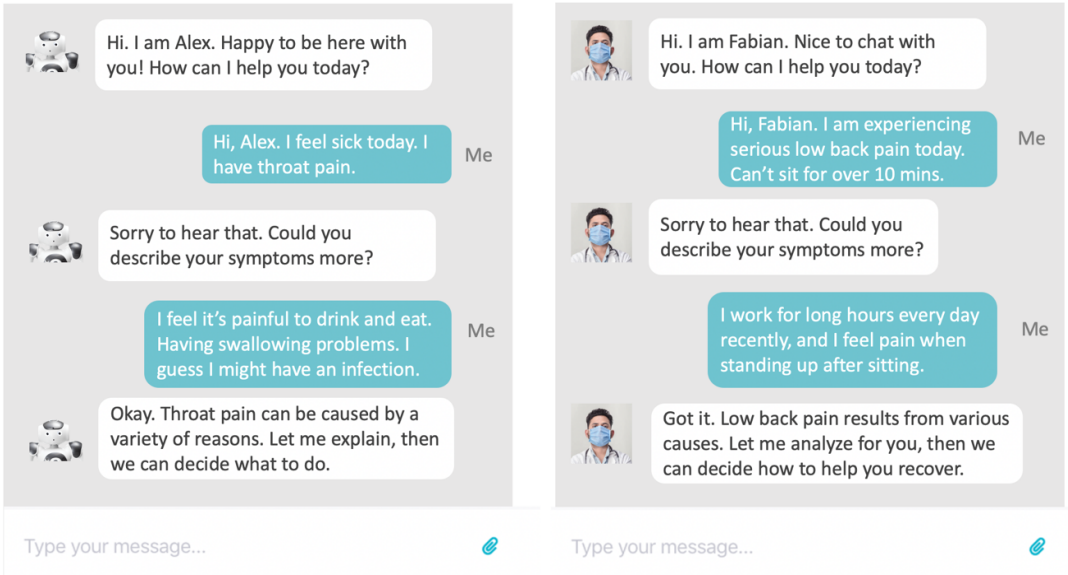
   Result: 100% of participants noticed the service robots in the mall.

Appendix C: Stimuli and Additional Measures and Analyses in Studies 2A-2B

- **Profiles of Pharmacists Shown to Participants**



- **Screenshots of Pharmacists' Conversations with Previous Customers Shown to Participants**



- **Participants' Interaction with the Pharmacist in Study 2A**

Duration. We measured the duration of participants' interaction with the pharmacist that they chose. A 2 (personal control) x 2 (potential for negative judgment) fixed effect ANOVA on duration showed a non-significant main effect of personal control ($F(1, 704) = .002$, $p = .966$, $\eta_P^2 < .001$), a non-significant main effect of potential for negative judgment ($F(1, 704) = 2.70$, $p = .101$, $\eta_P^2 = .004$), and a non-significant interaction effect ($F(1, 704) = .18$, $p = .672$, $\eta_P^2 < .001$).

Satisfaction with the Interaction. We measured participants' satisfaction with the interaction using one item (i.e., "how satisfied were you with the interaction?;" 1 = "not at all satisfied," 7 = "very satisfied"). A 2 (personal control) x 2 (potential for negative judgment) fixed effect ANOVA on satisfaction revealed a significant main effect of personal control ($F(1, 705) = 4.87$, $p = .028$, $\eta_P^2 = .007$), a non-significant main effect of potential for negative judgment ($F(1, 705) = 2.05$, $p = .153$, $\eta_P^2 = .003$), and a non-significant interaction effect ($F(1, 705) = 1.04$, $p = .309$, $\eta_P^2 = .001$). Participants with low (vs. high) personal control had significantly lower satisfaction with the interaction ($M_{low} = 3.47$, $SD_{low} = 2.07$ vs. $M_{high} = 3.81$, $SD_{high} = 1.95$, $F(1, 705) = 4.87$, $p = .028$, $\eta_P^2 = .007$).

Believability of the Pharmacist Being a Robot. We measured to what extent participants who chose a robot pharmacist believed that they had interacted with a robot. A 2 (personal control) x 2 (potential for negative judgment) fixed effect ANOVA on this measure suggested that the believability was not influenced by personal control ($F(1, 203) = .74$, $p = .390$, $\eta_P^2 = .004$), or potential for negative

judgment ($F(1, 203) = .18$, $p = .675$, $\eta_P^2 = .001$), or their interaction ($F(1, 203) = 1.07$, $p = .301$, $\eta_P^2 = .005$). In addition, the outcome of this measure was significantly higher than the mid-point of the scale (i.e., "4") ($M = 5.87$, $SD = 1.41$, $t(206) = 19.15$, $p < .001$, *Cohen's d* = 1.33).

Believability of the Pharmacist Being a Human. We also measured to what extent participants who chose a human pharmacist believed that they had interacted with a human. A 2 (personal control) x 2 (potential for negative judgment) fixed effect ANOVA on this measure suggested that the believability was not influenced by personal control ($F(1, 498) = .38$, $p = .539$, $\eta_P^2 = .001$), or potential for negative judgment ($F(1, 498) = .02$, $p = .883$, $\eta_P^2 < .001$), or their interaction ($F(1, 498) = .16$, $p = .690$, $\eta_P^2 < .001$). In addition, the outcome of this measure was significantly lower than the mid-point of the scale (i.e., "4") ($M = 2.81$, $SD = 1.93$, $t(501) = -13.87$, $p < .001$, *Cohen's d* = -.62).

Perception of Knowledgeableness. We measured to what extent participants viewed the pharmacist as knowledgeable (1 = "not at all;" 7 = "very much"). A 2 (personal control) x 2 (potential for negative judgment) fixed effect ANOVA on this measure revealed a non-significant main effect of personal control ($F(1, 705) = .104$, $p = .747$, $\eta_P^2 < .001$), a non-significant main effect of potential for negative judgment ($F(1, 705) = .003$, $p = .960$, $\eta_P^2 < .001$), and a non-significant interaction effect ($F(1, 705) = 1.54$, $p = .214$, $\eta_P^2 = .002$).

Perception of Friendliness. We measured to what extent participants viewed the pharmacist as friendly (1 = "not at all;" 7 = "very much"). A 2 (personal control) x 2 (potential for negative judgment) fixed effect ANOVA on this measure revealed a

non-significant main effect of personal control (F(1, 705) = .794, p = .373, $\eta_P^2 =$ .001), a non-significant main effect of potential for negative judgment (F(1, 705) = .954, p = .329, $\eta_P^2 = .001$), and a non-significant interaction effect (F(1, 705) = .589, p = .443, $\eta_P^2 = .001$).

- **Knowledge of Chatbots in Study 2A**

We had two items measuring participants' knowledge of chatbots: one was "to what extent are you familiar with chatbots," and the other was "to what extent do you perceive chatbots to be novel" (reversely coded). Participants answered these two items on 7-point scales with 1 = "not at all" and 7 = "very much." Through a 2 (personal control) x 2 (potential for negative judgment) fixed effect ANOVA, we found that participants across conditions were similar in their knowledge of chatbots: (i) the main effect of personal control was non-significant (F(1, 705) = .01, p = .909, $\eta_P^2 < .001$); (ii) the main effect of potential for negative judgment was non-significant (F(1, 705) = 1.79, p = .181, $\eta_P^2 = .003$); and (iii) the interaction between them was non-significant (F(1, 705) = 1.05, p = .307, $\eta_P^2 = .001$).

- **Perceived Realistic Level of Drugstores Using Chatbots in Study 2A**

We measured how realistic consumers believed it was to have online drugstores that provided chatbots to customers (1 = "not at all realistic;" 7 = "very realistic"). Through a 2 (personal control) x 2 (potential for negative judgment) fixed

effect ANOVA, we found that participants across conditions were not different in this aspect: (i) the main effect of personal control was non-significant ($F(1, 703) = .74$, $p = .392$, $\eta_P^2 = .001$); (ii) the main effect of potential for negative judgment was non-significant ($F(1, 703) = .99$, $p = .321$, $\eta_P^2 = .001$); and (iii) the interaction between them was non-significant ($F(1, 703) = 1.99$, $p = .159$, $\eta_P^2 = .003$).

- **General Attitudes toward Innovative Technologies in Study 2A**

Participants indicated their general attitudes toward recent technology innovations (e.g., artificial intelligence, robotics, and "the internet of things") on three items: very negative/positive, very doubtful/trustful, unsupportive/supportive ($\alpha = .93$), and 7-point scales. Through a 2 (personal control) x 2 (potential for negative judgment) fixed effect ANOVA, we found that participants across conditions were not different in their general attitudes toward technology innovations: (i) the main effect of personal control was non-significant ($F(1, 705) = .26$, $p = .610$, $\eta_P^2 < .001$); (ii) the main effect of potential for negative judgment was non-significant ($F(1, 705) = .14$, $p = .735$, $\eta_P^2 < .001$); and (iii) the interaction between them was non-significant ($F(1, 705) = .24$, $p = .625$, $\eta_P^2 < .001$).

- **Knowledge of Chatbots in Study 2B**

We had three items measuring participants' knowledge of chatbots. Two of them were choice questions: (i) "had you ever heard of chatbots before participating

in the study;" and (ii) "have you ever interacted with chatbots." Participants chose "yes" or "no." One of them was on 7-point scale (1 = "not at all;" 7 = "very much"). Participants answered to what extent they were familiar with chatbots. Through a 2 (personal control) x 2 (potential for negative judgment) fixed effect ANOVA, we found: (i) participants across conditions did not differ in whether they had heard of chatbots (main effect of personal control: B = .21, SE = .27, $Wald\chi^2_{(1)}$ = .64, p = .426, OR = 1.236; main effect of potential for negative judgment: B = -.23, SE = .28, $Wald\chi^2_{(1)}$ = .68, p = .410, OR = .791; interaction: B = -.11, SE = .40, $Wald\chi^2_{(1)}$ = .07, p = .787, OR = .899); (ii) participants across conditions did not differ in whether they had interacted with chatbots (main effect of personal control: B = .01, SE = .23, $Wald\chi^2_{(1)}$ = .003, p = .955, OR = 1.013; main effect of potential for negative judgment: B = -.22, SE = .24, $Wald\chi^2_{(1)}$ = .84, p = .360, OR = .804; interaction: B = .39, SE = .33, $Wald\chi^2_{(1)}$ = 1.42, p = .233, OR = 1.484); and finally, (3) participants across conditions did not differ in their familiarity with chatbots (main effect of personal control: $F(1, 702)$ = .37, p = .541, $\eta_P^2 = .001$; main effect of potential for negative judgment: $F(1, 702)$ = 1.01, p = .314, $\eta_P^2 = .001$; interaction: $F(1, 702)$ = 1.63, p = .202, $\eta_P^2 = .002$).

- **General Attitudes toward Innovative Technologies in Study 2B**

Participants indicated their general attitudes toward recent technology innovations (e.g., artificial intelligence, robotics, and "the internet of things") on three items: very negative/positive, very doubtful/trustful, unsupportive/supportive (α =

.92), and 7-point scales. A 2 (personal control) x 2 (potential for negative judgment) fixed effect ANOVA on the averaged attitude index showed a non-significant main effect of personal control ($F(1, 702) = .03$, $p = .856$, $\eta_P^2 < .001$), a marginally significant main effect of potential for negative judgment ($F(1, 702) = 2.98$, $p = .085$, $\eta_P^2 = .004$) – consumers faced with low (vs. high) potential for negative judgment had marginally significantly more positive attitudes toward technological innovations ($M_{low} = 5.05$, $SD_{low} = 1.13$ vs. $M_{high} = 4.90$, $SD_{high} = 1.21$), and a non-significant interaction effect ($F(1, 702) = 2.48$, $p = .116$, $\eta_P^2 = .004$).

Appendix D: Stimuli and Additional Measures and Analyses in Study 3

- **Attention Check Question**

Please choose the cities that are not in the US.

A. New York City

B. Los Angeles

C. Boston

D. Barcelona

E. Tokyo

F. San Diego

G. Beijing

Note: Correct answers are underlined.

- **Video Watched by Participants**

Link to the video: https://www.youtube.com/watch?v=pQ6vBU8FxEA

- **Perception of Warmth and Competence of Service Robots**

Warmth. We had two items measuring participants' perception of warmth of service robots (i.e., "to what extent do you expect a service robot to be friendly/kind; $r = .77$) on 7-point scales. Through a 3 (personal control) x 2 (potential for negative judgment) fixed effect ANOVA, we found that participants across conditions did not significantly differ in their perception of warmth (main effect of personal control:

$F(2, 571) = .05$, $p = .949$, $\eta_P^2 < .001$; main effect of potential for negative judgment: $F(1, 571) = .09$, $p = .765$, $\eta_P^2 < .001$; interaction: $F(2, 571) = .06$, $p = .945$, $\eta_P^2 < .001$).

Competence. Also, we had two items measuring participants' perception of competence of service robots (i.e., "to what extent do you expect a service robot to be knowledgeable/professional; $r = .53$) on 7-point scales. Similarly, through a 3 (personal control) x 2 (potential for negative judgment) fixed effect ANOVA, we found that participants across conditions did not significantly differ in their perception of competence (main effect of personal control: $F(2, 571) = .47$, $p = .625$, $\eta_P^2 = .002$; main effect of potential for negative judgment: $F(1, 571) = 1.08$, $p = .299$, $\eta_P^2 = .002$; interaction: $F(2, 571) = .06$, $p = .946$, $\eta_P^2 < .001$).

- **Knowledge of Service Robots**

We measured to what extent participants were familiar with service robots (1 = "not at all;" 7 = "very much"). A 3 (personal control) x 2 (potential for negative judgment) fixed effect ANOVA on this measure showed a significant main effect of personal control ($F(2, 571) = 3.65$, $p = .027$, $\eta_P^2 = .013$) – consumers in the high personal control condition had (marginally) significantly lower familiarity with service robots than participants in the low personal control condition ($M_{high} = 2.41$, $SD_{high} = 1.51$ vs. $M_{low} = 2.70$, $SD_{low} = 1.59$, $p = .063$) and than those in the baseline condition ($M_{high} = 2.41$, $SD_{high} = 1.51$ vs. $M_{baseline} = 2.81$, $SD_{low} = 1.44$, $p = .009$). This analysis also showed a non-significant main effect of potential for negative judgment

($F(1, 571) = .26$, $p = .613$, $\eta_P^2 < .001$) and a non-significant interaction effect ($F(2, 571) = .13$, $p = .876$, $\eta_P^2 < .001$).

- **General Attitudes toward Innovative Technologies**

We used the same items as in studies 2A-2B to measure consumer general attitudes toward innovative technologies. A 3 (personal control) x 2 (potential for negative judgment) fixed effect ANOVA revealed that participants across conditions did not significantly differ in this dimension (main effect of personal control: $F(2, 571) = 1.28$, $p = .279$, $\eta_P^2 = .004$; main effect of potential for negative judgment: $F(1, 571) = .48$, $p = .490$, $\eta_P^2 = .001$; interaction: $F(2, 571) = .44$, $p = .643$, $\eta_P^2 = .002$).

Appendix E: Stimuli and Additional Measures and Analyses in Study 4

- **Measures of Mind Perception (Gray et al., 2007)**

Please answer the following questions based on your perception of the robot service providers.

1 = Not at all

7 = Very much

(Agency)

1. How capable of exercising self-control do you think the robot service providers are?
2. How capable of remembering do you think the robot service providers are?
3. How capable of acting morally do you think the robot service providers are?

(Experience)

1. How capable of feeling fear do you think the robot service providers are?
2. How capable of feeling pleasure do you think the robot service providers are?
3. How capable of feeling hunger do you think the robot service providers are?

- **Perception of Warmth and Competence of Service Robots**

Warmth. We used the same measures as in Study 3 to capture participants' perception of warmth of service robots (r = .81). We ran a 2 (personal control) x 2 (agency) fixed effect ANOVA and found that the main effect of personal control was

marginally significant – participants in the low (vs. high) personal control condition perceived service robots to be warmer (M_{low} = 4.04, SD_{low} = 1.42 vs. M_{high} = 3.77, SD_{high} = 1.47, $F(1, 432) = 3.79$, $p = .052$, $\eta_P^2 = .009$). Also, the main effect of agency was marginally significant – participants in the low (vs. high) agency condition perceived service robots to be less warm (M_{low} = 3.78, SD_{low} = 1.49 vs. M_{high} = 4.03, SD_{high} = 1.40, $F(1, 432) = 3.04$, $p = .082$, $\eta_P^2 = .007$). However, the interaction was not significant ($F(1, 432) = .51$, $p = .475$, $\eta_P^2 = .001$), suggesting that perception of warmth cannot alternatively explain the interaction effect on our focal dependent variable.

Competence. Also, we used the same measures as in Study 3 to capture participants' perception of competence of service robots ($r = .51$). We ran a 2 (personal control) x 2 (agency) fixed effect ANOVA and found that participants across personal control conditions did not significantly differ in their perception of competence ($F(1, 432) = .01$, $p = .910$, $\eta_P^2 < .001$). Moreover, the interaction was not significant ($F(1, 432) = 2.19$, $p = .140$, $\eta_P^2 = .005$). However, the main effect of agency was significant – participants in the low (vs. high) agency condition perceived service robots to be less competent (M_{low} = 5.00, SD_{low} = 1.30 vs. M_{high} = 5.28, SD_{high} = 1.21, $F(1, 432) = 5.73$, $p = .017$, $\eta_P^2 = .013$).

Reference

Gray, H. M., Gray, K., & Wegner, D. M. (2007). Dimensions of mind perception. *Science*, *315*(5812), 619-619. https://doi.org/10.1126/science.1134475

Appendix F: Supplemental Study

Manipulating an Impression Management Motive

By explicitly manipulating consumers' motive, the supplemental study confirms the mediation of social anxiety through moderation (Spencer et al., 2005).

Method

Participants and Design. Of the 605 MTurk participants from completed the study, 583 passed the attention check (M_{age} = 39.57, *SD* = 13.16, 43.0% male; see Appendix G for the attention check). The study was a 2 (personal control: low vs. high, between-subjects) x 2 (potential for negative judgment: low vs. high, within-subject) x 3 (motive: none vs. impression management vs. non-impression management, between-subjects) mixed design. Participants were randomly assigned to the personal control and motive conditions.

Procedure. Adapted from prior work (Chen et al., 2017; Cutright et al., 2013; Cutright & Samper, 2014), we used a scenario visualization task to manipulate personal control. Participants imagined that they were traveling to France and had acquired some knowledge about the country's culture and customs. Personal control was manipulated by their confidence in their knowledge of French. In the low personal control condition, they did not know any French and were not confident about immersing themselves in the new environment. In the high personal control

condition, their French was at an intermediate level, and they were confident about immersing themselves in the new environment.

The manipulation of motive was also embedded in the scenario. In the no motive condition, participants did not receive any information about their motive. This condition best resembles our previous studies, where we assume that an impression management motive is implicit in the context. In the impression management condition, participants learned that they wanted to create a positive image of themselves to others and cared about others' evaluative reactions to them. In the non-impression management motive condition, they were told that they wanted to learn more about French culture, especially local communities and traditions. They then wrote about their feelings and thoughts in the scenario.

Next, participants imagined arriving at a French hotel that offered both human and robot service providers. As in study 3, we told them that these service providers were rated as "*equally knowledgeable, flexible, polite, and efficient*." Then, participants watched a 20-second video about a robot concierge (see Appendix G). Potential for negative judgment was manipulated within subjects via the degree of interactivity with the service provider. Participants indicated their preference to interact with a robot relative to a human service provider in two situations: checking in with a receptionist (high potential for negative judgment) and dropping off the key with a receptionist (low potential for negative judgment). For each item, participants answered on seven-point scales (1 = "definitely the human receptionist;" 7 = "definitely the robot receptionist"). The pretest (detailed in Appendix A) indicated that checking resulted in greater interactivity and potential for negative judgment than

did dropping off a key (M = 3.66 vs. 3.31, $SD_{checking\text{-}in}$ = 2.12, $SD_{dropping\text{-}off}$ = 2.10, F (1, 232) = 20.52, $p < .001$, $\eta_p^2 = .081$).

We then measured social anxiety. Participants were asked to recall the scenario and answered to what extent they experienced the emotions described as in study 3 ($\alpha = .97$). Next, participants completed the manipulation check measure for personal control as in study 3 ($\alpha = .93$). Note that in study 3, this manipulation check occurred before the potential for negative judgment manipulation. As a manipulation check for motive, they indicated to what extent the following motive, "to impress others" or "to learn French culture," respectively, was salient in their mind (1 = "not at all;" 7 = "very much"). Finally, participants indicated their perceptions and knowledge of service robots and their general attitude towards technological innovation, along with demographic measures. We report the analyses of these measures in Appendix G.

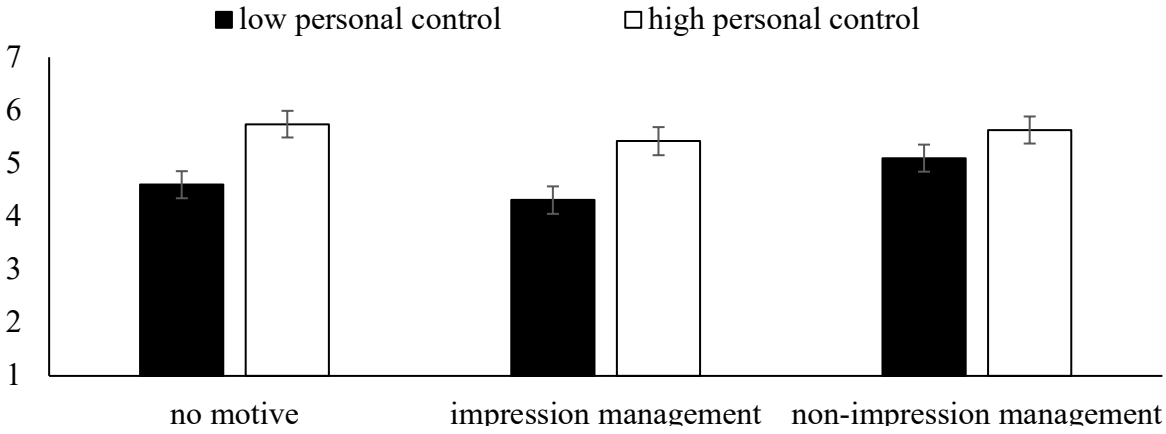
Results

Manipulation Check of Personal Control. A 2 (personal control: low vs. high) x 3 (motive: no motive vs. impression management vs. non-impression management) between-subjects ANOVA on sense of control revealed a significant main effect of personal control (F(1, 577) = 75.01, $p < .001$, $\eta_P^2 = .012$), a significant main effect of motive (F(2, 577) = 7.23, $p = .001$, $\eta_P^2 = .024$), and a significant interaction effect (F(2, 577) = 3.39, $p = .034$, $\eta_P^2 = .012$, Appendix Figure 1). As predicted, participants in the low (vs. high) personal control condition had a significantly lower sense of

control (M = 4.67 vs. 5.60, SD_{low} = 1.46, SD_{high} = 1.14, $F(1, 577) = 75.01$, $p < .001$, $\eta_P^2 = .115$). In addition, the main effect of motive showed that the impression management motive (M = 4.85, SD = 1.43) led to significantly lower sense of control than did the control condition (M = 5.18, SD = 1.35, $p < .001$) as well as the non-impression management condition (M = 5.36, SD = 1.34, $p = .020$). This suggests that explicitly stating an impression management goal led participants to feel less likely to attain desired outcomes.

Finally, though the interaction effect was significant, comparing the means within each motive showed that sense of control was significantly lower under low than high personal control (all p's < .005), which supported the effectiveness of our personal control manipulation. In addition, this interaction effect could not explain the results that we got on our focal dependent variable (i.e., preference for service robots when checking in, the high potential for negative judgment condition) as the mediation effect of sense of control was non-significant (see Appendix G).

Appendix Figure 1: Manipulation Check Results of Personal Control



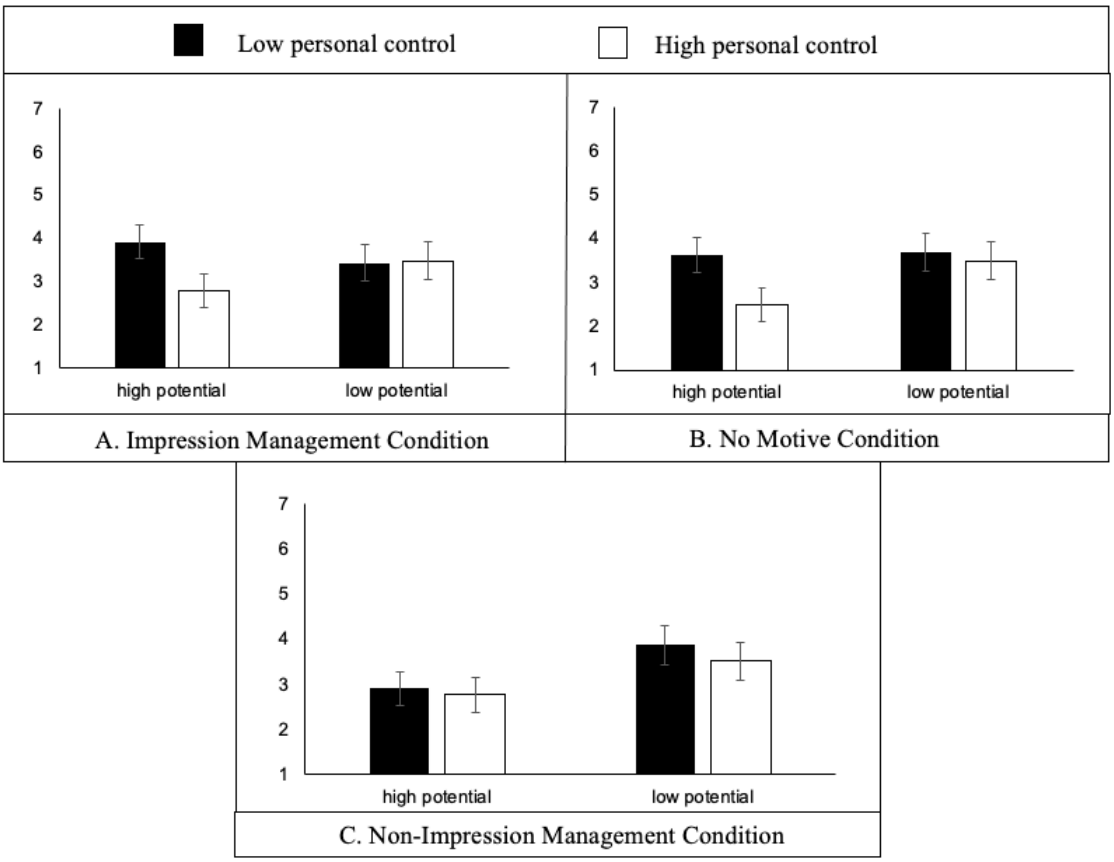
Manipulation Check of Impression Management Motive. A 2 (personal control: low vs. high) x 3 (motive: no motive vs. impression management vs. non-impression management) between-subjects ANOVA revealed only a significant main effect of motive ($F(2, 577) = 59.56$, $p < .001$, $\eta_P^2 = .171$). The other treatment effects were not significant (all p's > .20). As expected, explicitly specifying an impression management motive ($M = 4.12$, $SD = 1.97$) resulted in a significantly stronger motive to impress others than did the non-impression management condition ($M = 2.23$, $SD = 1.57$, $p < .001$) or the no motive condition ($M = 2.60$, $SD = 1.82$, $p < .001$). In addition, consistent with expectations, participants in the no motive condition ($M = 2.60$, $SD = 1.82$) had a significantly stronger motive to impress others than those in the non-impression management condition ($M = 2.23$, $SD = 1.57$, $p = .036$). These results confirmed the effectiveness of the impression management motive manipulation and supported our assumption that even without explicit activation (i.e., the no motive condition), consumers cared about impression management due to its social nature.

Preference for Service Robots. We had predicted a three-way interaction, such that the interaction effect of personal control and potential for negative judgment would only appear when either the impression management motive or no motive was prompted, but not when a non-impression management motive was prompted. As predicted, a 2 (personal control: low vs. high) x 3 (motive: no motive vs. impression management vs. non-impression management) x 2 (potential for negative judgment: high vs. low) repeated measure ANOVA revealed a significant main effect of personal control ($F(1, 577) = 12.70$, $p < .001$, $\eta_P^2 = .022$), a significant main effect of potential for negative judgment ($F(1, 577) = 24.20$, $p < .001$, $\eta_P^2 = .040$), a significant

interaction effect of personal control and potential for negative judgment ($F(1, 577) = 10.03$, $p = .002$, $\eta_P^2 = .017$), a significant interaction effect of motive and potential for negative judgment ($F(2, 577) = 4.59$, $p = .011$, $\eta_P^2 = .016$), and most importantly, a significant three-way interaction ($F(2, 577) = 4.56$, $p = .011$, $\eta_P^2 = .016$). Other treatment effects were non-significant (all p's > .100). We decompose the three-way interaction by motive to examine our hypotheses.

In the impression management condition, we expected support for H_1. A 2 (personal control) x 2 (potential for negative judgment) repeated measure ANOVA revealed a significant main effect of personal control ($F(1, 185) = 5.11$, $p = .025$, $\eta_P^2 = .027$), a significant main effect of potential for negative judgment ($F(1, 185) = 10.49$, $p = .001$, $\eta_P^2 = .054$), and more importantly, a significant interaction effect ($F(1, 185) = 10.49$, $p = .001$, $\eta_P^2 = .054$, Appendix Figure 2A). Consistent with H_{1A}, when the potential for negative judgment was high, low (vs. high) personal control led to significantly higher preference for service robots ($M = 3.92$ vs. 2.79, $SD_{low} = 2.16$, $SD_{high} = 1.70$, $F(1, 185) = 15.54$, $p < .001$, $\eta_P^2 = .077$). Consistent with H_{1B}, when the potential for negative judgment was low, personal control did not significantly change preference for service robots ($M = 3.43$ vs. 3.48, $SD_{low} = 2.22$, $SD_{high} = 2.03$, $F(1, 185) = .03$, $p = .856$, $\eta_P^2 < .001$).

Appendix Figure 2: Preference for Service Robots as a Function of Personal Control and Potential for Negative Judgement



As predicted, the same pattern emerged in the no motive condition. The same ANOVA revealed a significant main effect of personal control (F(1, 197) = 8.52, p = .004, η_P^2 =.041) and a significant main effect of potential for negative judgment (F(1, 197) = 8.85, p = .003, η_P^2 =.043), and more importantly, a significant interaction effect (F(1, 197) = 6.94, p = .009, η_P^2 = .034, Appendix Figure 2B). Decomposing the interaction, consistent with H_{1A}, when the potential for negative judgment was high, low (vs. high) personal control led to significantly higher preference for service robots (M = 3.63 vs. 2.48, SD_{low} = 2.23, SD_{high} = 1.65, F(1, 197) = 17.54, p < .001, η_P^2 =.081). And, consistent with H_{1B}, when the potential for negative judgment was

low, personal control did not significantly affect preference for service robots (M = 3.69 vs. 3.49, SD_{low} = 2.32, SD_{high} = 2.08, $F(1, 197) = .45$, $p = .504$, $\eta_P^2 = .002$).

Finally, we had predicted that H1 would not hold in the non-impression management condition. The same ANOVA revealed only a significant main effect of potential for negative judgment: participants in the low (vs. high) potential for negative judgment condition had a significantly stronger preference for robots ($F(1, 195) = 27.85$, $p < .001$, $\eta_P^2 = .125$). Consistent with our expectation, the interaction effect was non-significant ($F(1, 195) = .43$, $p = .513$, $\eta_P^2 = .002$, Appendix Figure 2C). This suggests that our predictions hold when an impression management motive is explicitly or implicitly triggered.

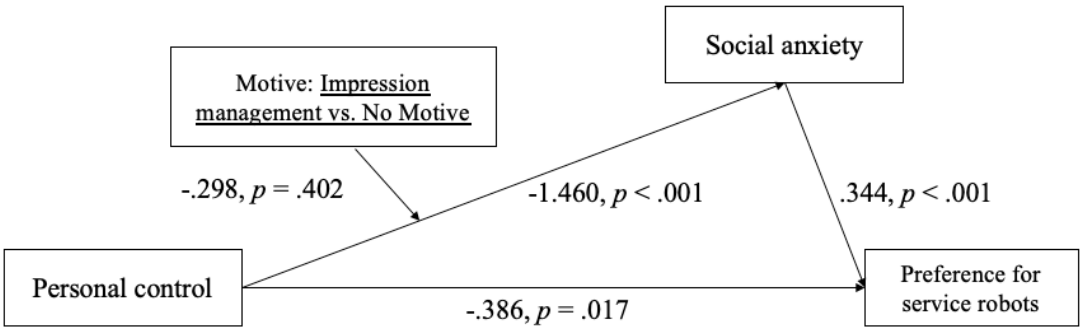
Social Anxiety. A 2 (personal control) x 3 (motive) fixed effects ANOVA revealed a significant main effects of personal control ($F(1, 577) = 70.52$, $p < .001$, $\eta_P^2 = .109$) and motive ($F(2, 577) = 44.74$, $p < .001$, $\eta_P^2 = .134$), as well as a significant interaction ($F(2, 577) = 8.00$, $p < .001$, $\eta_P^2 = .027$). Decomposing the interaction, low (vs. high) personal control led to significantly higher social anxiety in the impression management condition (M = 4.77 vs. 3.31, SD_{low} = 1.80, SD_{high} = 2.02, $F(1, 577) = 32.79$, $p < .001$, $\eta_P^2 = .054$) as well as the no motive condition (M = 3.73 vs. 1.97, SD_{low} = 2.00, SD_{high} = 1.37, $F(1, 577) = 50.62$, $p < .001$, $\eta_P^2 = .081$). However, as predicted, in the non-impression management condition, personal control had only a marginally significantly effect on social anxiety (M = 2.62 vs. 2.20, SD_{low} = 1.70, SD_{high} = 1.51, $F(1, 577) = 2.87$, $p = .091$, $\eta_P^2 = .005$).

Moderated Mediation. As in study 3, Process Model 7 (Hayes 2017) was used to analyze the mediation effect of social anxiety and the moderation effect of motive

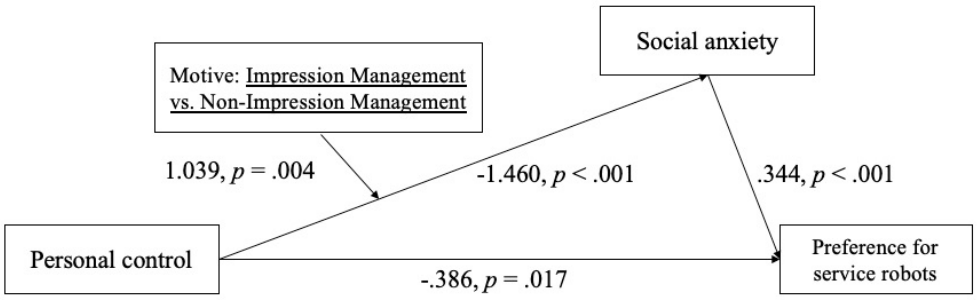
(see Appendix Figure 3). Notably, we conducted these analyses only in the high potential for negative judgment condition, consistent with our predictions. The analyses compared the moderation effect of two levels of motive each time. The results showed that: (1) the mediation effect of social anxiety was significant only in the impression management condition (*ab* = -.50, *SE* = .12, *95%CI* = [-.755, -.280]) and the no motive condition (*ab* = -.60, *SE* = .12, *95%CI* = [-.853, -.385]), but not in the non-impression management condition (*ab* = -.14, *SE* = .08, *95%CI* = [-.315, .009]); (2) when the compared two levels were impression management and no motive, the moderated mediation effect was non-significant (*contrast* = -.10, *SE* = .13, *95%CI* = [-.365, .140]); (3) when the compared two levels were impression management and non-impression management, the moderated mediation effect was significant (*contrast* = -.36, *SE* = .13, *95%CI* = [-.631, -.105]); and (4) when the compared two levels were no motive and non-impression management, the moderated mediation effect was also significant (*contrast* = -.46, *SE* = .13, *95%CI* = [-.732, -.224]). These results suggested that when being faced with high potential for negative judgment and having an impression management motive or no motive, consumers with low (vs. high) personal control prefer service robots due to heightened social anxiety. Thus, social anxiety mediated the treatment effects under no motive and an impression management motive, but not under a non-impression management motive.

Appendix Figure 3: Moderated Mediation Models (Within High Potential for Negative Judgment)

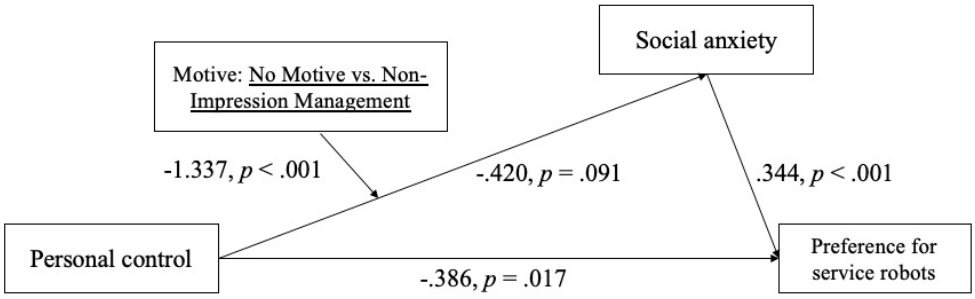
Appendix Figure 3A: Comparing Impression Management VS. No Motive



Appendix Figure 3B: Comparing Impression Management VS. Non-Impression Management



Appendix Figure 3C: No Motive VS. Non-Impression Management



Discussion

This supplemental study provides support for our conceptual model that in the presence of an impression management motive (implicit or explicit), low personal control leads to higher social anxiety and greater acceptance of robots when the potential for negative judgment is high. The fact that the no motive and impression

management motive conditions had similar results shows that an impression management motive was implicit in the service context that we tested. The potential for negative judgment was manipulated through the length of the interaction with the service provider; checking in with the hotel receptionist requires higher interactivity than dropping off the key. When participants felt less confident of attaining their impression management goals because of poor language skills, they wanted to avoid a lengthy interaction with the human receptionist because of social anxiety. Hence, preference for the robot increased. When impression management was not a concern (i.e., their motive was learning French), social anxiety was unaffected, and they preferred interacting with the human receptionist.

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Appendix G: Stimuli and Additional Measures and Analyses in the Supplemental Study

- **Attention Check Question**

Among the following holidays, which one(s) is(are) normally celebrated in the US?

A. Labor Day

B. Memorial Day

C. New Year's Day

D. Boxing Day

E. Valentine's Day

F. Chuseok

G. Surva Festival

H. Carpet of Flowers

I. Martin Luther King Jr. Day

Note: Correct answers are underlined.

- **Video Watched by Participants**

Link to the video: https://www.youtube.com/watch?v=fspyRe6DRdc

- **Perception of Warmth and Competence of Service Robots**

Warmth. We used the same two items to measure participants' perception of warmth of service robots (r = .78) as in Studies 3 and 4. We ran a 2 (personal control)

x 3 (motive) fixed effect ANOVA and found that participants across conditions did not significantly differ in their perception of warmth (main effect of personal control: $F(1, 577) = 1.52$, $p = .219$, $\eta_P^2 = .003$; main effect of motive: $F(2, 577) = .13$, $p = .881$, $\eta_P^2 < .001$; interaction: $F(2, 577) = .66$, $p = .515$, $\eta_P^2 = .002$).

Competence. Also, we used the same two items to measure participants' perception of competence of service robots ($r = .46$) as in Studies 3 and 4. Similarly, we ran a 2 (personal control) x 3 (motive) fixed effect ANOVA and found that participants across conditions did not significantly differ in their perception of competence (main effect of personal control: $F(1, 577) = 1.63$, $p = .202$, $\eta_P^2 = .003$; main effect of motive: $F(2, 577) = .19$, $p = .824$, $\eta_P^2 = .001$; interaction: $F(2, 577) = .81$, $p = .448$, $\eta_P^2 = .003$).

- **Knowledge of Service Robots**

We measured to what extent participants were familiar with service robots (1 = "not at all;" 7 = "very much"). A 2 (personal control) x 3 (motive) fixed effect ANOVA on this measure showed a significant main effect of personal control ($F(1, 577) = 7.15$, $p = .008$, $\eta_P^2 = .012$) – consumers with low (vs. high) personal control had significantly higher familiarity with service robots ($M_{low} = 5.10$, $SD_{low} = 1.55$ vs. $M_{high} = 4.75$, $SD_{high} = 1.61$), a non-significant motive ($F(2, 577) = .06$, $p = .941$, $\eta_P^2 < .001$) and a non-significant interaction effect ($F(2, 577) = .49$, $p = .614$, $\eta_P^2 = .002$).

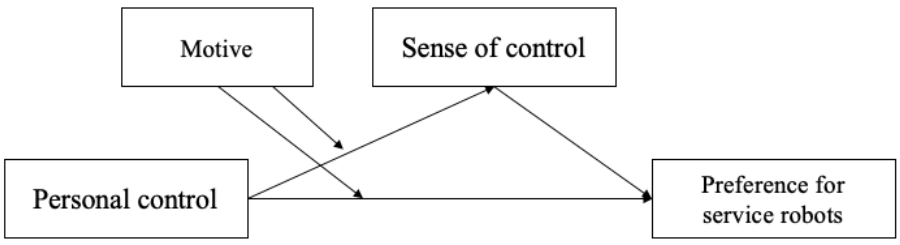
- **General Attitudes toward Innovative Technologies**

We used the same items as in studies 2-3 to measure consumer general attitudes toward innovative technologies. We ran a 2 (personal control) x 3 (motive) fixed effect ANOVA and found that participants across conditions did not significantly differ in this dimension (main effect of personal control: $F(1, 577) = .67$, $p = .415$, $\eta_P^2 = .001$; main effect of motive: $F(2, 577) = .09$, $p = .916$, $\eta_P^2 < .001$; interaction: $F(2, 577) = .37$, $p = .690$, $\eta_P^2 = .001$).

- **Mediation Results When Using Sense of Control (Manipulation Check Items) as the Mediator**

As for the manipulation check of personal control, we found a significant interaction effect of personal control and motive on the sense of control ($F(2, 577) = 3.39$, $p = .034$, $\eta_P^2 = .012$); however, sense of control did not significantly mediate the interaction effect of personal control and motive on the focal dependent variable – consumers' preference for service robots. Specifically, we examined the moderated mediation model shown in Appendix Figure 4 using Process Model 7 (Hayes 2017) to reach this conclusion. Notably, we conducted these analyses only in the high potential for negative judgment condition.

Appendix Figure 4: Moderated Mediation Model Using Sense of Control as the Mediator



The analyses compared the moderation effect of two levels of motive each time. The results showed that: (1) the mediation effect of sense of control was non-significant across conditions (no motive condition: *ab* = -.05, *SE* = .08, *95%CI* = [-.227, .103]; impression management condition: *ab* = -.05, *SE* = .08, *95%CI* = [-.221, .099]; non-impression management condition: *ab* = -.02, *SE* = .04, *95%CI* = [-.109, .055]); (2) when the compared two levels were impression management and non-impression management, the moderated mediation effect was non-significant (*contrast* = -.03, *SE* = .05, *95%CI* = [-.139, .052]); (3) when the compared two levels were no motive and non-impression management, the moderated mediation effect was non-significant (*contrast* = -.03, *SE* = .05, *95%CI* = [-.146, .056]); finally (4) when the compared two levels were impression management and no motive, the moderated mediation effect was non-significant (*contrast* = -.001, *SE* = .02, *95%CI* = [-.050, .046]). Combined, these results suggested that sense of control could not explain the results that we got on preference for service robots.

Reference

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Chapter 3: Why Do Consumers Resist Lab-Grown Meat? A Life-Creation Perception Theory[3]

Introduction

Global demand for meat—animal flesh used for food, technically including seafood and poultry (USDA 2019)—has drastically increased due to economic and population growth. Worldwide meat consumption increased by 58 percent from 1998 to 2018 (Whitnall and Pitts 2019) and has created major environmental and food security problems. For example, livestock production processes produce 14.5% of greenhouse gas emissions globally (DownToEarth 2019), and excessive land and water usage for livestock farming has also been tied to famines and malnutrition in developing areas (Our World in Data 2019). These phenomena reflect an intense tension between meat consumption and sustainable agriculture.

Scientists have proposed that lab-grown meat could be an innovative solution to these environmental challenges. To produce lab-grown meat, scientists take a sample of stem cells from an animal under local anesthesia and then cultivate the sample into muscle tissue and transform the tissue into cuts of meat, such as steak, chicken nuggets, and hamburger patties. Lab-grown meat has the same biological structure and chemical composition as conventional animal meat, but its production does not rely on animals and the traditional farming industry. In fact, the

[3] Yajin Wang is my co-author on this essay. We plan to submit this essay to the *Journal of Marketing Research*.

commercialization and legalization of lab-grown meat have made tremendous progress. For example, in 2020, Singapore became the first country to approve the commercialization of lab-grown meat. In 2022, US President Biden launched a national biotechnology and biomanufacturing initiative, which includes the development of lab-grown meat (The White House 2022). The US Food and Drug Administration (FDA) also authorized Upside Foods to produce lab-grown meat and claimed that it is safe to eat lab-grown meat (New York Times 2022). Given this, it seems that eating lab-grown meat is not science fiction anymore but will turn into reality for many consumers around the world.

However, industry reports have shown that lab-grown meat has not yet received enthusiasm from consumers in the marketplace (e.g., Kadence International 2018). Confirming this market reaction, existing academic research, mostly based on survey and focus group methods, suggests that consumers display negative attitudes toward lab-grown meat, especially in comparison to conventional animal meat (see Pakseresht, Kaliji, and Canavari 2022 for a review). Their explanations for this negativity can be divided into two types based on the theoretical framework established by Rozin and his coauthors to explain consumer resistance to unnatural food (Rozin et al. 2004; Rozin 2005). One is *instrumental* reasons about the material or functional product features, such as healthiness (Hartmann, Furtwaengler, Siegrist 2022) and taste (Ruzgys and Pickering 2020; Wilks and Phillips 2017), whereas the other is *ideational* reasons about moral, aesthetic, or psychological factors in general, such as fear of unfamiliar technology (Lupton and Turner 2018), perception of unnaturalness (Dupont and Fiebelkorn 2020; Siegrist, Sutterlin, and Hartmann 2018)

and high sensitivity to disgust (Siegrist et al. 2018; Verbeke, Sans, and Van Loo 2015). With the rapid advancement of technology, one can anticipate that soon, lab-grown meat will have the same quality and provide the same material or functional features as conventional animal meat. Thus, the *instrumental* concerns will decrease or even disappear. Against this backdrop, the present research focuses on consumers' *ideational* aversion to lab-grown meat and digs deeper into reasons why consumers display *ideational* resistance towards lab-grown meat. More specifically, we intend to answer the question: compared to lab-grown dairy products produced using similar technologies and through a similar process, why do consumers feel stronger disgust when imagining eating lab-grown meat? From a marketing perspective, we intend to shed light on: why do consumers have a lower intention to try, to pay for, and to purchase lab-grown meat?

To answer these questions, we propose a novel life-creation perception theory and apply it to form a systematic and nuanced understanding of consumer resistance to lab-grown meat. In particular, we show that: compared to lab-grown dairy products, consumers have more negative attitudes toward lab-grown meat, because they associate meat with life and producing lab-grown meat with artificially creating life and thereby violating the laws of nature to a greater degree. Moreover, the stronger resistance to lab-grown meat (vs. dairy products) is more prominent among more religious consumers because they tend to have a lower threshold to form a perception of creating life, and they are more protective of the laws of nature (Ho, Brossard, and Scheufele 2008; Liu and Priest 2009; Nisbet 2005). In other words, more religious consumers tend to associate producing lab-grown meat with creating

life artificially and violating the laws of nature to a greater degree. Along this line, we propose three theoretically relevant and practically implementable interventions that can enhance consumer acceptance of lab-grown meat by disassociating producing lab-grown meat from artificially creating life. Theoretically, this research contributes by providing a novel theory to explain consumers' *ideational* resistance to lab-grown meat and examining this theory in various contexts (i.e., comparing lab-grown food with both plant-based food and cloned animal food) and with different consumer segments (i.e., religious versus non-religious consumers). Managerially, this research helps marketers and policymakers to better understand why consumers are not acceptive of lab-grown meat that has many advantages over conventional animal meat and offers theory-based interventions for them to act upon to increase consumer acceptance of lab-grown meat.

Prior Consumer Research on Food Consumption and Technology

We situate our research on lab-grown meat in the historical context of food consumption and technology research. Throughout history, one of the greatest challenges in the food domain has been attaining safe and sufficient sources of food and preserving food for a longer period. Food technologies, such as food pasteurization, irradiation, and genetically modified food, were developed to address this challenge (Siegrist and Hartmann 2020). However, consumers' attitudes have been shown to be mostly negative toward these innovations, such as food irradiation (e.g., Finn and Louviere 1992; Zheng, Bolton, and Alba 2019) and genetically

modified food (e.g., Ellen and Bone 2008; Hingston and Noteworthy 2018; Kim, Kim and Arora 2022; Pham and Mandel 2019; Zheng et al. 2019).

Another challenge is promoting healthy food consumption, especially when food is readily available as it is for a large portion of the population in the US, Europe, and many parts of Asia. Humans instinctively prefer higher-calorie food and tend to eat more than needed (Griskevicius and Kenrick 2013), causing weight gain and other related health issues. Thus, consumer researchers have investigated topics about healthy food consumption, including the tradeoff between healthiness and tastiness (Mai and Hoffmann 2015; Raghunathan, Naylor, and Hoyer 2006; Sela, Berger, and Liu 2009), healthy eating habits (Khare and Inman 2006; Ma, Ailawadi, and Grewal 2013), food packaging and labeling (Deng and Srinivasan 2013; Irmak, Vallen, and Robinson 2011; Scott et al. 2008; Ye, Morrin, and Kampfer 2019), and social influence on healthy eating (Hasford, Kidwell, and Lopez-Kidwell 2018; Liu, McFerran, and Haws 2019; McFerran et al. 2010). However, little research has been done on how consumers react to food technology used to promote healthy eating, except for a few on how consumers utilize technologies to pursue health, fitness, or self-regulation goals in general (e.g., Etkin 2016; Hadi and Valenzuela 2020).

A relatively recent trend in the food consumption area is research on sustainable food consumption, such as reducing food waste (Block et al. 2016; de Visser-Amundson, Peloza, and Kleijnen 2021; Grewal et al. 2019; Mookerjee et al. 2021), choosing food with a lower carbon footprint (Groening, Inman, and Ross 2015; Panzone et al. 2020), and eating local food with lower transportation costs (Reich, Beck, and Price 2018). At the intersection of food technology and sustainable

food consumption, an emerging topic is examining how consumers react to alternative food enabled by innovative technologies, such as plant-based food (Florack et al. 2021) and lab-grown food (Zheng et al. 2019). To illustrate, plant-based food is made from plant ingredients, such as soybeans, lentils, grains, and peas. The production of plant-based food, mostly plant-based meat and plant-based dairy products, relies on innovative bioengineering technologies to mimic the texture and taste of conventional food. Though human beings have a long history of consuming plant-based protein-rich food, such as tofu and soymilk, the advanced technologies that enable plant-based food to taste very similar to animal-based food are relatively recent. Accordingly, brands in this arena are mostly innovative startups, such as Impossible Foods and Beyond Meat. On the other hand, lab-grown food is made from ingredients taken from animals (e.g., stem cells). Its production involves the application of cutting-edge cellular biotechnology, which allows it to approximate the taste of conventional animal food and to have almost identical biochemical components and nutritional value as conventional animal food (Post et al. 2020). In brief, though the ending products of plant-based food and lab-grown food are similar in terms of sensory characteristics, their ingredients and processes are distinct.

We apply the theoretical framework developed by Rozin and his coauthors to summarize extant findings on consumer attitude toward innovative alternative food (Rozin et al. 2004; Rozin 2005). Specifically, prior research suggests that consumers are hesitant to incorporate this tech-enabled alternative food into their daily diets due to both *instrumental* reasons about the material and functional product features (e.g., Gomez-Luciano et al. 2019; Siegrist et al. 2018; Wilks et al. 2019) and *ideational*

reasons about moral, aesthetic, and general psychological factors (e.g., Dupont and Fiebelkorn 2020; Siegrist et al. 2018; Verbeke et al. 2015). However, this stream of literature mostly relies on survey and focus group methods and thus lacks causal evidence. Moreover, when explaining consumers' *ideational* aversion, they concentrate on mental states, such as disgust and unnaturalness perceptions, which are proximal to behavioral outcomes (e.g., low willingness to purchase). But it has remained unclear why consumers form these mental states at the outset; for instance, why does lab-grown meat invoke a strong sense of disgust? Lastly, most of the prior research compares lab-grown meat with conventional animal meat, where *instrumental* reasons, such as taste and price, are dominant barriers to consumer adoption. Nevertheless, to our knowledge, no research has compared different types of lab-grown food produced using similar technologies. Therefore, it is unknown whether systematic differences exist within consumers' attitudes towards lab-grown meat versus other types of lab-grown food, and if this is the case, why this variation appears.

Our research fills these gaps by putting the spotlight on lab-grown meat, comparing it with lab-grown dairy products, and revealing a more fundamental and causal explanation – life-creation perception – for why consumers feel stronger disgust with lab-grown meat and have more negative attitudes towards it. In the next section, we first introduce the research background that we situate our research against, which is consumer resistance to food technology. We then clarify our rationale for the life-creation perception theory.

The Present Research

Consumer Resistance to Food Technology

Prior consumer research on food technology has compared natural food and unnatural food, and consumers have consistently shown a "natural-is-better" tendency (e.g., Rozin 2005; Siegrist and Hartmann 2020). That is, consumers seem to intuitively prefer natural food over unnatural food (i.e., food with additives and human intervention) (Rozin 2005). In addition, the inference of food naturalness is largely influenced by product labeling (Rozin et al. 2004). And both the FDA and the US Department of Agriculture (USDA) allow companies to use the word "natural" on food labeling as long as the product has no additives "that would not normally be expected to be in the food" (FDA 1993, p. 2407).

Rozin and his coauthors have established an influential theoretical framework to explain consumers' "natural-is-better" tendency (Rozin et al. 2004; Rozin 2005). According to this framework, the first explanation is *instrumental* reasons about the material and functional product features. For instance, prior research has indicated that consumers consider natural food to be tastier and healthier (Hingston and Noseworthy 2018; Rozin et al. 2004; Rozin 2005). The second explanation is *ideational* reasons about moral, aesthetic, or general psychological factors. Explanations that have been documented in prior literature in this vein include that natural food is less disgusting, "feels right," is "inherently" better, and even has "sacred value" (Askegaard et al. 2014; Li and Chapman 2012). Plenty of evidence has

supported the existence of these *ideational* reasons. For example, even though the transformed entity is identical to the original natural entity in material and functional features (e.g., one natural substance is added and then removed from the tomato), consumers still displayed an aversion to the transformed entity because of some unknown ideational aversion to the transformation process (Rozin 2006). However, the *ideational* explanation lacks clarity as it is unclear precisely what makes consumers feel that certain food is "right or wrong," why they consider one "inherently" better than the other, and why they find the transformation unacceptable.

Against this backdrop, we concentrate our investigation on explaining why consumers have stronger *ideational* resistance towards lab-grown meat than other types of lab-grown food, specifically lab-grown dairy products. We propose that lab-grown meat triggers a stronger perception of artificially creating life, and thus a stronger perception of violating the laws of nature.

Lab-Grown Meat and the Perception of Artificially Creating Life

We propose that consumers closely associate meat with life, and thus they associate producing lab-grown meat with artificially creating life. The question "What is life?" has led to long-lasting and intense debates across various disciplines, including anthropology, philosophy, biology, and psychology (Deplazes-Zemp 2012; Fernau, Braun, and Dabrock 2020; Koshland 2002). However, consumers have shown consistent patterns in how they perceive life. Prior research suggests that individuals' view of life depends on the number of life properties of an entity (Deplazes-Zemp

2012; Koshland 2002). Life properties refer to features that distinguish living organisms from non-living ones (Fernau et al. 2020), such as the ability to grow and reproduce as well as the complexity of biological structures. Importantly, the life properties, of which consumers have an intuitive understanding, tend to dominate their perceptions of life (Beisbart and Reuter 2021). Prior research has shown that consumers rate cells and tissue as the most essential characteristic of life (Beisbart and Reuter 2021). Based on this logic, because meat comes from animals' bodies, is technically animal flesh used for food (USDA 2019), and has a cellular and tissular structure, we argue that consumers associate meat with life and associate producing lab-grown meat with artificially creating life. In contrast, dairy products are animal by-products (not part of animals' bodies) and do not have a cellular and tissular structure. Indeed, the highest-level biological structure of dairy products is the molecular structure. Thus, we argue that consumers do not associate dairy products with life to the same degree and producing dairy products in the lab does not lead to such a strong perception of artificially creating life.

We also argue that a strong perception of creating life leads to a strong perception of violating the laws of nature. The laws of nature are defined as the universal principles governing the natural world (Swartz 2021). This definition assumes that humans believe that the natural world has rules, structures, and balance above and beyond human control (Swartz 2021), and that artificially creating life is controversial and goes against the laws of nature (Kass 1972). For instance, religious individuals may understand the laws of nature as the creation of God, so life-creating technologies, such as cloning, are widely criticized as "playing God" (e.g., Link

2013). Others may equate the laws of nature with Darwin's law of natural selection, which emphasizes the critical role of natural selection and reproduction (Reed 1981), so they may think that humans should not interrupt the equilibrium of nature by artificially creating life. Regardless of which perspective one takes— creationist or evolutionary—because of the stronger association between meat (vs. dairy products) and life, the creation of lab-grown meat (vs. dairy products) tends to be construed as artificially creating life and thereby violating the laws of nature to a greater degree.

In this light, we predict that consumers have more negative attitudes toward lab-grown meat than lab-grown dairy products. We further propose that this negative attitude manifests as stronger disgust because disgust is a common type of food rejection, and it is often invoked by moral or ideological reasons (Rozin and Fallon 1987). From a marketing standpoint, consumers' negative attitudes should lead to a lower willingness to try, to pay for, and to purchase lab-grown meat. Formally, we hypothesize:

H_1: Consumers have more negative attitudes and stronger disgust toward lab-grown meat than lab-grown dairy products.

H2: The effect in H_1 is serially mediated by the perception of creating life and the perception of violating the laws of nature.

Consumers' Religiosity as a Moderator

Religiosity refers to individuals' varying tendencies to commit themselves to religious beliefs, principles, and activities (Cutright 2012). Existing consumer and

marketing research suggests that religiosity has a critical impact on consumer behavior in many domains, such as preference for structure in product design (Cutright 2012), preference for brand leaders (Beck, Rahinel, and Bleier 2020), honesty (Mazar, Amir, and Ariely 2008), and sharing of negative word of mouth about companies (Casidy et al. 2021). Important takeaways from this stream of literature are that more religious consumers rely on religious beliefs to restore their sense of control and that they are more sensitive to the violations of moral or ideological rules (e.g., fairness rule; Casidy et al. 2021).

More related to our inquiry, prior research in public communication has implied that more religious individuals have a lower threshold to detect behaviors of artificially creating life and are more protective of the laws of nature (Ho et al. 2008; Liu and Priest 2009; Nisbet 2005). For example, for religious individuals, having more knowledge does not significantly enhance their support for stem cell research due to their ideological predispositions (Ho et al. 2008). Also, individuals who have more traditional religious beliefs are more likely to resist human embryo research for moral reasons than those who have a more open-ended approach to religion (Nielsen, Williams, and Randolph-Seng 2009). Along this line, we predict that consumers with stronger religiosity will have even more prominent resistance to lab-grown meat (vs. dairy products) because they are more sensitive to violations to the laws of nature, including artificially creating life. Formally, we hypothesize that:

> **H_3:** More religious consumers have stronger resistance to lab-grown meat (vs. dairy products) because of stronger perceptions of creating life and violating the laws of nature.

3 "D" Marketing Interventions

Based on the life-creation perception theory, we propose three marketing interventions that can enhance consumer acceptance of lab-grown meat by disassociating producing lab-grown meat from the perception of creating life artificially. We label these three interventions as "3D" interventions and explain the rationale for each of them as follows.

Disassociating Meat from the Animal Concept. As reasoned earlier, a major reason why consumers associate meat (vs. dairy products) with life to a greater degree is that meat is technically animals' body parts and has a cellular and tissular structure, whereas dairy products are animal by-products, and the highest biological structure of milk is the molecular structure. Therefore, if we can decrease the psychological association between meat and the animal, then presumably, consumers will think of artificially creating life less when facing lab-grown meat. Prior psychological research suggests that one of the effective ways to diminish the salience of a psychological association is to make another association more salient at the moment (Rothermund and Wentura 2004). Therefore, we propose that by associating meat with the ending food product (e.g., beef burger), the psychological association between meat and life (or the animal) will be reduced. In this case, producing lab-grown meat should be less associated with creating life. More specifically, we propose to apply this intervention to food packaging design – displaying a food product image, instead of an animal image, on product packaging. We empirically examine the effectiveness of this intervention in study 4.

Deconstructing the Concept of Meat into a Simpler Biological Structure. Biological organization is defined as the hierarchy of complex biological structures that compose life; Solomon, Berg, and Martin 2002). For example, the earliest life forms are microbes which are constituted by a single cell; by contrast, more advanced life forms, such as mammals, contain more complicated structures at varying biological organization levels: cell, tissue, organ, and system. Moreover, the complexity of biological structure influences the perception of life, and entities with more complicated biological structures are considered to be a higher-level form of life (Beisbart and Reuter 2021; Fernau et al. 2020). Therefore, we argue that by reforming consumers' cognition of meat, specifically deconstructing meat into components at a lower biological organization level, consumers will perceive meat to be less associated with life and become more accepting of lab-grown meat. We propose to apply this intervention to advertisement design. We empirically examine the effectiveness of this intervention in study 5.

Drawing an Analogy with Growing Plants from Plant Cuttings. The process of growing plant cuttings into plants is fundamentally similar to the process of producing lab-grown meat. Both involve growing a part of or the full life entity from more basic components. In the case of meat, animal stem cells grow into muscle tissues, whereas in the case of plants, plant cuttings grow into entire plants. However, these plants, by their nature, have a different way of reproduction – asexual reproduction – from mammals, meaning that they can naturally reproduce asexually through vegetive propagation, and this way of reproduction is considered normal for plants across history. In contrast, mammals cannot naturally reproduce asexually, so

although the process of producing lab-grown meat is fundamentally similar to the process of growing plant cuttings into plants, it is still regarded as unnormal and violative to the laws of nature. Therefore, we predict that by drawing an analogy (Zheng et al. 2019) between producing lab-grown meat and growing plants from plant cuttings (GFI 2019), consumers will be reminded of their similarity, and their high acceptance of the latter will carry over to lead to more positive attitudes toward the former. We empirically examine the effectiveness of this intervention in study 6.

Empirical Overview

We examined our hypotheses across six main studies (with two supplemental studies reported in Appendix B). Study 1 compares meat and dairy products across two types of alternative food technology – both lab-grown and plant-based food – and demonstrates that consumers have more negative attitudes toward lab-grown meat than lab-grown dairy products (H_1), and importantly, this effect occur only for the lab-grown technology but not any other innovative alternative food technology (i.e., plant-based food). Two supplemental studies reported in Appendix B expand this demonstration to another form of meat – seafood – and support the mediation role of perceptions of creating life and violating the laws of nature (H_2). Study 2 further compares lab-grown food with another life-creating technology – cloned animal food and finds that consumers react to lab-grown meat and cloned animal meat similarly negatively but more negatively than conventional meat. This result provides further evidence for our life-creation perception theory. Study 3 then demonstrates the

moderation of religiosity and rules out product labeling as an alternative explanation. Finally, studies 4-6 examine the effectiveness of the "3D" interventions and the underlying role of perceptions of creating life and violating the laws of nature.

Study 1: Meat vs. Dairy Products in Lab-Grown and Plant-Based Sectors

In study 1, we examine whether consumers have more negative attitudes toward lab-grown meat than toward lab-grown dairy products. We also compare lab-grown food with another type of innovative alternative food: plant-based food. Plant-based food is made from plant ingredients and emphasizes similar benefits to those of lab-grown food, such as reducing carbon emissions and animal cruelty. We predict that because the production of plant-based meat (as well as plant-based dairy products) uses plant ingredients that come from the natural environment, it should trigger a weaker perception of creating life, and therefore consumers should react to plant-based meat more positively compared to lab-grown meat. To control for the effect that consumers might differ in their general attitudes towards meat and dairy products as two product categories, we also include the comparison of conventional meat and conventional dairy products and do not expect consumers to react to them differently.

Method

Study 1 had a 3 (production method: lab-grown vs. plant-based vs. conventional) x 2 (product category: meat vs. dairy products) between-subjects

design. Participants (N = 604, M_{age} = 28.74, 34% male, Prolific) in either the lab-grown or the plant-based condition first read an introduction about food produced using their assigned production method. In the lab-grown condition, we described that "lab-grown meat…grows from muscle stem cells in a biolaboratory setting without the involvement of animals…dairy products…can also be created in the lab using bioengineering technologies without the involvement of animals. All lab-grown food has the same biological structures and chemical compositions as conventional food derived from animals. The only difference is that the creation of lab-grown food does not involve the process of animals' participation." In the plant-based condition, we introduced that "plant-based meat is made predominantly with extracts from plants (e.g., peas, soybeans, and wheat) and processed using genetic engineering technologies without the involvement of animals…plant-based dairy products…are produced from plants using innovative enzyme technologies. All plant-based food mimics the taste and texture of conventional food derived from animals. The biggest difference is that the creation of plant-based food does not involve the process of animals' participation." Appendix A reports the full stimuli. Participants in the conventional condition did not read an introduction.

Then, we measured participants' willingness to purchase either meat or dairy products produced using the assigned method (e.g., "How likely are you to cook your meals using *the product*[4] as an ingredient?") and their disgust when imagining eating food made from the same food product (e.g., "When imagining eating food made with

[4] The wording "the product" in the items was replaced with the specific category depending on the assigned condition, such as "lab-grown meat."

the product, to what extent do you feel disgusted?") on 7-point scales. The measures were contextualized and reported in detail in Appendix A. Finally, participants completed measures of alternative explanations, including perceptions of technical difficulty, tastiness, nutritiousness, healthiness, and safety of the assigned product (see Appendix A).

Results

As shown in figure 8, we found a significant interaction effect of the production method and product category on consumers' willingness to purchase ($F(1, 598) = 3.56$, $p = .029$, $\eta_p^2 = .012$). Specifically, for lab-grown food, consistent with our prediction, consumers had a significantly lower willingness to purchase lab-grown meat than lab-grown dairy products (M_{meat} vs. M_{dairy} = 3.44 vs. 3.93, SD_{meat} = 1.73, SD_{dairy} = 1.80, $F(1, 598) = 4.55$, $p = .033$, $\eta_p^2 = .008$). However, this effect was non-significant for either plant-based food (M_{meat} vs. M_{dairy} = 4.12 vs. 3.97, SD_{meat} = 1.67, SD_{dairy} = 1.58, $F(1, 598) = .374$, $p = .541$, $\eta_p^2 = .001$) or conventional food (M = 5.72 vs. 5.38, SD_{meat} =1.61, SD_{dairy} = 1.38, $F(1, 598) = 2.19$, $p = .139$, $\eta_p^2 = .004$). Moreover, consumers had a significantly lower willingness to purchase lab-grown meat than plant-based meat and conventional meat ($M_{lab\text{-}grown}$ vs. $M_{plant\text{-}based}$ = 3.44 vs. 4.12, $SD_{lab\text{-}grown}$ = 1.73, $SD_{plant\text{-}based}$ = 1.67, t (598) = -2.92, $p = .004$, *Cohen's d* = -.397; $M_{lab\text{-}grown}$ vs. $M_{conventional}$ = 3.44 vs. 5.72, $SD_{lab\text{-}grown}$ = 1.73, $SD_{conventional}$ = 1.61, $t(598) = -9.96$, $p < .001$, *Cohen's d* = -1.361). Also, they had a significantly lower willingness to purchase plant-based meat than conventional meat ($M_{plant\text{-}based}$ vs.

$M_{conventional}$ = 4.12 vs. 5.72, $SD_{plant\text{-}based}$ = 1.67, $SD_{conventional}$ = 1.61, t (598) = -6.93, p < .001, *Cohen's d* = -.975). Finally, consumers had a significantly lower willingness to purchase lab-grown dairy products and plant-based dairy products than conventional dairy products ($M_{lab\text{-}grown}$ vs. $M_{conventional}$ = 3.93 vs. 5.38, $SD_{lab\text{-}grown}$ = 1.80, $SD_{conventional}$ = 1.38, t(598) = -6.28, p < .001, *Cohen's d* = -.900; $M_{plant\text{-}based}$ vs. $M_{conventional}$ = 3.97 vs. 5.38, $SD_{plant\text{-}based}$ = 1.58, $SD_{conventional}$ = 1.38, t(598) = -6.07, p < .001, *Cohen's d* = -.945), but their willingness to purchase lab-grown dairy products and plant-based dairy products did not significantly differ ($M_{lab\text{-}grown}$ vs. $M_{plant\text{-}based}$ = 3.93 vs. 3.97, $SD_{lab\text{-}grown}$ = 1.80, $SD_{plant\text{-}based}$ = 1.58, t(598) = .183, p = .855, *Cohen's d* = .025).

Our interpretations of the results include two layers. First, consumers like conventional products more than innovative products, and for this reason, they react to lab-grown food and plant-based food more negatively than conventional food. Second, lab-grown meat triggers stronger perceptions of creating life and violating the laws of nature than both lab-grown dairy products and plant-based food, and as a result, consumers react to lab-grown meat more negatively than either lab-grown dairy products or plant-based meat. In the supplemental study A, we test and support the underlying role of perceptions of creating life and violating the laws of nature.

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INSERT FIGURE 8 HERE

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For disgust, we found consistent patterns (see figure 9): a significant interaction effect of the production method and product category appeared (F(1, 598) = 3.97, p = .019, η_p^2 = .013). Specifically, for lab-grown food, consumers had significantly stronger disgust toward the meat (vs. dairy products) (M_{meat} vs. M_{dairy} = 2.94 vs. 2.37, SD_{meat} = 1.77, SD_{dairy} = 1.62, F(1, 598) = 7.58, p = .006, η_p^2 = .013). However, this effect was not present for either plant-based food (M_{meat} vs. M_{dairy} = 1.83 vs. 2.07, SD_{meat} = 1.34, SD_{dairy} = 1.38, F(1, 598) = 1.29, p = .258, η_p^2 = .002) or conventional food (M_{meat} vs. M_{dairy} = 1.78 vs. 1.44, SD_{meat} = 1.53, SD_{dairy} = 1.07, F(1, 598) = 2.69, p = .101, η_p^2 = .004). Moreover, consumers had significantly stronger disgust for lab-grown meat than for plant-based meat and conventional meat ($M_{lab\text{-}grown}$ vs. $M_{plant\text{-}based}$ = 2.94 vs. 1.83, $SD_{lab\text{-}grown}$ = 1.77, $SD_{plant\text{-}based}$ = 1.34, t (598) = 5.33, p < .001, *Cohen's d* = .704; $M_{lab\text{-}grown}$ vs. $M_{conventional}$ = 2.94 vs. 1.78, $SD_{lab\text{-}grown}$ = 1.77, $SD_{conventional}$ = 1.53, t(598) = .26, p = .798, *Cohen's d* = .037). However, their disgust level was similarly high with both plant-based meat and conventional meat ($M_{plant\text{-}based}$ vs. $M_{conventional}$ = 1.83 vs. 1.78, $SD_{plant\text{-}based}$ = 1.34, $SD_{conventional}$ = 1.53, t(598) = 5.66, p < .001, *Cohen's d* = .703). Finally, their disgust was higher with lab-grown dairy products and plant-based dairy products than conventional dairy products ($M_{lab\text{-}grown}$ vs. $M_{conventional}$ = 2.37 vs. 1.44, $SD_{lab\text{-}grown}$ = 1.62, $SD_{conventional}$ = 1.07, t(598) = -4.50, p < .001, *Cohen's d* = -.677; $M_{plant\text{-}based}$ vs. $M_{conventional}$ = 2.07 vs. 1.44, $SD_{plant\text{-}based}$ = 1.38, $SD_{conventional}$ = 1.07, t(598) = -3.02, p = .003, *Cohen's d* = -.511), but their disgust with lab-grown dairy products and plant-based dairy products did not significantly differ ($M_{lab\text{-}grown}$ vs. $M_{plant\text{-}based}$ = 2.37 vs. 2.07, $SD_{lab\text{-}grown}$ = 1.62, $SD_{plant\text{-}based}$ = 1.38, t(598) = 1.45, p = .146, *Cohen's d* = .201).

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INSERT FIGURE 9 HERE

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Notably, we ruled out alternative explanations, including perceptions of technical difficulty, tastiness, nutritiousness, healthiness, and safety, because none of their patterns could explain the patterns of our focal effects. We reported full details in Appendix A.

Discussion

The results of study 1 highlight the unique nature of consumer resistance to lab-grown meat. First, consumers react to lab-grown meat more positively than lab-grown dairy products (H_1). Second, consumers dislike meat made from cells and tissue but not meat made from plants, which are life in the natural environment. We infer that this is because lab-grown meat leads to a stronger perception of creating life than either lab-grown dairy products or plant-based meat. To support this inference, we conduct a supplemental study A (reported in Appendix B). In short, the supplemental study A examines the serial mediation of the perception of creating life and the perception of violating the laws of nature. The results demonstrate that this serial mediation is the underlying process of the effects that we observed in study 1.

Furthermore, a supplemental study B introduces the comparison with lab-grown seafood. Specifically, this study demonstrates that consumers react to lab-grown seafood similarly to lab-grown meat, and their reaction to lab-grown seafood is

again more negative than their reaction to lab-grown dairy products. We reason that this is because seafood is the flesh of (marine) animals used for food, making it technically meat; as a result, lab-grown seafood evokes the perception of creating life to the same degree as lab-grown meat.

Study 2: Lab-Grown Food versus Cloned Animal Food

To further support our life-creation theory, we introduce a comparison with another life-creating food technology: cloned animal food. Cloned animal food comes from cloned livestock, which are genetically identical copies of the original animal (FDA 2021). In 2008, cloned animal food was officially approved by the FDA (FDA 2021). We demonstrate in a pretest (see Appendix C) that cloned animal food, regardless of the category (i.e., meat or dairy products), triggers stronger perceptions of creating life and violating the laws of nature than lab-grown food. Indeed, unlike the production of lab-grown meat that only creates animal muscle tissue, the production of cloned animal food involves the creation of an entire cloned animal. Given this, we predict that consumers will have stronger perceptions of creating life and violating the laws of nature with cloned animal food and thus have more negative attitudes toward it than lab-grown food. Moreover, their attitudes toward cloned animal meat and cloned animal dairy products should not differ that much because both come from artificially created animals and should invoke similar levels of perceptions of creating life and violating the laws of nature. Finally, this comparison helps rule out alternative explanations related to the quality of food products (e.g.,

taste, nutrition) because, presumably, cloned animal food should have the same quality as conventional animal food.

Method

Study 2 had a 3 (production method: lab-grown vs. cloned animal vs. conventional) x 2 (product category: meat vs. dairy products) between-subjects design. We only recruited consumers who eat meat to control for the effect of dietary habits on attitudes toward meat products. Similar to study 1, participants (N = 566, M_{age} = 41.14, 48.2% male, MTurk) first read an introduction about food produced using their assigned production method. In the lab-grown condition, participant read the same introduction as in study 1 (see Appendix A). In the cloned animal condition, participants read that "cloned animal meat is harvested from cloned animals, animals created by copying the genetic traits of natural-born animals in a biolaboratory setting without the reproduction of natural-born animals…dairy products…can also be produced by cloned animals without the involvement of natural-born animals. All cloned animal food has the same biological structures and chemical compositions as conventional food derived from natural-born animals. The only difference is that the creation of cloned animal food does not involve the process of natural-born animals' participation." Appendix C reports the full stimuli. Participants in the conventional condition did not read an introduction.

Then, participants answered measures about their willingness to try this food, either meat or dairy products, depending on the condition that they were randomly assigned to (e.g., "Suppose you were at a restaurant, and their menu listed a

recommended new dish made with lab-grown meat/dairy products. How likely would you be to try it?"; see Appendix C for full measures). Next, participants completed measures of alternative explanations, including their knowledge of and familiarity with the food technology, and we found that controlling for these alternative explanations did not change the patterns of our focal effects (see Appendix C).

Results and Discussion

We found a significant interaction between the production method and product category ($F(1, 560) = 3.63$, $p = .027$, $\eta_p^2 = .013$; see figure 10). For lab-grown food, consumers had a significantly lower willingness to try food made with lab-grown meat (vs. dairy products) (M_{meat} vs. $M_{dairy} = 3.70$ vs. 4.26, $SD_{meat} = 2.05$, $SD_{dairy} = 1.64$, $F(1, 560) = 5.40$, $p = .020$, $\eta_p^2 = .010$). However, this effect was non-significant for cloned animal food (M_{meat} vs. $M_{dairy} = 3.17$ vs. 3.07, $SD_{meat} = 1.89$, $SD_{dairy} = 1.91$, $F(1, 560) = .177$, $p = .674$, $\eta_p^2 < .001$) and conventional food (M_{meat} vs. $M_{dairy} = 5.86$ vs. 5.54, $SD_{meat} = 1.15$, $SD_{dairy} = 1.01$, $F(1, 560) = 1.78$, $p = .183$, $\eta_p^2 = .003$). We infer that this is because lab-grown meat (vs. dairy products) triggers stronger perceptions of creating life and violating the laws of nature; whereas both cloned animal meat and cloned animal dairy products trigger very strong perceptions of creating life and violating the laws of nature, and both conventional meat and conventional dairy products trigger weak perceptions of creating life and violating the laws of nature. Our inference was confirmed by a pretest reported in Appendix C.

Moreover, consumers had a significantly lower willingness to try food made with cloned animal meat than food made with lab-grown meat or conventional meat ($M_{cloned\ animal}$ vs. $M_{lab\text{-}grown}$ = 3.17 vs. 3.70, $SD_{cloned\ animal}$ = 1.89, $SD_{lab\text{-}grown}$ = 2.05, t (560) = -2.15, p = .032, *Cohen's d* = -.264; $M_{cloned\ animal}$ vs. $M_{conventional}$ = 3.17 vs. 5.86, $SD_{cloned\ animal}$ = 1.89, $SD_{conventional}$ = 1.15, t(560) = -11.16, p < .001, *Cohen's d* = -1.725). They also had a significantly lower willingness to try food made with lab-grown meat than food made with conventional meat ($M_{lab\text{-}grown}$ vs. $M_{conventional}$ = 3.70 vs. 5.86, $SD_{lab\text{-}grown}$ = 2.05, $SD_{conventional}$ = 1.15, t(560) = -9.05, p < .001, *Cohen's d* = -1.307). In addition, as for dairy products, consumers had a significantly lower willingness to try food made with cloned animal dairy products than food made with lab-grown dairy products or conventional dairy products ($M_{cloned\ animal}$ vs. $M_{lab\text{-}grown}$ = 3.07 vs. 4.26, $SD_{cloned\ animal}$ = 1.91, $SD_{lab\text{-}grown}$ = 1.64, t (560) = -4.90, p < .001, *Cohen's d* = -.664; $M_{cloned\ animal}$ vs. $M_{conventional}$ = 3.07 vs. 5.54, $SD_{cloned\ animal}$ = 1.91, $SD_{conventional}$ = 1.01, t(560) = -10.27, p < .001, *Cohen's d* = -1.621). Similarly, consumers had a significantly lower willingness to try food made with lab-grown dairy products than food made with conventional dairy products ($M_{lab\text{-}grown}$ vs. $M_{conventional}$ = 4.26 vs. 5.54, $SD_{lab\text{-}grown}$ = 1.64, $SD_{conventional}$ = 1.01, t(560) = -5.36, p < .001, *Cohen's d* = -.944).

These findings confirmed that consumers dislike innovative food with a strong perception of creating life (i.e., cloned animal food in general and lab-grown meat specifically) even when the food has almost identical quality as the conventional food. These findings further supported the life-creation perception theory as an explanation for consumers' *ideational* resistance to lab-grown meat (H_2).

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Study 3: Moderation Effect of Religiosity

In study 3, we examine the moderation effect of an individual trait factor: religiosity (H_3). Religiosity is defined as individuals' tendency to be committed to their religious beliefs, principles, and activities (Cutright 2012). As reasoned earlier, we predict that more religious consumers will have more negative attitudes toward lab-grown meat but not necessarily toward lab-grown dairy products because they are more aversive to life-creating technologies and more protective of the laws of nature. In addition, we investigate the effect of product labeling by comparing the "lab-grown meat" label with another popular label for the same product: "cultured meat." In so doing, we rule out the alternative explanation that it is the word "lab-grown" that triggers a stronger perception of artificially creating life and leads to more negative consumer attitudes toward lab-grown meat in our earlier studies.

Method

Study 3 adopted a 2 (product category: meat vs. dairy) x 2 (labeling: lab-grown vs. cultured) between-subjects design and included religiosity as an individual factor. As in study 1, participants ($N = 596$, $M_{age} = 41.52$, 42.0% male, Prolific) first

read the same introduction about lab-grown food as in study 1 (see Appendix A), but the labeling was either "lab-grown" or "cultured."

Then, participants were randomly assigned to either the meat or dairy products condition and completed measures about their willingness to purchase the assigned product in the long term (as in study 1; see Appendix A), their perception of creating life (as in study A; a sample item was "the production of the product reminds you of the process of creating life;" see Appendix B), and their perception of violating the laws of nature in random order (as in study A; a sample item was "to what extent do you think this production goes against the laws of nature?" see Appendix B). Finally, they answered individual measures, including their religiosity (adopted from Cutright 2012; see Appendix D).

Results and Discussion

First, a 2 (product category) x 2 (labeling) fixed effect ANOVA on participants' willingness to purchase showed a non-significant interaction ($F(1, 592) = .09$, $p = .759$, $\eta_p^2 < .001$), suggesting that even with the "cultured" labeling, consumers still reacted more negatively to lab-grown meat than lab-grown dairy products. Thus, we collapsed the labeling factor and focused on the effect of product category.

We then examined the interaction effect of product category and religiosity. We found a significant main effect of the product category ($F(1, 592) = 7.61$, $p = .006$, $\eta_p^2 = .013$), confirming our earlier finding that consumers had more negative

attitudes toward lab-grown meat (vs. dairy products) (M_{meat} vs. M_{dairy} = 3.35 vs. 3.74, SD_{meat} = 1.70, SD_{dairy} = 1.74, $F(1, 592) = 7.61$, $p = .006$, $\eta_p^2 = .013$). In addition, we found that the moderation of religiosity was significant (F (1, 592) = 8.21, p = .004, *95%CI* = [-.333, -.062]). This finding suggests that more religious consumers have a significantly lower willingness to purchase lab-grown meat relative to lab-grown dairy products. An additional Johnson-Neyman analysis showed that starting from "religiosity = 2.3," consumers had a significantly lower willingness to purchase lab-grown meat than lab-grown dairy products (see figure 11).

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INSERT FIGURE 11 HERE

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Finally, we applied Process Model 85 (Hayes 2013) to test the moderated serial mediation model (see Appendix D for the model illustration). The moderated serial mediation model was significant (B = -.03, SE = .01, *95%CI* = [-.059, -.009]), suggesting that more religious consumers have a significantly lower willingness to purchase lab-grown meat relative to lab-grown dairy products due to a stronger perception of creating life and a stronger perception of violating the laws of nature.

Study 4: Disassociating Meat from the Animal Concept

In study 4, we examine the effectiveness of the first marketing intervention: disassociating meat from the animal concept. We apply this intervention to the context of product packaging. Notably, animal figures are widely used on the packaging of lab-grown meat (see Appendix E for examples). However, we predict that by showing the image of the food product (e.g., beef burger), rather than the animal figure (e.g., cow), consumers will be less likely to associate the product with the animal (life), and their attitudes towards lab-grown meat will improve. We test this prediction in study 4.

Method

Study 4 had a three-cell (packaging: food product vs. animal vs. control) between-subjects design. We only recruited meat eaters to participate. First, participants (N = 395, M_{age} = 41.32, 50.1% male, MTurk) read an introduction about lab-grown food as in study 1 (see Appendix A). Then, we told them that we were interested in their willingness to purchase lab-grown beef patties and showed them the packaging of the beef patty. In the food product (animal) condition, they saw a burger print (cow print) on the package (see Appendix E). In the control condition, we showed them the same package without any print.

We then measured their willingness to purchase the beef patty (e.g., "If you are in a grocery store to buy beef patties and see this lab-grown beef patty, to what extent are you willing to purchase the lab-grown beef patty?" see Appendix E). We also measured their evaluations of the packaging (e.g., aesthetical appeal,

informativeness) and found that these evaluations could not alternatively explain our focal effect (see Appendix E for details).

Results and Discussion

We found a significant main effect of packaging ($F(2, 392) = 5.47$, $p = .005$, $\eta_p^2 = .027$). Consumers had a significantly stronger willingness to purchase lab-grown meat in the food product condition than in the animal condition ($M_{food\ product}$ vs. M_{animal}= 4.31 vs. 3.68, $SD_{food\ product} = 1.73$, $SD_{animal} = 1.63$, $t(392) = 2.978$, $p = .003$, *Cohen's d* = .368) and in the control condition ($M_{food\ product}$ vs. $M_{control}$ = 4.31 vs. 3.73, $SD_{food\ product} = 1.73$, $SD_{control} = 1.72$, $t(392) = 2.744$, $p = .006$, *Cohen's d = .338*). However, consumers across the animal and the control conditions did not significantly differ in their willingness to purchase lab-grown meat (M_{animal} vs. $M_{control}$ = 3.68 vs. 3.73, $SD_{animal} = 1.63$, $SD_{control} = 1.72$, $t(392) = .240$, $p = .810$, *Cohen's d* =.030). These results suggest that disassociating meat from the animal concept is an effective way to improve consumer attitudes toward lab-grown meat.

Study 5: Deconstructing the Concept of Meat into a Simpler Biological Structure

In study 5, we examine the effectiveness of another proposed marketing intervention: deconstructing the concept of meat into a simpler biological structure. We apply this intervention to the advertisement design context. We predict that if we deconstruct the concept of meat into molecular components (i.e., water, protein, and

fat; Solomon et al. 2002) in advertisements, consumers will associate meat less closely with life and have more positive attitudes toward lab-grown meat. We test this prediction in study 5.

Method

This study had a three-cell (deconstruction ad vs. control ad vs. no ad) between-subjects design. First, participants (N = 606, M_{age} = 32.75, 47% male, MTurk) read the same introduction about lab-grown food as in study 1 (see Appendix A). In the two ad conditions, participants viewed visuals ostensibly of a marketing campaign launched by an innovative food. In the deconstruction ad condition, the visuals included deconstruction information (e.g., "Meat is simply protein, water, and fat"). In contrast, no such information was included in the control ad condition. Appendix F reports the full stimuli. In the no ad condition, participants did not view any visuals. Next, participants answered measures about their perception of creating life (as in study A; see Appendix B), perception of violating the laws of nature (as in study A; see Appendix B), and attitudes towards lab-grown meat: extremely unfavorable/favorable, extremely negative/positive, and extremely unappealing/appealing on 0-100 slider bars. We also measured their evaluations of the ad and found that the ad evaluations could not explain our focal effect (see Appendix F for the measures and results).

Results and Discussion

We found a significant main effect of the ad on consumers' attitudes ($F(2, 603) = 10.26$, $p < .001$, $\eta_p^2 = .033$). Consumers had significantly more positive attitudes toward lab-grown meat in the deconstruction ad condition than the control ad condition ($M_{deconstruction}$ vs. $M_{control}$ = 60.24 vs. 54.13, $SD_{deconstruction}$ = 24.97, $SD_{control}$ = 29.58, $t(603) = 2.10$, $p = .036$, *Cohen's d* = .209) and the no ad condition ($M_{deconstruction}$ vs. $M_{no\text{-}ad}$ = 60.24 vs. 47.16, $SD_{deconstruction}$ = 24.97, $SD_{no\text{-}ad}$ = 32.48, $t(603) = 4.53$, $p < .001$, *Cohen's d* = .448). In addition, consumers' attitudes were significantly more positive in the control ad condition than in the no ad condition ($M_{control}$ vs. $M_{no\text{-}ad}$ = 54.13 vs. 47.16, $SD_{control}$ = 29.58, $SD_{no\text{-}ad}$ = 32.48, $t(603) = 2.39$, $p = .017$, *Cohen's d* = .239).

Furthermore, we found similar patterns for the perception of creating life and the perception of violating the laws of nature. A fixed effect ANOVA revealed a significant main effect of ad type on the perception of creating life ($F(2, 603) = 4.42$, $p = .012$, $\eta_p^2 = .014$). Consumers indicated a significantly lower perception of creating life in the deconstruction ad condition than in the control ad condition ($M_{deconstruction}$ vs. $M_{control}$ = 2.99 vs. 3.46, $SD_{deconstruction}$ = 1.51, $SD_{control}$ = 1.66, $t(603) = -2.90$, $p = .004$, *Cohen's d* = -.289) and than in the no ad condition ($M_{deconstruction}$ vs. $M_{no\text{-}ad}$ = 2.99 vs. 3.31, $SD_{deconstruction}$ = 1.51, $SD_{no\text{-}ad}$ = 1.70, $t(603) = -2.02$, $p = .044$, *Cohen's d* = -.200). But consumers' perceptions of creating life were similarly high in the control ad condition and in the no ad condition ($M_{control}$ vs. $M_{no\text{-}ad}$ = 3.46 vs. 3.31, $SD_{control}$ = 1.66, $SD_{no\text{-}ad}$ = 1.70, $t(603) = .89$, $p = .374$, *Cohen's d* = .089).

In addition, a fixed effect ANOVA showed a significant main effect of ad type on the perception of violating the laws of nature ($F(2, 603) = 4.48$, $p = .012$, $\eta_p^2 = .015$). Consumers indicated a significantly lower perception of violating the laws of nature in the deconstruction ad condition than the control ad condition ($M_{deconstruction}$ vs. $M_{control} = 3.11$ vs. 3.59, $SD_{deconstruction} = 1.72$, $SD_{control} = 1.92$, $t(603) = -2.54$, $p = .011$, *Cohen's d* = -.254) and than the no ad condition ($M_{deconstruction}$ vs. $M_{no\text{-}ad} = 3.11$ vs. 3.60, $SD_{deconstruction} = 1.72$, $SD_{no\text{-}ad} = 1.99$, $t(603) = -2.64$, $p = .009$, *Cohen's d* = -.261). But consumers' perceptions of violating the laws of nature were equally high in the control ad condition and the no ad condition ($M_{control}$ vs. $M_{no\text{-}ad} = 3.59$ vs. 3.60, $SD_{control} = 1.92$, $SD_{no\text{-}ad} = 1.99$, $t(603) = -.07$, $p = .942$, *Cohen's d* = -.007).

More importantly, the focal main effect on consumer attitude was significantly serially mediated by these two factors. We utilized Process Model 6 to examine the causal chain "deconstruction ad/control ad/no ad → perception of creating life → perception of violating the laws of nature → attitude." We found that: (i) the serial mediation underlying the contrast between the deconstruction ad and the control ad conditions was significant (*B* = -.04, *SE* = .02, *95%CI* = [-.078, -.012]); (ii) the serial mediation underlying the contrast between the deconstruction ad and the no ad conditions was significant (*B* = -.03, *SE* = .02, *95%CI* = [-.062, -.001]); however, (iii) the serial mediation underlying the contrast between the control ad and the no ad conditions was non-significant (*B* = -.01, *SE* = .02, *95%CI* = [-.044, .017]).

Together, these results suggest that the deconstruction (vs. control) marketing messages improve consumer attitudes towards lab-grown meat more effectively

because they decrease consumer perceptions of creating life and violating the laws of nature to a greater degree.

Study 6: Drawing an Analogy with Growing Plants from Plant Cuttings

In study 6, we examine the effectiveness of the last proposed marketing intervention: drawing an analogy with growing plants from plant cuttings. We predict that by doing so, consumers' perceptions of creating life and violating the laws of nature caused by lab-grown meat will decrease and their attitudes toward lab-grown meat will be improved. The effectiveness of this intervention has been initially supported in research by the Good Food Institute (GFI 2019), so our focus is to demonstrate that the life-creation perception theory is the underlying process.

Method

The study had a two-cell (analogy vs. control) between-subjects design. First, participants (N = 205, M_{age} = 40.18, 47% male, MTurk) read an introduction about lab-grown food as in earlier studies (see Appendix A). Then, in the analogy condition, participants read an analogy ostensibly from a food innovation company to enhance consumers' understanding of lab-grown meat: "*The process of cultivating lab-grown meat is similar to growing plant cuttings into vegetables and fruits in a greenhouse. We provide a nutrient-rich environment and let nature do the job*." In the control condition, participants did not read such information.

Next, participants completed a series of measures about lab-grown meat, including willingness to purchase (e.g., "How likely are you to purchase lab-grown meat regularly?" see Appendix G), attitudes (as in study 5), and perceptions of creating life (as in study A; see Appendix B) and violating the laws of nature (as in study A; see Appendix B).

Results and Discussion

Consumers in the analogy (vs. control) condition had a significantly higher willingness to purchase lab-grown meat ($M_{analogy}$ vs. $M_{control}$ = 3.76 vs. 3.15, $SD_{analogy}$ = 1.71, $SD_{control}$ = 1.93, $F(1, 203) = 5.55$, $p = .019$, $\eta_p^2 = .027$). Similar effects were shown with consumer attitudes ($M_{analogy}$ vs. $M_{control}$ = 56.81 vs. 45.16, $SD_{analogy}$ = 28.73, $SD_{control}$ = 33.68, $F(1, 203) = 6.90$, $p = .009$, $\eta_p^2 = .033$), perception of creating life ($M_{analogy}$ vs. $M_{control}$ = 4.50 vs. 5.08, $SD_{analogy}$ = 1.66, $SD_{control}$ = 1.81, $F(1, 203)$ = 5.54, $p = .020$, $\eta_p^2 = .027$), and perception of violating the laws of nature ($M_{analogy}$ vs. $M_{control}$ = 3.22 vs. 4.06, $SD_{analogy}$ = 1.81, $SD_{control}$ = 2.09, $F(1, 203) = 9.30$, $p = .003$, η_p^2 = .044). Importantly, the main effects on consumer willingness to purchase and attitude were serially mediated by the perceptions of creating life perception and violating the laws of nature (WTP: $B = .03$, $SE = .02$, $95\%CI$ = [.001, .069]; attitude: $B = .03$, $SE = .02$, $95\%CI$ = [.001, .075]).

These results confirmed our prediction that drawing an analogy between producing lab-grown meat and growing plants from plant cuttings can effectively

improve consumer acceptance of lab-grown meat by making this process less associated with artificially creating life and violating the laws of nature.

General Discussion

Across six studies, we found evidence that consumers have more negative attitudes toward lab-grown meat than toward lab-grown dairy products due to a stronger perception of creating life and a stronger perception of violating the laws of nature. This effect is not canceled out by adopting a seemingly more appealing label (e.g., cultured meat) and is even more prominent among more religious consumers. Further, we ruled out alternative explanations including taste, nutrition, safety, healthiness, safety, and technical difficulty. Lastly, we demonstrated the effectiveness of the "3D" marketing interventions. These interventions function due to their decreasing effect on the psychological association between producing lab-grown meat and artificially creating life.

Theoretical and Practical Implications

This research contributes to the food consumption and technology literature. Our primary contribution lies in demonstrating a novel theory to explain consumers' *ideational* resistance to lab-grown meat. Although prior literature in food consumption and agriculture has explored how consumers react to lab-grown meat

compared to conventional meat and why consumers dislike lab-grown meat (Siddiqui et al. 2022), most of them apply survey and focus group methods and thus lack causal evidence, and none of them has compared lab-grown food across different product categories or explained why, more fundamentally, consumers display a stronger *ideational* aversion to lab-grown meat. Therefore, our research fills these gaps by applying an experimental approach to identify causal effects, comparing lab-grown meat with lab-grown dairy products, and demonstrating a novel mechanism underlying consumers' *ideational* resistance to lab-grown meat – perceptions of creating life and violating the laws of nature. Moreover, by expanding the investigation to other innovative food production methods (plant-based food and cloned animal food) and varying groups of consumers (religious and non-religious consumers), we improve the generalizability of our life-creation perception theory.

More broadly, our research speaks to the emerging topic in food consumption area – decreasing the environmental impact of food consumption and reducing the tension between human eating and environmental protection. To summarize, we provide a historical framework of research on food consumption and technology in Appendix H. In the present research, we show that to encourage consumers to consume food in a sustainable approach, not only their *instrumental* concerns about material and functional product features need to be taken care of, but their fundamental *ideational* barriers also need to be alleviated. In regard to lab-grown meat, we offer three actionable and effective interventions for marketers: displaying food product (rather than animal) images on product packaging, deconstructing the concept of meat into simpler biological components (i.e., water, protein, and fat) in

advertisements, and drawing an analogy with growing plants from plant cuttings in marketing communication.

Future Directions

Consumers with Different Dietary Habits. Food consumption is largely considered habitual behavior (Khare and Inman 2006), and consumers have a variety of dietary habits, such as vegetarian and non-vegetarian. Future research can explore how dietary habits influence consumer reactions to lab-grown meat. We reason that the impact of dietary habits depends on how these habits were formed and what values and motives are behind them. We predict that compared to non-vegetarians, vegetarians may have more positive attitudes toward lab-grown food in general. Many vegetarians choose not to eat animal meat because they care about animal welfare and environmental protection, and therefore they may value the benefits of lab-grown food. We believe that related research questions are worth future inquiry not only due to their theoretical importance but also due to their practical relevance. Answering these questions can shed light on the segmentation and targeting of lab-grown food.

From Healthy Eating to Sustainable Eating. Food consumption research has started to shift from focusing on healthy eating to sustainable eating, and food technology has played a critical role in this process. In addition to lab-grown meat, other environmentally friendly food technologies, such as the ohmic heating process, deserve further attention. Future research can explore how consumers understand

tech-enabled food production processes and how they form perceptions and attitudes toward food produced through these processes. Future research can also explore how to improve marketing communication about tech-enabled innovative food to enhance consumer acceptance. Finally, our life-creation theory centers around the biological nature of food to explain why consumers do not favor lab-grown meat. Future research may take other perspectives, such as a sociocultural perspective, to analyze why consumers from different sociocultural backgrounds like or dislike food made with innovative food technologies. For instance, future research can investigate the role of a hedonic versus utilitarian culinary culture (Gomez and Torelli 2015).

Conclusion

In sum, our paper contributes a novel conceptualization by integrating biological, cultural, and psychological constructs to address consumer reactions to food innovation. The research also speaks to critical societal issues, including the impact of farming and livestock on health and diet, famine, animal welfare, and climate change. More generally, we view the interface of science, engineering, and consumer behavior as an exciting arena for consumer researchers to examine how consumers will eat and live in the future.

Appendices

Appendix A: Stimuli, Measures, Analyses, and Results in Study 1

1. Stimuli details

(1) Introduction in the lab-grown condition

Currently, there are biotechnology innovation companies that are in the process of providing or have already provided a variety of lab-grown food to consumers. Lab-grown food is often contrasted with conventional food made from natural ingredients. Specifically, lab-grown food is made through man-made processes, while conventional food originates from the natural environment.

For example, meat is the "flesh" of animals (e.g., cattle, chicken, and sheep) used for food. But nowadays, there is also "lab-grown meat," which grows from muscle stem cells in a biolaboratory setting without the involvement of animals. Similarly, dairy products, such as milk, normally originate from animals (e.g., cattle or goats). Recently, they can also be created in the lab using bioengineering technologies without the involvement of animals.

All lab-grown food has the same biological structures and chemical compositions as conventional food derived from animals. The only difference is that the creation of lab-grown food does not involve the process of animals' participation.

(2) Introduction in the plant-based condition

Currently, there are biotechnology innovation companies that are in the process of providing or have already provided a variety of plant-based food to consumers. Plant-based food is often contrasted with conventional food made from ingredients derived from animals. Specifically, plant-based food is made through man-made processes and using plant ingredients such as soybeans, lentils, grains, and peas.

For example, meat is the "flesh" of animals (e.g., cattle, chicken, and sheep) used for food. But nowadays, there is also "plant-based meat," which is made predominantly with extracts from plants (e.g., peas, soybeans, and wheat) and processed using genetic engineering technologies without the involvement of animals. Similarly, dairy products, such as milk, normally originate from animals (e.g., cattle or goats). Recently, there have been more plant-based dairy products available to consumers that are produced from plants using innovative enzyme technologies.

All plant-based food mimics the taste and texture of conventional food derived from animals. The biggest difference is that the creation of plant-based food does not involve the process of animals' participation.

2. DV measures

(1) Willingness to purchase

1) How likely are you to cook your meals using *the product*[5] as an ingredient? (1 = very unlikely; 7 = very likely)
2) How willing are you to consume *the product* regularly? (1 = not at all; 7 = very much)
3) To what extent will you rely on *the product* as one of the major sources of protein? (1 = not at all; 7 = very much)

(2) Disgust

When imagining eating food made with *the product*, to what extent do you feel? (1 = "not at all" to 7 = "to a great deal")

1) Disgust?
2) Revolted?
3) Repulsed?

3. Alternative measures and results:

(1) Technical difficulty

(Measures)

Please reflect on the production of *the product* and answer:

The production of *the product*…

[5] The wording "the product" in the items was replaced with the specific category depending on the assigned condition, such as "lab-grown meat."

1) is complicated
2) is technically difficult

(Analyses and Results)

Two items were combined (r = .85). A fixed effect 2 (product category) x 3 (production method) ANOVA revealed only a significant main effect of production method ($F(2, 598) = 17.68$, $p < .001$, $\eta_p^2 = .056$). Both the main effect of product category ($F(1, 598) = 1.78$, $p = .183$, $\eta_p^2 = .003$) and the interaction effect ($F(2, 598) = 2.28$, $p = .104$, $\eta_p^2 = .008$) were non-significant. Consumers viewed lab-grown products as technically more difficult than conventional products ($M_{lab\text{-}grown}$ vs. $M_{conventional}$ = 5.03 vs. 4.34, $SD_{lab\text{-}grown}$ = 1.24, $SD_{conventional}$ = 1.53, $p < .001$) and than plant-based products ($M_{lab\text{-}grown}$ vs. $M_{plant\text{-}based}$ = 5.03 vs. 4.28, $SD_{lab\text{-}grown}$ = 1.24, $SD_{plant\text{-}based}$ = 1.44, $p < .001$), whereas the latter two production methods did not differ ($M_{conventional}$ vs. $M_{plant\text{-}based}$ = 4.34 vs. 4.28, $SD_{conventional}$ = 1.53, $SD_{plant\text{-}based}$ = 1.44, p = .686). However, this main effect of production method cannot alternatively explain the interaction effect that we found for the dependent measures.

(2) Other perceptions

(Measures)

To what extent do you perceive the product to be... (1 = not at all; 7 = very much)

1) Tasty

2) Delicious
3) Nutritious
4) Nourishing
5) Healthy
6) Safe

(Perception 1: Taste – Analyses and Results)

The first two items combined (r = .96). A fixed effect 2 (product category) x 3 (production method) ANOVA revealed a significant main effect of production method (F(2, 598) = 109.98, p < .001, η_p^2 = .269). Neither the main effect of product category (F(1, 598) = 109.98, p < .001, η_p^2 = .269) nor the interaction effect (F(2, 598) = 109.98, p < .001, η_p^2 = .269) were significant. Consumers viewed conventional products as tastier than lab-grown products ($M_{conventional}$ vs. $M_{lab\text{-}grown}$ = 5.92 vs. 4.00, $SD_{conventional}$ = 1.37, $SD_{lab\text{-}grown}$ = 1.60, p < .001) and plant-based products ($M_{conventional}$ vs. $M_{plant\text{-}based}$ = 5.92 vs. 3.95, $SD_{conventional}$ = 1.37, $SD_{plant\text{-}based}$ = 1.60, p < .001), whereas the latter two did not differ ($M_{lab\text{-}grown}$ vs. $M_{plant\text{-}based}$ = 4.00 vs. 3.95, $SD_{lab\text{-}grown}$ = 1.60, $SD_{plant\text{-}based}$ = 1.60, p = .765). But the main effect in perception of taste cannot alternatively explain the interaction that we got for the dependent measures.

(Perception 2: Nutritiousness – Analyses and Results)

The third and fourth items were combined (r = .89). A fixed effect 2 (product category) x 3 (production method) ANOVA revealed a significant main effect of production method (F(2, 598) = 22.80, p < .001, η_p^2 = .071) and a significant interaction (F(2, 598) = 3.11, p = .045, η_p^2 = .010). But the main effect of product category was non-significant (F(1, 598) = 1.48, p = .224, η_p^2 = .002). Within the lab-grown sector, consumers viewed meat and dairy products as similarly nutritious (M_{meat} vs. M_{dairy} = 4.48 vs. 4.69, SD_{meat} = 1.62, SD_{dairy} = 1.53, F(1, 598) = 2.00, p = .275, η_p^2 = .002); within the plant-based sector, consumers viewed meat as significantly more nutritious than dairy products (M_{meat} vs. M_{dairy} = 5.31 vs. 4.83, SD_{meat} = 1.34, SD_{dairy} = 1.31, F(1, 598) = 5.86, p = .016, η_p^2 = .010); finally, within the conventional sector, consumers viewed meat and dairy products as similarly nutritious (M_{meat} vs. M_{dairy} = 5.44 vs. 5.59, SD_{meat} = 1.31, SD_{dairy} =1.15, F(1, 598) = .57, p = .450, η_p^2 = .001). However, the patterns of perception of nutritiousness cannot explain the results we got for the dependent measures.

(Perception 3: Healthiness – Analyses and Results)

A fixed effect 2 (product category) x 3 (production method) ANOVA revealed a significant main effect of production method (F(2, 598) = 19.05, p < .001, η_p^2 = .060). Neither the main effect of product category (F(1, 598) = .72, p = .397, η_p^2 = .001) nor the interaction effect (F(2, 598) = .41, p = .665, η_p^2 = .001) were significant. Consumers viewed plant-based products as significantly healthier than conventional products ($M_{plant\text{-}based}$ vs. $M_{conventional}$ = 5.29 vs. 4.96, $SD_{plant\text{-}based}$ = 1.37, $SD_{conventional}$=

1.60, p = .030) and viewed conventional products as significantly healthier than lab-grown products ($M_{conventional}$ vs. $M_{lab\text{-}grown}$ = 4.96 vs. 4.37, $SD_{conventional}$ = 1.60, $SD_{lab\text{-}grown}$ = 1.73, p < .001). Thus, the main effect in perception of healthiness cannot alternatively explain the interaction effect that we got for the dependent measures.

(Perception 4: Safety – Analyses and Results)

A fixed effect 2 (product category) x 3 (production method) ANOVA revealed a marginally significant main effect of product category (F(1, 598) = 3.06, p = .081, η_p^2 = .005) and a significant main effect of production method (F(2, 598) = 22.83, p < .001, η_p^2 = .071), while the interaction effect was non-significant (F(2, 598) = .83, p = .436, η_p^2 = .003). Consumers viewed plant-based products as significantly safer than conventional products ($M_{plant\text{-}based}$ vs. $M_{conventional}$ = 5.56 vs. 5.21, $SD_{plant\text{-}based}$ = 1.24, $SD_{conventional}$ = 1.36, p = .018) and viewed conventional products as significantly safer than lab-grown products ($M_{conventional}$ vs. $M_{lab\text{-}grown}$ = 5.21 vs. 4.57, $SD_{conventional}$ = 1.36, $SD_{lab\text{-}grown}$ = 1.79, p < .001). In addition, consumers viewed dairy products as marginally significantly safer than meat (M_{meat} vs. M_{dairy} = 5.01 vs. 5.22, SD_{meat} = 1.59, SD_{dairy} = 1.47, p = .081). Thus, these two main effects in perception of safety cannot alternatively explain the interaction effect that we got for the dependent measures.

Appendix B: Additional Studies A-B

Additional Study A

Method. The additional study A examines the process underlying consumers' aversion to lab-grown meat: perceptions of creating life and violating the laws of nature. The study had a 2 (production method: lab-grown vs. plant-based) x 2 (product category: meat vs. dairy products) between-subjects design and was pre-registered.[6] Similar to study 1, participants (N = 448, M_{age} = 29.78, 35% male, Prolific) were randomly assigned to either the lab-grown or the plant-based condition. Each group read an introduction about food produced using the assigned production method (same as in study 1; see Appendix A). Next, participants completed measures about their feelings and thoughts on the assigned product in the following order: disgust (same as in study 1; see Appendix A), willingness to purchase (same as in study 1; see Appendix A), perception of creating life (see below), and perception of violating the laws of nature (see below).

(Measurement of Perception of Creating Life)

[6] (https://osf.io/fepj5/?view_only=68319f3ffad24f13b2a1223e7311d01b). Please note: In our pre-registration, we reported using the perception of creating life as the manipulation check. However, after more deliberation on our theory, we decided to treat it as a serial mediator. Notably, the moderated mediation model with the perception of violating the laws of nature being the only mediator, production method being the independent variable, and product category being the moderator was significant (willingness to purchase: B = -.37, SE = .14, $95\%CI$ = [-.657, -.091]; disgust: B = .40, SE = .15, $95\%CI$ = [.100, .704]).

Please reflect on the production of the product and rate to what extent you disagree or disagree with the following statements. (1 = "not at all" to 7 = "to a great deal")

The production of the product…

1) Reminds you of the process of creating life
2) Is similar to making life from scratch
3) Is a replacement for the natural reproduction process of organisms

(Measurement of Perception of Violating the Laws of Nature)

Please continue reflecting on the production of the product and answer: (1 = "not at all" to 7 = "to a great deal")

1) To what extent do you think this production goes against the laws of nature?
2) To what extent do you think this production breaks the dynamic balance of nature?
3) To what extent do you regard this production as humans' abuse of power to influence nature arbitrarily?

Results. For willingness to purchase, we found a marginally significant interaction effect of production method and product category ($F(1, 444) = 3.10$, $p = .079$, $\eta_p^2 = .007$). Specifically, consumers reported a significantly lower willingness to purchase lab-grown meat than lab-grown dairy products (M_{meat} vs. $M_{dairy} = 3.49$ vs. 4.16, $SD_{meat} = 1.73$, $SD_{dairy} = 1.79$, $F(1, 444) = 9.00$, $p = .003$, $\eta_p^2 = .020$). However, consumers reported similar willingness to purchase plant-based meat and plant-based

dairy products (M_{meat} vs. M_{dairy} = 4.01 vs. 4.12, SD_{meat} = 1.75, SD_{dairy} = 1.52, $F(1, 444) = .24$, $p = .627$, $\eta_p^2 = .001$). These results supported that consumers have more negative attitudes toward alternative meat products than dairy products when the alternative meat products have the same biochemical structures and components as conventional meat and are created in the lab.

For disgust, we found identical patterns as the results of willing to purchase. Specifically, we found a significant interaction effect of production method and product category on disgust ($F(1, 444) = 4.92$, $p = .027$, $\eta_p^2 = .011$). Consumers reported significantly stronger disgust when imagining eating lab-grown meat (vs. dairy products) (M_{meat} vs. M_{dairy} = 3.20 vs. 2.63, SD_{meat} = 1.82, SD_{dairy} = 1.73, $F(1, 444) = 6.47$, $p = .011$, $\eta_p^2 = .014$). However, this effect diminished in the plant-based sector (M_{meat} vs. M_{dairy} = 2.11 vs. 2.25, SD_{meat} = 1.62, SD_{dairy} = 1.51, $F(1, 444) = .37$, $p = .544$, $\eta_p^2 = .001$).

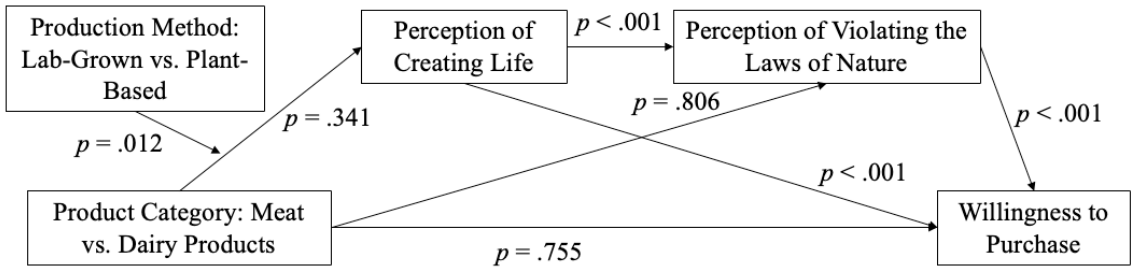
For perception of creating life, again, we observed a significant interaction effect of product category and production method ($F(1, 444) = 6.34$, $p = .012$, $\eta_p^2 = .014$). Within the lab-grown sector, consumers indicated a significantly stronger perception of creating life with lab-grown meat (vs. dairy products) (M_{meat} vs. M_{dairy} = 3.24 vs. 2.79, SD_{meat} = 1.48, SD_{dairy} = 1.54, $F(1, 444) = 6.86$, $p = .009$, $\eta_p^2 = .015$); however, this effect did not happen within the plant-based sector (M_{meat} vs. M_{dairy} = 1.79 vs. 1.96, SD_{meat} = .92, SD_{dairy} = 1.16, $F(1, 444) = .91$, $p = .341$, $\eta_p^2 = .002$). This was consistent with the patterns of results of dependent variables.

For perception of violating the laws of nature, consistently, we found a significant interaction effect of product category and production method ($F(1, 444) =$

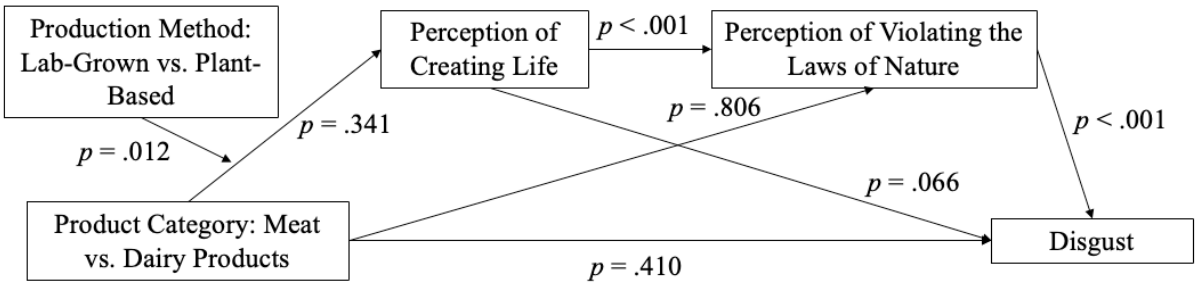
6.72, p = .010, η_p^2 = .015). Within the lab-grown sector, consumers indicated a significantly stronger perception of violating the laws of nature with lab-grown meat (vs. dairy products) (M_{meat} vs. M_{dairy} = 3.63 vs. 2.86, SD_{meat} = 1.79, SD_{dairy} = 1.79, F(1, 444) = 14.21, p < .001, η_p^2 = .031); in contrast, this effect did not occur within the plant-based sector (M_{meat} vs. M_{dairy} = 1.81 vs. 1.79, SD_{meat} = 1.32, SD_{dairy} = 1.18), F(1, 444) = .01, p = .938, η_p^2 < .001). This was again consistent with the patterns of results of dependent variables.

Finally, we applied Process Model 85 (Hayes 2013) to test the moderated serial mediation model (see Appendix Figures 1A and A1B for model illustration). The moderated serial mediation model was significant (willingness to purchase: B = -.07, SE = .04, $95\%CI$ = [-.151, -.010]; disgust: B = -.39, SE = .15, $95\%CI$ = [-.149, -.011]). We conclude that consumers have a lower willingness to purchase and stronger disgust toward lab-grown meat (vs. dairy products) due to stronger perceptions of creating life and stronger perceptions of violating the laws of nature.

Appendix Figure 1A: Moderated Serial Mediation Model When Willingness to Purchase Was the Dependent Variable



Appendix Figure 1B: Moderated Serial Mediation Model When Disgust Was the Dependent Variable



Additional Study B

Method. This study has a three-cell (product category: meat vs. seafood vs. dairy products) between-subjects design. We expect that consumers have more negative attitudes toward lab-grown meat than toward lab-grown dairy products because meat is more associated with life. In addition to meat, seafood was also included as a comparison. Seafood is considered meat in some cultures but not in others (Nam, Jo, and Lee 2010). But given that it is also the flesh of (marine) animals used for food and has prominent life properties, such as having cellular and tissue structures, we expect that lab-grown seafood would similarly evoke a perception of creating life and thus trigger a similar level of aversion as lab-grown meat. Participants (N = 445, M_{age} = 20.00, 47% male, undergraduate students) first read an introduction about lab-grown food (as shown below). Next, participants were randomly assigned to one product category. They read some background information (see below) and indicated their relative willingness to pay (WTP) for the lab-grown food in that category relative to the same category of food produced in a conventional way (1 = "much less" to 7 = "much more"). By measuring relative WTP rather than

absolute WTP, we controlled for the impact of the price level of a certain product category on WTP. WTP was our key dependent measure in this study to assess consumer attitude.

(Introduction of Lab-Grown Food)

Currently, there are biotechnology innovation companies that are in the process of providing or have already provided a variety of lab-grown food to consumers. Lab-grown food is often contrasted with conventional food made from natural ingredients. Specifically, lab-grown food is made through man-made processes, while conventional food originates from the natural environment.

For example, meat is the "flesh" of animals (e.g., cattle, chicken, and sheep) used for food. But nowadays, there is also "lab-grown meat," which grows from muscle stem cells in a biolaboratory setting without the involvement of animals. Similarly, seafood is any form of marine animal regarded as food by humans and often includes fish, shellfish, and roe. Lately, lab-grown seafood, which relies on the extraction and propagation of cells in the lab, has become a new option for eaters. Finally, dairy products, such as milk, normally originate from animals (e.g., cattle or goats). Recently, they can also be created in the lab using bioengineering technologies without the involvement of animals.

All lab-grown food has the same biological structures and chemical compositions as conventional food derived from animals. The only difference is that the creation of lab-grown food does not involve the process of animals' participation.

(Background Information before the WTP Measurement)

(Meat condition) There is a company, Future Meat, that produces and sells lab-grown meat (e.g., beef, lamb, chicken). They also use their lab-grown meat as an ingredient in producing meat products, such as burger patties, meatballs, and chicken nuggets.

(Seafood condition) There is a company, Future Seafood, that produces and sells lab-grown seafood (e.g., fish, shrimp). They also use their lab-grown seafood as an ingredient in producing seafood products, such as fish sticks, fish fillets, and breaded shrimp.

(Dairy products condition) There is a company, Future Dairy, that produces and sells lab-grown dairy products (i.e., milk). They also use their lab-grown milk as an ingredient in producing dairy products, such as ice cream, cheese, and yogurt.

Results and Discussion. The effect of the product category on WTP was significant ($F(2, 442) = 4.46$, $p = .012$, $\eta_p^2 = .020$). Compared to lab-grown dairy products, participants reported significantly lower WTP for lab-grown meat (M_{dairy} vs. $M_{meat} = 3.31$ vs. 2.93, $SD_{dairy} = 1.44$, $SD_{meat} = 1.51$, $p = .029$) and lab-grown seafood (M_{dairy} vs. $M_{seafood} = 3.31$ vs. 2.82, $SD_{dairy} = 1.44$, $SD_{seafood} = 1.44$, $p = .004$). However, consumers did not show significant differences between lab-grown meat and lab-grown seafood (M_{meat} vs. $M_{seafood} = 2.93$ vs. 2.82, $SD_{meat} = 1.51$, $SD_{seafood} = 1.44$, $p = .509$). Taken together, the results show that regardless of the animal type (terrestrial

or marine), consumers have more negative attitudes toward lab-grown meat than toward lab-grown dairy products.

Appendix C: Stimuli, Measures, Analyses, and Results in Study 2

1. Pretest: The effect of product category and production method on the perception of creating life and the perception of violating the laws of nature

Method. The pretest had a 2 (product category: meat vs. dairy products) x 2 (production method: cloned animal vs. lab-grown) between-subjects design. A total of 301 participants (M_{age} = 39.06, 46.8% male, Prolific) participated in this pretest online. Same as the main study, we only recruited participants who eat meat. Participants first read an introduction about food produced using the assigned production method, either cloned animal food or lab-grown food. (We report the introduction in the section "stimuli details" in this appendix). Then, they were randomly assigned to either meat or dairy products condition and answered measures about their perception of creating life and perception of violating the laws of nature triggered by this food product produced through the assigned method. Appendix B provides the measures.

Analyses and Results. We ran the 2 (product category) x 2 (production method) fixed effect ANOVA analyses and got the results as follows.

(1) Perception of creating life

We found a significant main effect of product category ($F(1, 297) = 9.47$, $p = .002$, $\eta_p^2 = .031$) and a significant main effect of production method ($F(1, 297) = 22.14$, $p < .001$, $\eta_p^2 = .069$), which were qualified by a significant interaction effect ($F(1, 297) = 5.84$, $p = .016$, $\eta_p^2 = .019$). Decomposing this interaction, we found that

within the lab-grown sector, consumers indicated a stronger perception of creating life in the meat (vs. dairy products) condition (M_{meat} vs. M_{dairy} = 3.54 vs. 2.63, SD_{meat} = 1.58, SD_{dairy} = 1.43, $F(1, 297) = 15.24$, $p < .001$, $\eta_p^2 = .049$); whereas within the cloned animal sector, consumers indicated similarly strong perceptions of creating life across meat and dairy product conditions (M_{meat} vs. M_{dairy} = 3.92 vs. 3.81, SD_{meat} = 1.20, SD_{dairy} = 1.51, $F(1, 297) = .22$, $p = .643$, $\eta_p^2 = .001$). Importantly, compared to cloned animal meat, lab-grown meat triggered a similarly strong perception of creating life ($M_{lab\text{-}grown}$ vs. $M_{cloned\ animal}$ = 3.54 vs. 3.92, $SD_{lab\text{-}grown}$ = 1.58, $SD_{cloned\ animal}$ = 1.20, $F(1, 297) = 2.64$, $p = .105$, $\eta_p^2 = .009$), whereas compared to cloned animal dairy products, lab-grown dairy products triggered a significantly weaker perception of creating life ($M_{lab\text{-}grown}$ vs. $M_{cloned\ animal}$ = 2.63 vs. 3.81, $SD_{lab\text{-}grown}$ = 1.43, $SD_{cloned\ animal}$ = 1.51, $F(1, 297) = 25.12$, $p < .001$, $\eta_p^2 = .078$).

These results supported our reasoning that for cloned animal food, regardless of product category, consumers have a strong perception of creating life; but for lab-grown food, consumers have a stronger perception of creating life with meat than with dairy products.

(2) Perception of violating the laws of nature

We found a significant main effect of product category ($F(1, 297) = 9.00$, $p = .003$, $\eta_p^2 = .029$) and a significant main effect of production method ($F(1, 297) = 33.33$, $p < .001$, $\eta_p^2 = .101$), which were qualified by a significant interaction effect ($F(1, 297) = 6.91$, $p = .009$, $\eta_p^2 = .023$). Decomposing this interaction, we found that within the lab-grown sector, consumers indicated a stronger perception of violating

the laws of nature in the meat (vs. dairy products) condition (M_{meat} vs. M_{dairy} = 3.52 vs. 2.33, SD_{meat} = 2.14, SD_{dairy} = 1.46, $F(1, 297) = 16.00$, $p < .001$, $\eta_p^2 = .051$); whereas within the cloned animal sector, consumers indicated similarly strong perceptions of violating the laws of nature across meat and dairy product conditions (M_{meat} vs. M_{dairy} = 4.19 vs. 4.11, SD_{meat} = 1.90, SD_{dairy} = 1.80, $F(1, 297) = .07$, $p = .795$, $\eta_p^2 < .001$). Importantly, compared to cloned animal meat, lab-grown meat triggered a significantly weaker perception of violating the laws of nature ($M_{lab\text{-}grown}$ vs. $M_{cloned\ animal}$ = 3.52 vs. 4.19, $SD_{lab\text{-}grown}$ = 2.14, $SD_{cloned\ animal}$ = 1.90, $F(1, 297) = 4.99$, $p = .026$, $\eta_p^2 = .017$); also, compared to cloned animal dairy products, lab-grown dairy products triggered a significantly weaker perception of violating the laws of nature ($M_{lab\text{-}grown}$ vs. $M_{cloned\ animal}$ = 2.33 vs. 4.11, $SD_{lab\text{-}grown}$ = 1.46, $SD_{cloned\ animal}$ = 1.80, $F(1, 297) = 34.95$, $p < .001$, $\eta_p^2 = .105$).

Again, these results supported our reasoning that for cloned animal food, regardless of product category, consumers have a strong perception of violating the laws of nature. However, for lab-grown food, consumers have a stronger perception of violating the laws of nature with meat than with dairy products.

2. Stimuli details

(1) Introduction in the lab-grown condition: Same as in study 1 (see Appendix A)

(2) Introduction in the cloned animal condition

Currently, there are biotechnology innovation companies that are in the process of providing or have already provided a variety of food made from cloned animals to consumers. Cloned animal food is often contrasted with conventional food

made from natural-born animals. Specifically, cloned animal food is made through man-made processes, while conventional food originates in the natural environment.

For example, meat is the "flesh" of animals (e.g., cattle, chicken, and sheep) used for food. Nowadays, there is also "cloned animal meat," which is harvested from cloned animals, animals created by copying the genetic traits of natural-born animals in a biolaboratory setting without the reproduction of natural-born animals. Similarly, dairy products, such as milk, normally originate from natural-born animals (e.g., cattle or goats). Recently, they can also be produced by cloned animals without the involvement of natural-born animals.

All cloned animal food has the same biological structures and chemical compositions as conventional food derived from natural-born animals. The only difference is that the creation of cloned animal food does not involve the process of natural-born animals' participation.

3. DV measures: Willingness to try

(1) Suppose that you were at a restaurant, and their menu listed a recommended new dish made from lab-grown meat/milk (or cloned animal meat/milk) (or a recommended new meat/dairy dish). How likely would you be to try it? (1 = Not at all likely; 7 = Very likely)

(2) Suppose that you were shopping at a grocery store and noticed a recommended meat/dairy product (made from lab-grown meat/milk or cloned animal meat/milk) on the shelf. How likely would you be to purchase it? (1 = Not at all likely; 7 = Very likely)

(3) Suppose that you were ordering food online and paid attention to a recommended meat/dairy dish (made from lab-grown meat/milk or cloned animal meat/milk). How likely would you be to choose it? (1 = Not at all likely; 7 = Very likely)

4. Measures and results of consumer knowledge of and familiarity with the food technology

(Measures)

(1) How familiar are you with the technology behind the production of lab-grown food?

(2) How much knowledge do you have of the technology behind the production of lab-grown food?

(3) How familiar are you with the technology behind the production of cloned animal food?

(4) How much knowledge do you have of the technology behind the production of cloned animal food?

(Results)

When controlling for technology knowledge and familiarity (lab-grown: r = .91; cloned animal: r = .96), We still found a significant interaction effect of production method and product category ($F(1, 558) = 3.70$, $p = .025$, $\eta_p^2 = .013$). Within the lab-grown sector, consumers had a significantly lower willingness to try food made with lab-grown meat (vs. dairy products) (M_{meat} vs. M_{dairy} = 3.70 vs. 4.26, SD_{meat} = 2.05, SD_{dairy} = 1.64, $F(1, 560) = 5.36$, $p = .021$, $\eta_p^2 = .010$). However, this effect was non-significant for either the cloned animal sector (M_{meat} vs. M_{dairy} = 3.17

vs. 3.07, SD_{meat} = 1.89, SD_{dairy} = 1.91, $F(1, 558) = .189$, $p = .664$, $\eta_p^2 < .001$) or the conventional sector (M_{meat} vs. M_{dairy} = 5.86 vs. 5.54, SD_{meat} = 1.15, SD_{dairy} = 1.01, $F(1, 558) = 1.89$, $p = .170$, $\eta_p^2 = .003$). Meanwhile, consumers had a lower willingness to try food made with cloned animal meat than lab-grown meat and conventional meat ($M_{cloned\ animal}$ vs. $M_{lab\text{-}grown}$ vs. $M_{conventional}$ = 3.17 vs. 3.70 vs. 5.86, $SD_{cloned\ animal}$ = 1.89, $SD_{lab\text{-}grown}$ = 2.05, $SD_{conventional}$ = 1.15, $F(1, 558) = 74.74$, $p < .001$, $\eta_p^2 = .210$). These findings were consistent with the findings when not controlling for technology knowledge and familiarity.

Appendix D: Stimuli, Measures, Analyses, and Results in Study 3

1. Measures of religiosity (from Worthington et al. 2003; used in Cutright 2012)

   (1) My religious beliefs lie behind my whole approach to life.

   (2) I spend time trying to grow in understanding of my faith.

   (3) It is important to me to spend periods of time in private religious thought and reflection.

   (4) Religious beliefs influence all my dealings in life.

   (5) Religion is especially important to me because it answers many questions about the meaning of life.

   (6) I often read books and magazines about my faith.

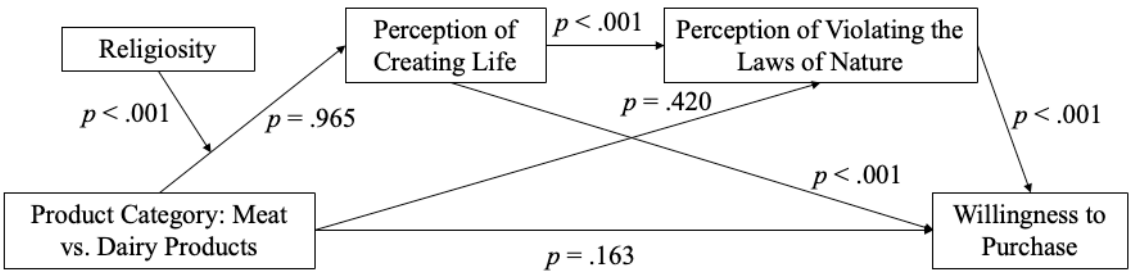
   (7) I enjoy working in the activities of my religious organization.

   (8) I enjoy spending time with others of my religious affiliation.

   (9) I keep well informed about my local religious group and have some influence on its decisions.

   (10) I make financial contributions to my religious organization.

2. Moderated serial mediation model



References

Cutright, Keisha M. (2012), "The Beauty of Boundaries: When and Why We Seek Structure in Consumption," *Journal of Consumer Research*, 38 (5), 775-790.

Worthington Jr, Everett L., Nathaniel G. Wade, Terry L. Hight, Jennifer S. Ripley, Michael E. McCullough, Jack W. Berry, Michelle M. Schmitt, James T. Berry, Kevin H. Bursley, and Lynn O'Connor (2003), "The Religious Commitment Inventory--10: Development, Refinement, and Validation of A Brief Scale for Research and Counseling," *Journal of Counseling Psychology*, 50 (1), 84.

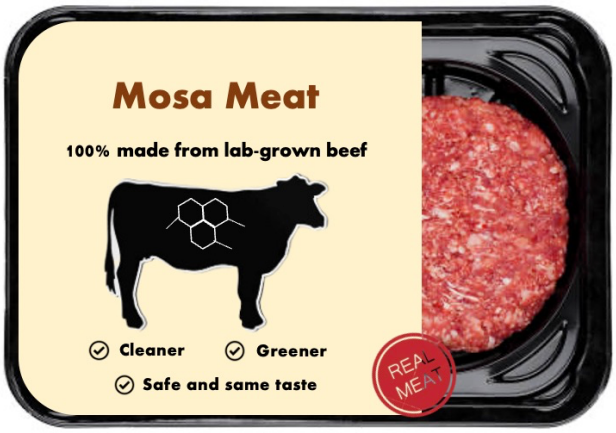
Appendix E: Stimuli, Measures, Analyses, and Results in Study 4

1. Examples of product packaging that displays animal prints

2. Study stimuli: Product packaging

(Food Product Condition)

(Animal Condition)



(Control Condition)

3. Dependent measures

(1) If you are in a grocery store to buy beef patties and see this lab-grown beef patty, to what extent are you willing to purchase the lab-grown beef patty? (1 = Not at all; 7 = To a great degree)

(2) If you eat beef patties in your regular meals, how likely are you to replace the conventional beef patties in your meals with lab-grown beef patties? (1 = Very unlikely; 7 = Very likely)

(3) How much are you willing to pay for the lab-grown beef patty compared to a conventional beef patty? (1 = Much less; 7 = Much more)

4. Alternative measures and results: Evaluation of the packaging stimuli

(Measures)

To what extent do you perceive the packaging to be:

(1) Aesthetically appealing; (2) Well-designed; (3) Clear; (4) Easy to remember; (5) Informative

(Results)

Aesthetics. We averaged the first two items to form an aesthetics index (r = .86). We found that participants gave higher aesthetic ratings in the food product condition ($M_{food\ product}$ = 5.15, $SD_{food\ product}$ = 1.29) and in the animal condition (M_{animal} = 5.02, SD_{animal} = 1.38) than in the control condition ($M_{control}$ = 4.52, $SD_{control}$ = 1.47, $F(2, 392) = 7.60$, $p < .001$, $\eta_p^2 = .037$). This suggested that aesthetic level could not explain why consumers reacted to lab-grown meat more positively in the food product condition than in the animal condition.

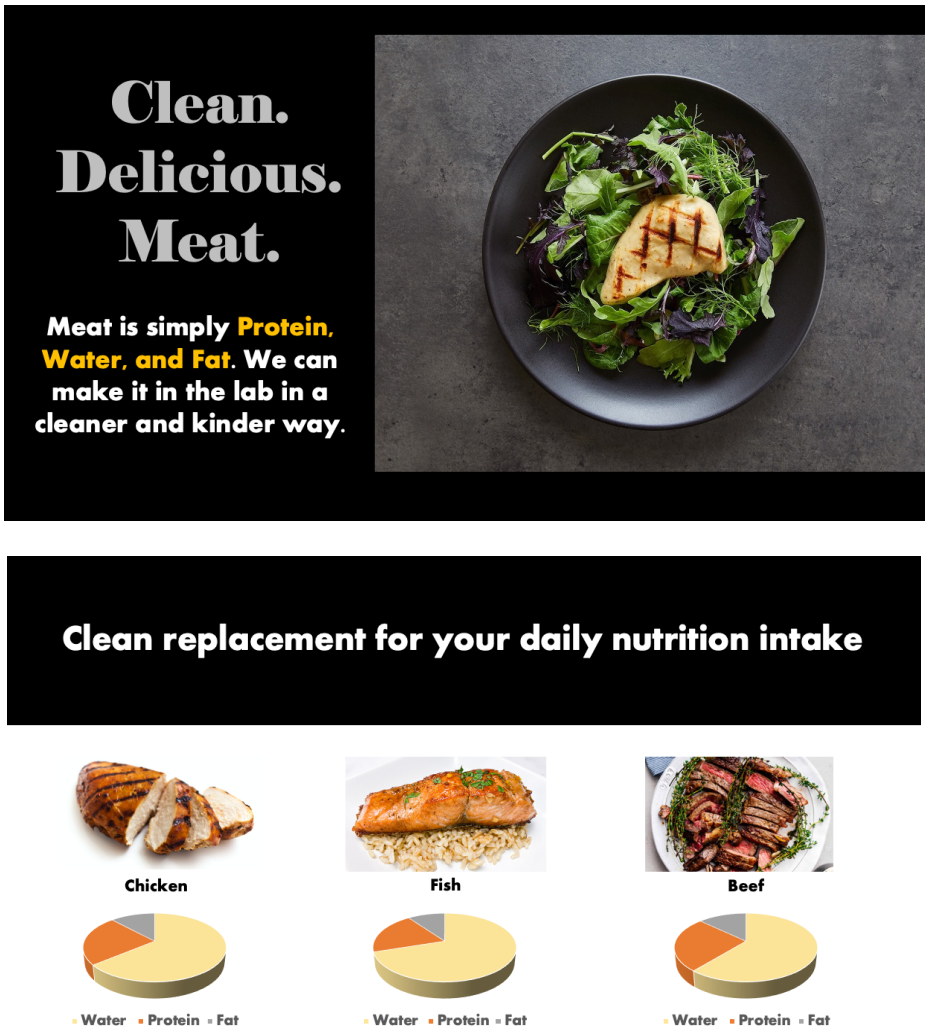
Clarity. We averaged the third and fifth items to form a clarity index (r = .57). We found that participants gave similarly high clarity ratings across conditions ($M_{food\ product}$ = 5.61, $SD_{food\ product}$ = 1.05 vs. M_{animal} = 5.40, SD_{animal} = 1.14 vs. $M_{control}$ = 5.48, $SD_{control}$ = 1.05, $F(2, 392) = 1.21$, $p = .300$, $\eta_p^2 = .006$).

Memorability. We found that participants rated packaging across conditions similarly easy to remember ($M_{food\ product}$ = 5.59, $SD_{food\ product}$ = 1.20 vs. M_{animal} = 5.31, SD_{animal} = 1.34 vs. $M_{control}$ = 5.32, $SD_{control}$ = 1.35, $F(2, 392) = 1.96$, $p = .142$, $\eta_p^2 = .010$).

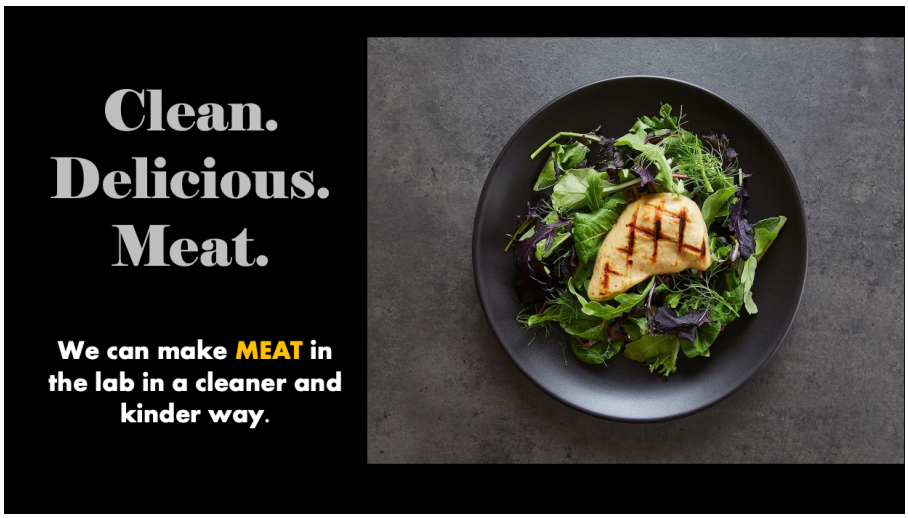
Appendix F: Stimuli, Measures, Analyses, and Results in Study 5

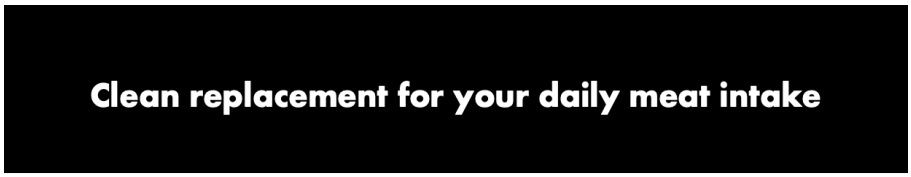
1. Stimuli details: Marketing campaign visuals

(1) Deconstruction ad condition



(2) Control ad condition





Chicken Fish Beef

2. Measures of Attitude

We would like to know your attitudes toward lab-grown meat as a type of food in general. Please indicate your attitudes towards lab-grown meat:

(1) Extremely unfavorable/Extremely favorable

(2) Extremely negative/Extremely positive

(3) Extremely unappealing/Extremely appealing

(*Note:* Participants answered these measures by moving the slider bar on 0-100 scales.)

3. Alternative measures and results: Evaluation of the visuals

(Measures)

To what extent do you perceive these visuals to be: (1 = not at all; 7 = to a great deal)

(1) Aesthetically appealing; (2) Well-designed; (3) Clear; (4) Easy to understand; (5) To what extent do you like these visuals? (1 = dislike a great deal; 7 = like a great deal)

(Analyses and results)

In terms of the aesthetical appeal (the first two items combined, $r = .75$), the main effect of ad type (deconstruction ad vs. control ad) was non-significant, and two types of ads were similarly aesthetically appealing to participants ($M_{deconstruction}$ vs. $M_{control}$= 4.95 vs. 4.96, $SD_{deconstruction} = 1.31$, $SD_{control} = 1.56$, $F(1, 400) = .006$, $p = .939$, $\eta_p^2 < .001$). In terms of informativeness (the third and fourth items combined, $r = .84$), the main effect of ad type was again non-significant, and two types of ads were rated as similarly informative to participants ($M_{deconstruction}$ vs. $M_{control}$ = 5.58 vs. 5.59, $SD_{deconstruction} = 1.23$, $SD_{control} = 1.49$, $F(1, 400) = .008$, $p = .927$, $\eta_p^2 < .001$). Finally, in terms of liking, the main effect of ad type was non-significant, and participants seemed to like the visuals to a similar degree ($M_{deconstruction}$ vs. $M_{control}$ = 5.02 vs. 5.03, $SD_{deconstruction} = 1.27$, $SD_{control} = 1.49$, $F(1, 400) = .006$, $p = .938$, $\eta_p^2 < .001$).

Appendix G: Measures in Study 6

- Measures of willingness to purchase ($\alpha = .92$)

1. How likely are you to purchase lab-grown meat regularly? (1 = Very unlikely; 7 = Very likely)
2. How likely are you to eat lab-grown meat as a replacement for conventional meat? (1 = Very unlikely; 7 = Very likely)
3. How much are you willing to pay for lab-grown meat compared to conventional meat? (1 = Much less; 7 = Much more)

Appendix H: Historical Summary of Prior Consumer Research

Appendix Table 1. Historical Summary of Prior Consumer Research on Food Consumption and Technology

Major Challenge	Relation between Food Consumption and Nature	Overall Research Issue	Examples of Ideas Studied in Empirical Articles
To attain safe and sufficient sources of food and to preserve food for a longer period	• Harmony • Humans exploit nature for more food consumption	Research studies how consumers react to food technologies that can help increase the supply of, disinfect, and preserve food	• Food irradiation (Finn and Louviere 1992; Zheng, Bolton, and Alba 2019) • Genetically modified food (Ellen and Bone 2008; Hingston and Noteworthy 2018; Kim, Kim, and Arora 2022; Pham and Mandel 2019; Zheng, Bolton, and Alba 2019)
To improve self regulation and engage in healthy eating behaviors	• Upgraded tension • Food overconsumption has caused a heavy burden on the natural environment	Research studies how consumers can improve self control and adopt healthy diets, as well as how marketers can encourage consumers to engage in healthy eating behaviors	• Trade off between tastiness and healthiness (Mai and Hoffmann 2015; Raghunathan, Naylor, and Hoyer 2006; Sela, Berger, and Liu 2009; Vosgerau, Scopelliti, and Huh 2019) • Healthy eating habits (Khare and Inman 2006; Ma, Ailawadi, and Grewal 2013) • Food packaging and labeling (Deng and Srinivasan 2013; Irmak, Vallen, and Robinson 2011; Scott et al. 2008; Shah et al. 2014; Ye, Morrin, and Kampfer 2019) • Social influence on healthy eating (Hasford, Kidwell, and Lopez-Kidwell 2018; Liu, McFerran, and Haws 2019; McFerran et al. 2010)
To decrease the negative impact of food production and consumption on the natural environment	• More upgraded tension • Food waste and overconsumption are threatening sustainability and food security in the long term	Research studies how consumers choose or form their preferences for sustainable food options, as well as how marketers can motivate consumers to have more environmentally friendly food consumption	• Food waste (Block et al. 2016; de Visser-Amundson, Peloza, and Kleijnen 2021; Grewal et al. 2019; Mookerjee, Cornil, and Hoegg 2021) • Carbon footprints of food choices (Groening, Inman, and Ross 2015; Panzone et al. 2020) • Preference for local food (Reich, Beck, and Price 2018) • Alternative food (Florack et al. 2021; Zheng, Bolton, and Alba 2019)

Additional References

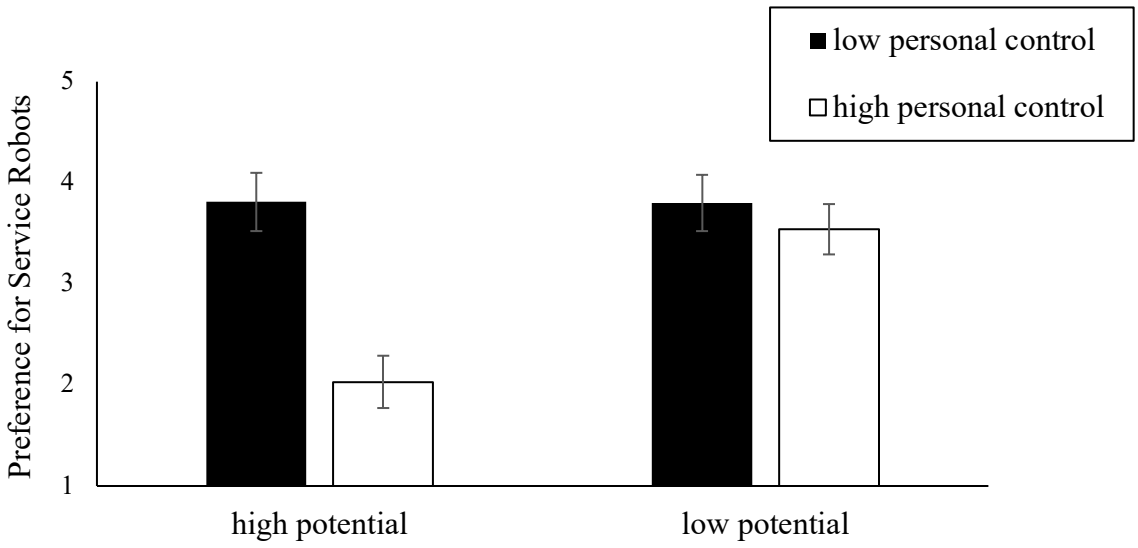
Shah, Avni M., James R. Bettman, Peter A. Ubel, Punam Anand Keller, and Julie A. Edell (2014), "Surcharges plus Unhealthy Labels Reduce Demand for Unhealthy Menu Items," *Journal of Marketing Research*, 51(6), 773-789.

Vosgerau, Joachim, Irene Scopelliti, and Young Eun Huh (2020), "Exerting Self-Control≠ Sacrificing Pleasure," *Journal of Consumer Psychology*, 30 (1), 181-200.

Figures

Figure 1

Preference for service robots as a function of personal control and potential for negative judgment (Study 1 in Essay 1)



Note. Error bars are 95% confidence intervals.

Figure 2

Choice of robot pharmacist as a function of personal control and potential for negative judgment (Study 2A in Essay 1)

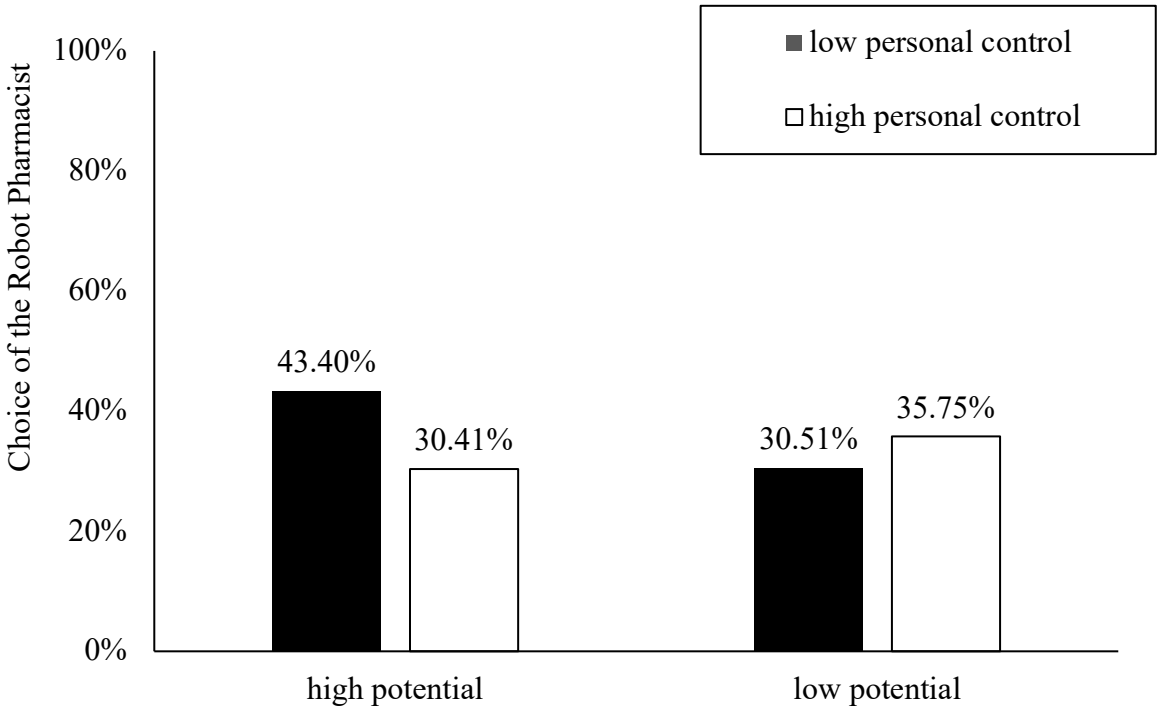
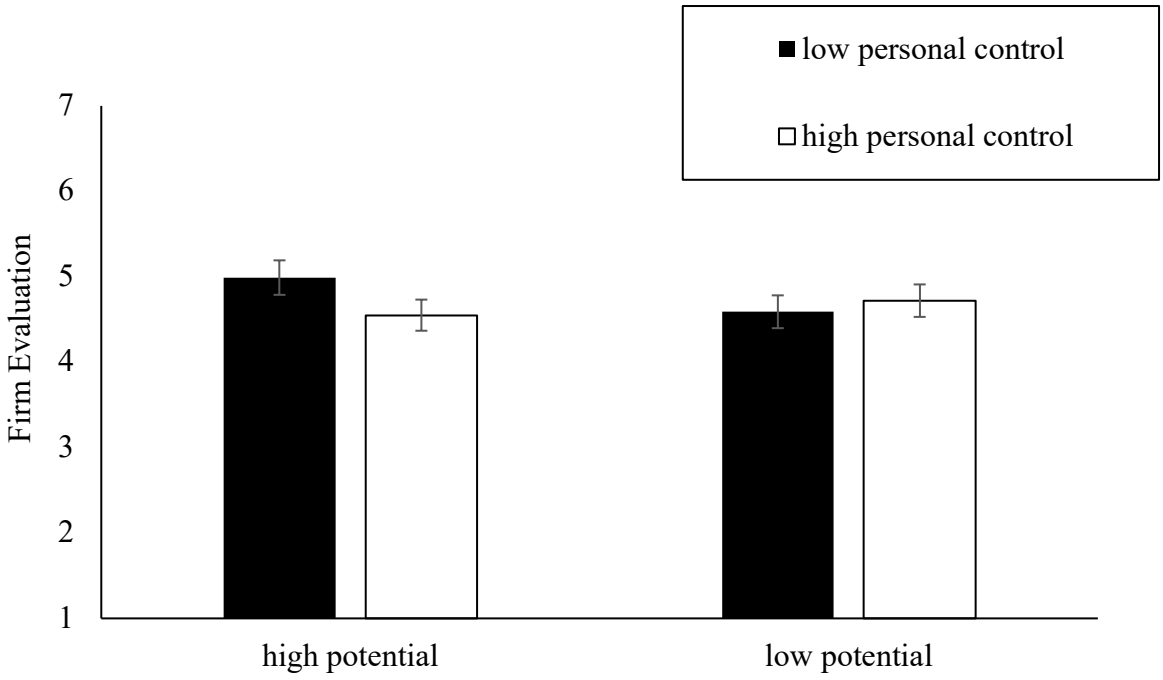


Figure 3

Firm evaluation as a function of personal control and potential for negative judgment (Study 2A in Essay 1)



Note. Error bars are 95% confidence intervals.

Figure 4

Choice of robot pharmacist as a function of personal control and potential for negative judgment (Study 2B in Essay 1)

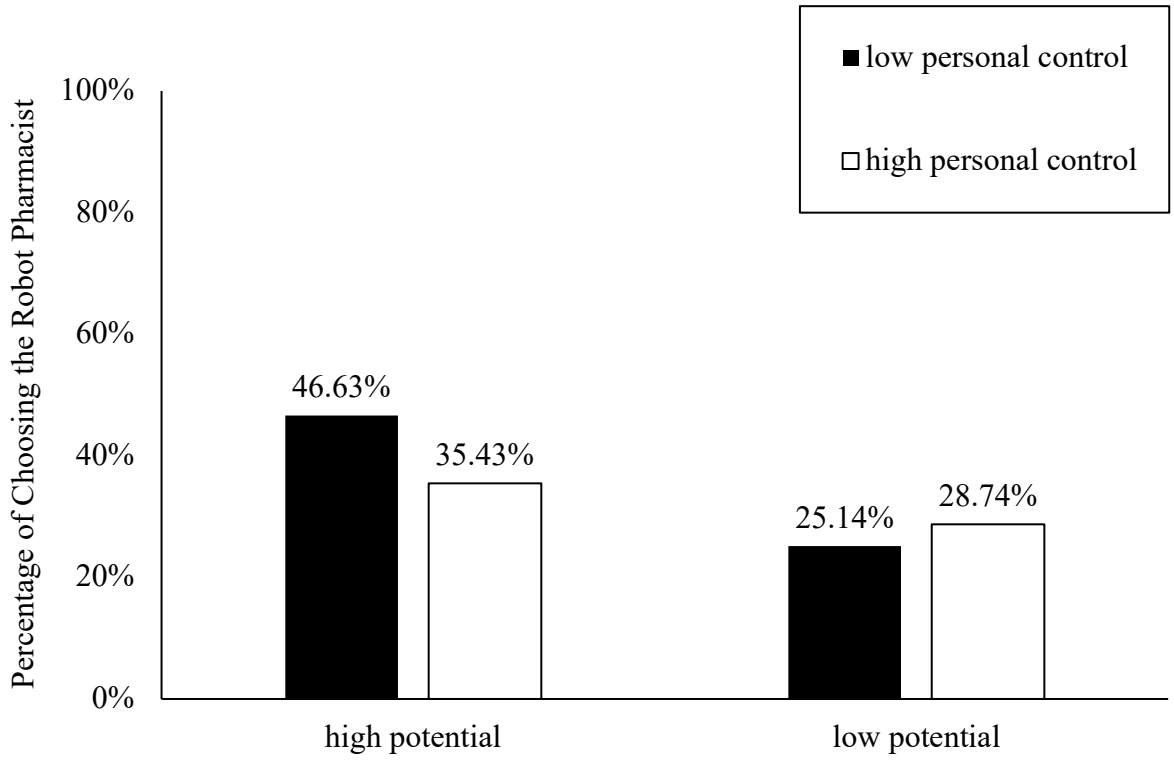
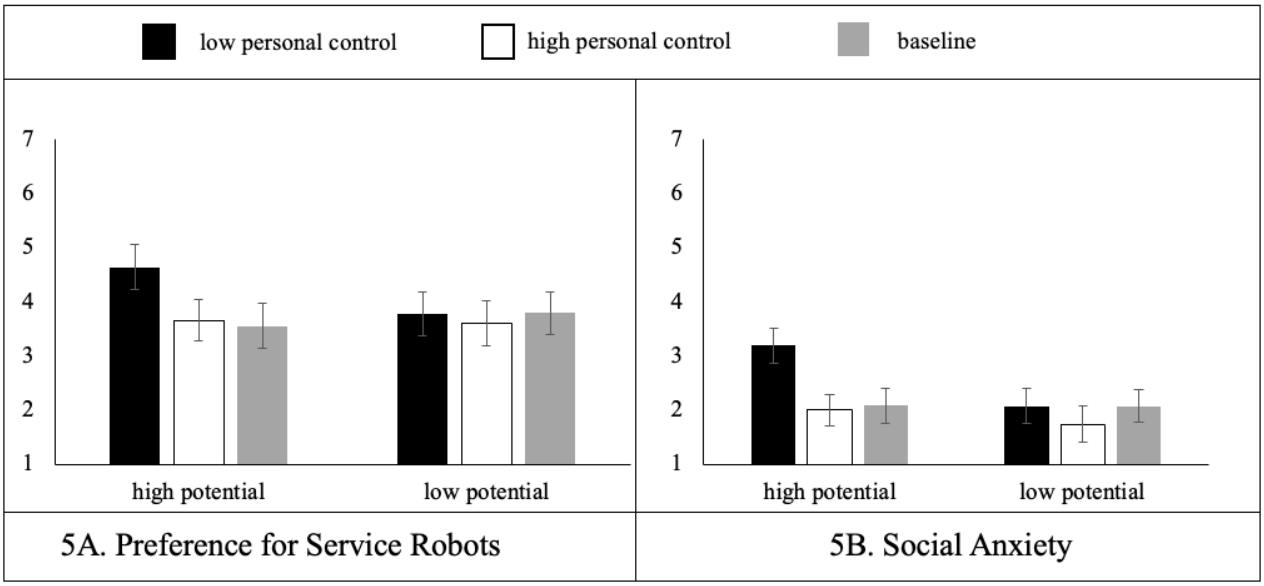


Figure 5

Preference for service robots and social anxiety as a function of personal control and potential for negative judgement (Study 3 in Essay 1)



Note. Error bars are 95% confidence intervals.

Figure 6

The moderated mediation models (Study 3 in Essay 1)

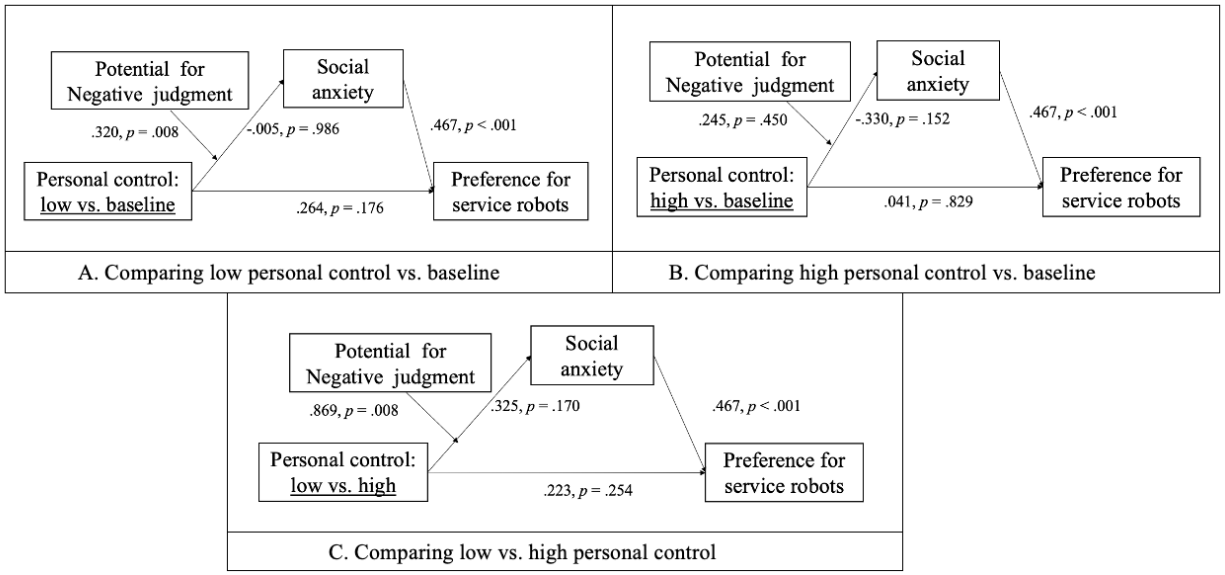
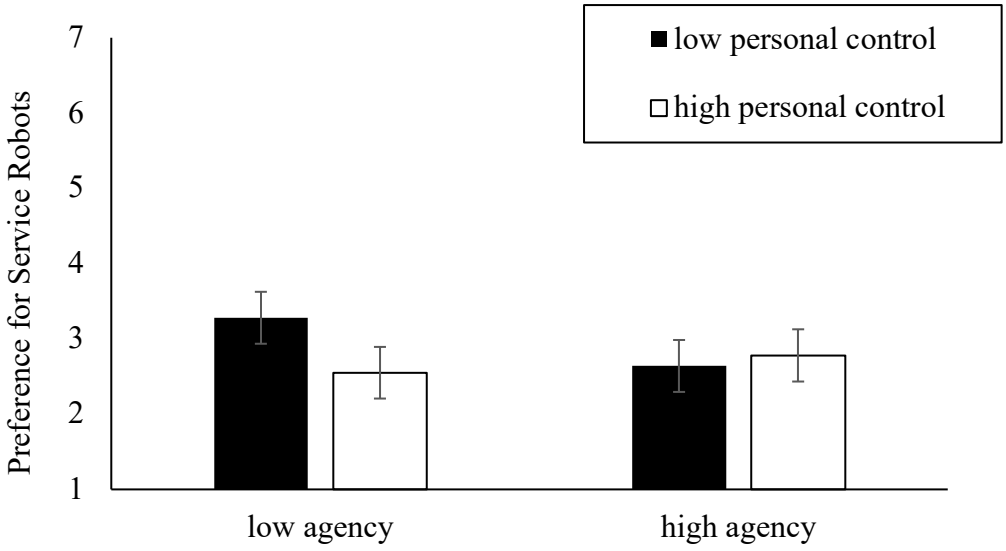


Figure 7

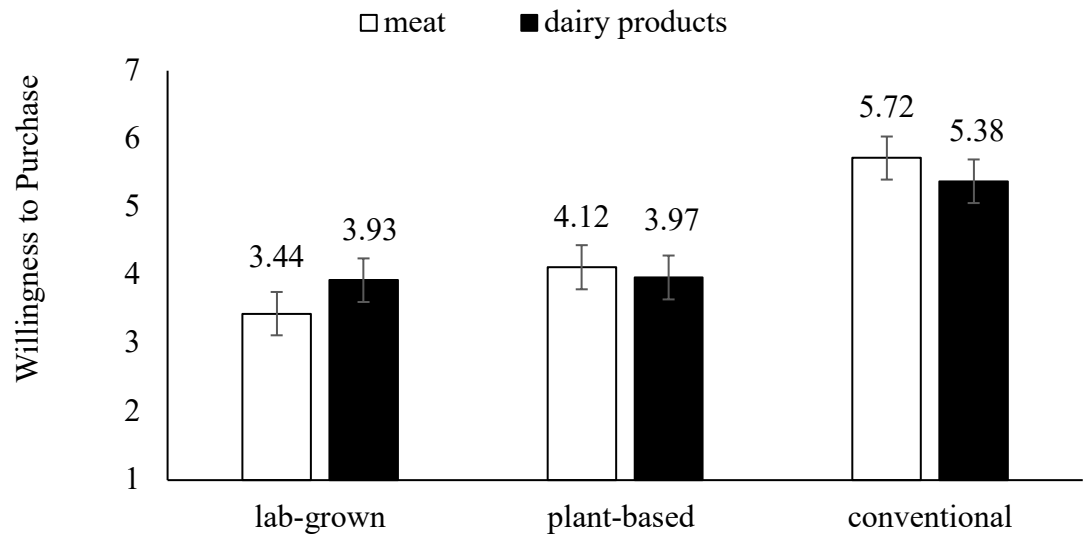
Preference for service robots as a function of personal control and robot agency (Study 4 in Essay 1)



Note. Error bars are 95% confidence intervals.

Figure 8

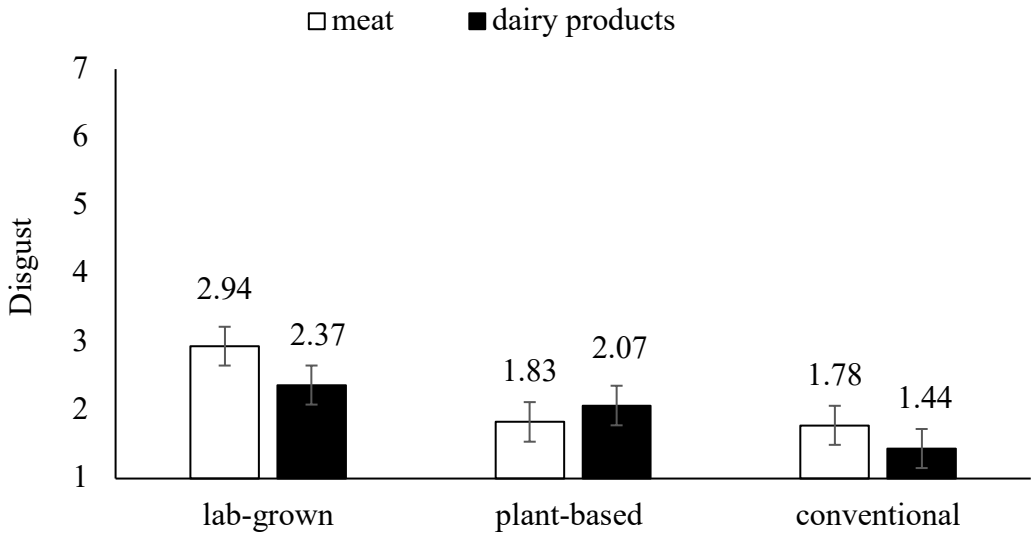
Willingness to purchase meat vs. dairy products across production methods (Study 1 in Essay 2)



Note. Error bars are 95% confidence intervals.

Figure 9

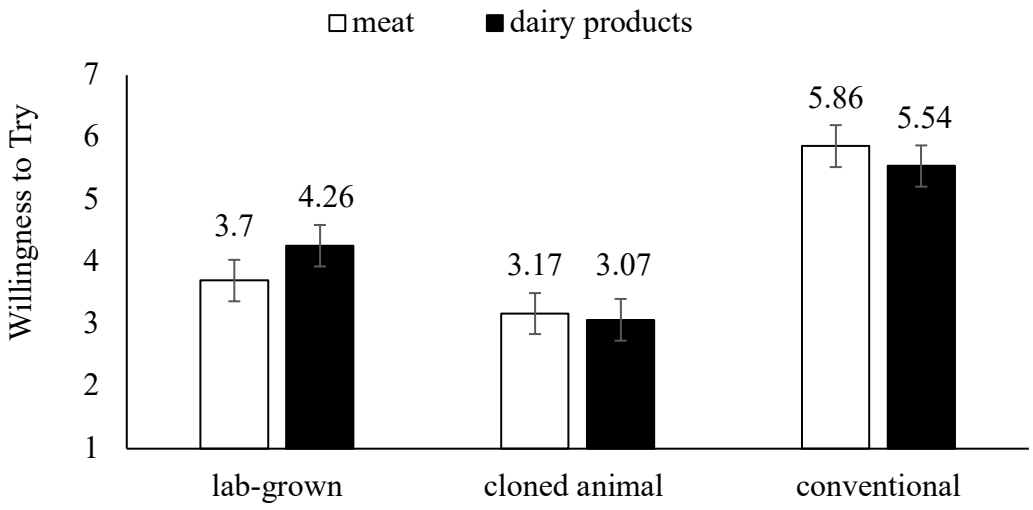
Disgust with meat vs. dairy products across production methods (Study 1 in Essay 2)



Note. Error bars are 95% confidence intervals.

Figure 10

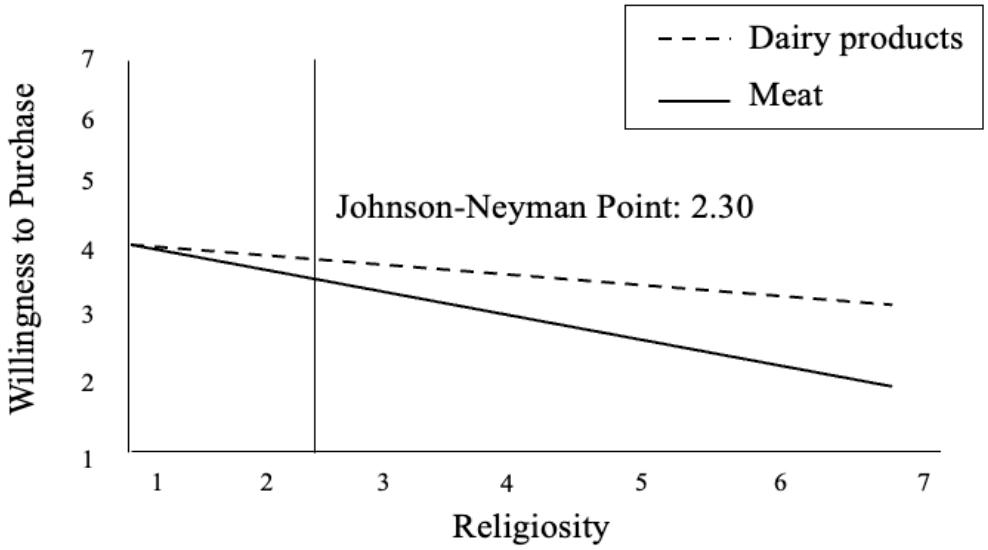
Willingness to try meat vs. dairy products across production methods (Study 2 in Essay 2)



Note. Error bars are 95% confidence intervals.

Figure 11

The moderation effect of religiosity (Study 3 in Essay 2)



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