

Nudge Effectiveness and Personalization: The Effects of Threat to Autonomy and Reactance Proneness



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Abstract

Concerns about unhealthy lifestyles have increased in recent years. Unhealthy food choices are one of the biggest contributors to rising obesity, which can have negative health consequences. Nudges might be an effective intervention to promote behavioral change. Moreover, this effect can be stronger when a nudge is personalized. However, little is known about how underlying mechanisms and individual differences can affect this relationship. This thesis aims to examine how the threat to autonomy and reactance proneness may affect the relationship between personalization and nudge effectiveness. This thesis utilized an experimental, quantitative between-subject design to examine how the threat to autonomy and reactance proneness may affect the relationship between personalization and nudge effectiveness. Participants used a mock supermarket application in which they were exposed to either personalized or non-personalized JIT nudges. Afterward, they were asked to what extent they experienced the threat to autonomy and their character trait reactance proneness was measured. The results showed no significant differences between nudge effectiveness and personalization. Threat to autonomy did not mediate this relationship and there was no moderating effect of reactance proneness found between threat to autonomy and nudge effectiveness. Therefore, further research can investigate whether mechanisms may explain the relationship between personalization and nudge effectiveness.

Introduction

Over the past years, the concern about unhealthy lifestyles in Western civilization has increased (Hartmann et al., 2012). For example, research from the Dutch Ministry of Health, Welfare, and Sport showed that more than 80% of Dutch residents do not adhere to dietary guidelines (Schuurman et al., 2020). More specifically, unhealthy food choices are a lifestyle that is considered to be a major contributor to the dramatic increase in obesity prevalence (Friedrich, 2017), as the consumption of foods high in sugar, fat, and salt is increasing (Folkvord, 2019). This overconsumption is affecting all population groups in high-income countries (Swinburn et al., 2011). An individual is considered to be obese when their Body Mass Index (BMI) crosses 30. Research by Ritchie and Roser (2017) shows that globally, 13% of adults are obese and 20% of children and adolescents suffer from being overweight. With more than 4 million people per year dying from obesity, the WHO considers obesity a global epidemic (2020). Since obesity can have different negative consequences such as health problems, healthcare costs, and negative self-images (Wyatt et al., 2006; Chu et al., 2018), an intervention to encourage healthier eating behavior is of great importance. One is defined as overweight when their BMI crosses 25 (Kankerbestrijding, 2023).

Recently, interest in nudging has grown to stimulate healthier food choices (Van Der Laan & Orcholska, 2022). Thaler & Sunstein (2009) described nudging as “any aspect of the choice architecture that alters people’s behavior predictably without forbidding any options or significantly changing their economic incentives”. Individuals’ food choices are biased by cognitive automatic processes that often lead to unhealthy choices. Nudges aim to respond to this bias, to stimulate people to make healthier choices (Broers et al., 2017). Nudge is an umbrella term and under which different types of nudges are recognized.

One of these types is visibility nudges which increase the apparentness of a suggestion (Van Der Laan & Orcholska, 2022). A Just In Time nudge (JIT nudge) can be considered a

visibility nudge and is defined by Goldstein et al. (2017) as “an intervention design framework that could be delivered via mobile app to facilitate in-the-moment monitoring of triggers for lapsing, and deliver personalized coping strategies to the user to prevent lapses from occurring” (p. 673). Because of its just-in-time suggestion, a JIT nudge differentiates from a traditional intervention in which time is not a factor. An example of a JIT nudge is a push notification on a mobile phone while doing online grocery shopping (Van Der Laan & Orcholska, 2022).

A meta-analysis by Mertens et al. (2021) showed that nudges can help people make more beneficial choices in different behavioral domains. In addition, previous research observed that a JIT nudge may be a helpful intervention for stimulating healthy food choices (König & Renner, 2019; Van Der Laan & Orcholska, 2022). As noted by Mills (2020), nudges are often based on one specific approach that should suit every individual, which can be effective if the target group is heterogeneous. Mills adds a criticism of this approach which is that behavioral nudges occasionally nudge individuals who would have made a more beneficial decision if their independent set of conditions were known. Mills (2020) suggests that personalization in nudging may resolve this issue. Personalized nudges utilize the personal data of an individual, aiming to produce nudges that connect with that individual’s wishes and needs (Dalecke & Karlsen, 2020). For example, when a consumer chooses regular cola, a nudge can be used to suggest cola without sugar as an alternative for that food item. Recent evidence suggests that personalized nudges can be effective in the online security domain (Guo et al., 2020; Péér et al., 2020), but to our knowledge, no research has been conducted on the effectiveness of personalized nudging in the healthy food choice domain. In addition, individual differences such as personality traits can influence the effectiveness of these nudges. However, research into the effects of individual differences on personalized nudge effectiveness compared to a non-personalized nudge has not yet been extensively researched (Zucchelli et al., 2023).

Nudge effectiveness may be lower when a nudge is exposed to an individual high in reactance proneness than when it is exposed to an individual low in reactance proneness. Reactance can also lead to changes in an individual's behavior. Brehm (1966) defined reactance as “a motivational state directed toward the re-establishment of [a] threatened or eliminated freedom” (p. 15). Therefore, reactance is a driver that influences an individual's behavior to reinforce their freedom (Steindl et al., 2015). A persuasive message can be considered by the receiver as a hazard to their freedom, which can trigger reactance. This can cause the receiver to dismiss a message or nudge (Breves et al., 2021). In the past, reactance was only seen as a behavioral state, but recent studies argue that there are also individual differences in reactance proneness. Thus, reactance proneness can be considered a personality trait (Moreira et al., 2021; Shen & Dillard, 2007). Reactance is considered to be a variable that can predict autonomous motivation (Pavey & Sparks, 2009; Powers & Altman, 2022).

Threat to autonomy may change the effectiveness of a personalized nudge. Wertenbroch et al. (2020) define autonomy as “the individual's subjective sense of being able to make and enact decisions of their own volition” (p. 431). It is argued that autonomy could be an antecedent to behavioral adaptations. For example, individuals with a low need for autonomy wish to be consulted by others, while individuals with a high need for autonomy want to make their own choices (Smit et al., 2019). Data from previous studies suggest that when the need for autonomy is high, individuals are more likely to deny a nudge than when the need for autonomy is low. Threat to freedom is suggested to be the cause of this effect (Wertenbroch et al., 2019). Nonetheless, no previous studies have investigated the effect of threat to autonomy on the effectiveness of nudging.

This thesis will examine how personalization and reactance proneness may influence the effectiveness of nudging in a healthy food consumption context, and if this effect is mediated by threat to autonomy. Therefore, the following research questions have been

formulated: *“To what extent does personalization affect nudge effectiveness, and is this effect mediated by threat to autonomy and moderated by reactance proneness?”*.

Theoretical framework

Nudge effectiveness

Nudging is an umbrella term, meaning that there are different types of nudges, such as visibility and salience nudges. For example, a visibility nudge can be putting vegetables at eye-level in grocery stores is a nudge aiming to stimulate healthy consumption. In addition, there are different ways of delivering nudges. For example, JIT nudges are described by Goldstein et al. (2017) as “an intervention design framework that could be delivered via mobile app to facilitate in-the-moment monitoring of triggers for lapsing, and deliver personalized coping strategies to the user to prevent lapses from occurring” (p. 673).

The dual system theory provides a useful account of how nudges can influence cognition during the decision-making process (Kahneman, 2011; Thaler & Sunstein, 2008). The dual process theory argues that two distinct cognitive processes (i.e., type 1 and type 2 thinking) are the cause of how an individual makes certain judgments. Type 1 thinking is characterized by acting on intuition, making quick choices, and sensitivity to heuristics. A well-known example of Type 1 thinking is tying the laces of your shoes, which occurs without thinking. Characteristics of Type 2 thinking are making well-considered choices and logical reasoning. As suggested by Raue et al. (2018) and Van Gestel et al. (2020), Type 2 thinking also requires more cognitive resources compared to Type 1 thinking. An example of Type 2 thinking is choosing where to spend your time during the holidays since it requires conscious thinking. Individuals often use Type 1 thinking, since an individual has limited cognitive resources to make rational choices (Simon, 1990). This can cause unwillingness or a lack of ability to devote cognitive effort to the decision-making process. Therefore, nudges aim to respond to Type 1

thinking to increase their effectiveness without affecting individuals' cognitive resources (Van Gestel et al., 2020). This is in line with the nudge theory, which explains that individuals are susceptible to biases, which can lead to making unhealthy choices (Sunstein, 2017).

Data from a meta-analysis by Mertens et al. (2021) provide evidence to argue that nudges can be effective across behavioral domains. This study gathered data from over 200 studies on behavioral nudges and calculated a small to medium effect size of behavioral nudge interventions. More specifically, individuals' food selections seem to be exceptionally reactive to these interventions. However, the results of a meta-analysis by Cadario and Chandon (2020) on healthy eating nudges suggest that nudges are less effective in increasing healthy consumption but more effective in decreasing unhealthy consumption. In addition, Van Der Laan and Orcholska (2022) researched the effects of Just-In-Time nudges (JIT nudge) on food choices with a mobile application where supermarket customers could purchase food items. Results from this study showed that pop-ups with a healthy alternative after selecting a food item led to a higher number of healthy food choices in comparison to the number of food choices without a pop-up. Thus, data from several sources have identified that (digital) nudging can be a suitable intervention for behavioral changes (e.g., healthy food choices). However, one criticism of much of the literature on nudging is that it can have the opposite effect than was intended when a nudge is not congruent with an individual's preferences (Mills, 2020).

Personalization

Mills (2020) suggests that personalization might be a solution to the gap between a nudge and individual preferences. The term 'personalization' will be used solely in this thesis when referring to personalized communication. In the present study, the definition of personalization is described by White et al. (2007) as "a specialized flow of communication that sends different recipients distinct messages tailored to their individual preferences or characteristics." (p. 40).

Over the past century, there has been a dramatic increase in the gathering and analyzing of big data via digital means (e.g., mobile phones) by institutions. Using this data, organizations get a better grasp of the patterns and attitudes of consumers to create personalized content. The main goal of providing personal content to communicate to consumers is to increase an individual's perceived value of a product or service (Anshari et al., 2019; Fan & Poole, 2011). A model of tailoring effects developed by Lustria et al. (2016) explains that personalization increases effectiveness in behavioral changes by increasing personal relevance and attention. Moreover, Dalecke and Karlsen (2020) investigated the effects of personalization on digital nudging and suggested that personal data from individuals should be used to create personalized nudges since it can positively change consumer preferences. For example, if a customer in the grocery store selects and buys products based on price, nudges with healthier alternatives with a better price can be presented to stimulate healthier food choices.

Extensive research has shown that personalization can be effective in different domains. For example, Dawson et al. (2021) found that personalized interventions in mobile phone technologies had a positive effect on lifestyle decisions. Martin et al. (2016) studied the effects of personalization on weight loss and concluded that personalized interventions were more successful in promoting behavioral change compared to non-personalized interventions. Additionally, a recent study by De Hoogh et al. (2022) established that personalized dietary interventions can increase intrinsic motivation and thereby encourage behavioral change concerning food intake. Personalized nudges have also been proven to be effective in increasing the stronger passwords of internet users (Guo et al., 2020). Furthermore, Desai's study (2006) found that the personalization of e-commerce websites resulted in higher customer satisfaction compared to e-commerce websites without personalization. Thus, various studies show that

personalization can have a positive effect on behavioral change in various domains. Some studies also show that nudge personalization can help promote healthier food choices.

Reactance proneness

There are individual differences in reactance proneness, resulting in different levels of reactance to a nudge (Moreira et al., 2021; Shen & Dillard, 2007). Recently, there has been a shift from reactance as an emotional state that everyone can experience to the recognition of individual differences in reactance proneness (Shen & Dillard, 2007). Therefore, reactance can also be seen as a personality trait, suggesting individual differences cause people to interpret threats in various ways due to their variations in reactance proneness.

Previous research has established that individuals higher in reactance proneness generally have a more negative attitude towards persuasive messages compared to individuals who are lower in reactance proneness. For example, a study by Quick and Stephenson (2007) demonstrated that individuals who are higher in reactance proneness experience the motivational state reactance more often when exposed to a persuasive message. To reduce this negative feeling, they also showed higher levels of autonomy re-establishment (i.e., low need for autonomy) compared to individuals low in reactance proneness.

In line with these results, Dillard and Shen (2005) identified that individuals who are more sensitive to reactance reported higher levels of reactance compared to those less sensitive to reactance. However, they found no evidence for an interaction effect of reactance proneness and threat to freedom on reactance arousal. In other words, their study suggests that a higher threat to freedom and higher reactance proneness does not result in a higher degree of reactance to their persuasive health message. Reactance proneness has also been studied in the therapeutic context, where it has been proven that reactance proneness negatively affects advice effectiveness. Individuals higher in reactance proneness perceive advice given by a therapist to

change a given behavior as a threat to their freedom. Moreover, these individuals also show less compliance during therapy sessions (Seibel & Dowd, 1999).

The personality trait reactance proneness has also been associated with a certain scope of variables related to it. This has been seen in the case of Dowd and Wallbrown (1993) who showed that individuals who are sensitive to autonomy are more likely to be higher in reactance proneness. Additionally, Dowd et al. (1994) observed that individuals higher in reactance proneness are indifferent to others' opinions and beliefs, are reluctant to rules and order, and are more likely to express feelings and emotions. This may suggest that individuals who are high in the reactance proneness personality trait may respond more negatively to a persuasive message (eg, nudge) compared to individuals lower in reactance proneness. Additionally, higher autonomy individuals (i.e., high need for autonomy) are less likely to accept a proposed persuasive message compared to lower autonomy individuals (i.e., low need for autonomy) (Pavey & Sparks, 2009).

However, to the best of our knowledge, there is no existing literature on personalization and reactance proneness. However, studies on personalization and motivational state reactance mainly show that personalization can have a negative influence on persuasive messages, such as a nudge. For example, Chen et al. (2019) showed that reactance was evoked when non-personalization was perceived as cheap. But despite that, when a proposed choice was actually personalized, individuals also experience reactance. In line with the results of the study by Chen et al. (2019), the findings of a study conducted by White et al. (2008) show that reactance was also the reason why individuals receiving an email about a potential job declined the offer. In addition, Bleier and Eisenbeiß (2015) revealed personalized marketing banners can result in reactance when the receiver does not trust the messenger of the banner.

In adherence with previous research that has examined personalization, reactance proneness, and nudge effectiveness, the first hypothesis (H1) is “*Reactance proneness will moderate the effect of personalization on threat to freedom, such that the personalized condition will result in higher levels of threat to freedom for participants higher in reactance proneness compared to participants lower in reactance proneness.*”.

Autonomy: Threat to freedom

Yet, to date, there has been little agreement if differences in nudge effectiveness might be explained by threat to autonomy (Folkvord, 2019; Lv & Huang, 2022). According to the Self-Determination Theory (SDT), individuals have a fundamental need for autonomy which concerns free choice and free will (Niemiec & Ryan, 2009). Generally, it is argued that persuasive messages can be a threat to individuals' autonomy (e.g., Jenkins & Dragojevic, 2011; Pavey & Sparks, 2009). This threat is due to the rebuttal of autonomy, in a manner that inhibits an individual's control over their own reasoning process (Strauss, 1991). The term ‘threat to autonomy’ is used here to refer to the threat to freedom. Higher autonomy is equal to a higher threat to freedom and lower autonomy is equal to a lower threat to freedom. Results of a study by Lv and Huang (2022) are in line with this phenomenon, which shows that people were less likely to donate money to a charity when they were exposed to a personalized ad, compared to people who were confronted with a non-personalized ad. Moreover, the threat to autonomy can increase when personalization is detected by the receiver, but autonomy does not seem to be affected when the receiver does not detect the personalization in a message (Osman & Bechlivanidis, 2022).

Nonetheless, nudges are intended as a behavioral intervention that aims to preserve the autonomy (i.e., freedom of choice) of individuals (Folkvord, 2019). For example, the results of a study by Michaelsen et al. (2021) showed that autonomy was not threatened by nudges. In contrast, Schubert (2015) argues that nudges provide a threat to autonomy since they intend to

change an individual's behavior by exploiting cognitive biases. A study by Wachner et al. (2021) is in line with Schubert's opinion, showing that participants forecasted a threat to their autonomy when nudged. However, when they were actually exposed to a nudge, there were no signs that participants felt that their autonomy was threatened.

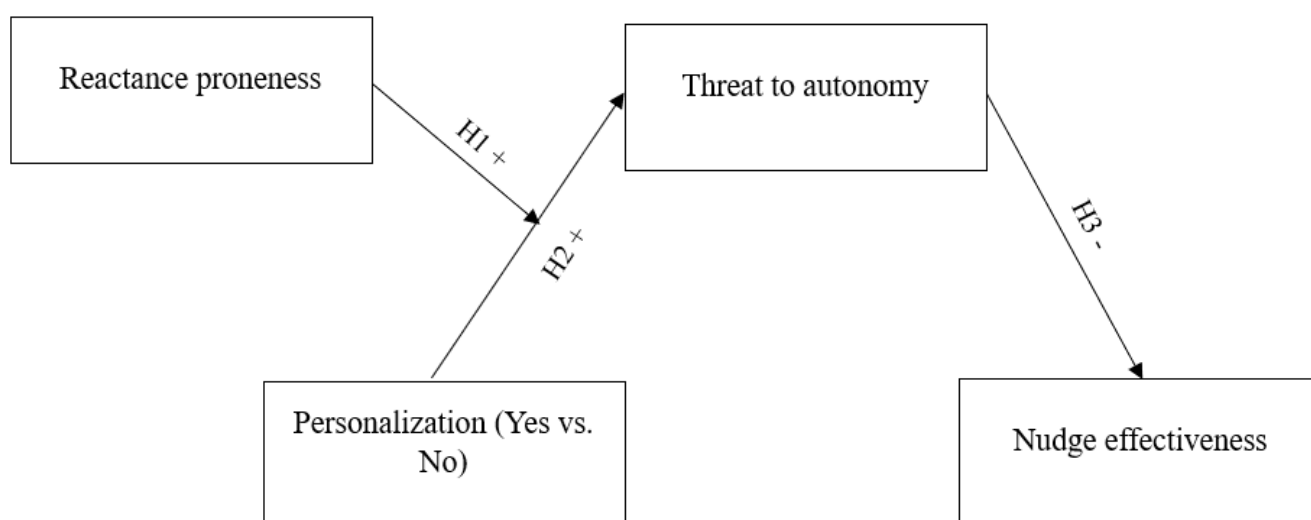
Although personalized messages can have positive effects on individuals' behavior (e.g., Guo et al., 2020; Péér et al., 2020; De Hoogh et al., 2022), it has the potential to become more of a threat to an individual's freedom or autonomy than non-personalized messages. When this threat is perceived by the receiver, they are confronted with a motivational state named 'reactance' (Jenkins & Dragojević, 2011). Personalized messages can become too intimate for the receiver, eliciting reactance (White et al., 2007). In contrast, the self-referencing effect explains that personalization can compensate for reactance when it successfully gets recipients engaged by appealing to their personal interests (Bartsch & Kloß, 2018). Thus, debate continues about whether and how autonomy explains the results of nudging by eliciting reactance.

According to the reactance theory, this motivational state elicited by personalized nudging inclines individuals to restore this freedom (Fogarty, 1997). This restoration of freedom is often done via source derogation and counterarguing (Rains, 2012), which often negatively impacts the persuasiveness of a message, such as noncompliance (Moreira et al., 2021; Thalhoffer & Kirscht, 1968). Moreover, reactance can cause the receiver to dismiss a message or nudge (Breves et al., 2021). Additionally, when an individual wants to restore their freedom, they might do that by employing freedom. Eventually, this can emerge as the 'boomerang effect', meaning that the opposite behavior of what is desired by the sender is carried out by the recipient (Jenkins & Dragojević, 2011; Silvia, 2006). Therefore, a threat to autonomy may mediate the effect of personalization on nudge effectiveness.

Following the literature on autonomy, personalization, and nudge effectiveness, it is hypothesized (H2) that “H2: *The levels of threat to freedom will be higher in the personalized condition compared to the level of threat to freedom in the non-personalized condition.*” and (H3) “*The effect of personalization on nudge effectiveness is mediated by threat to autonomy.*”. Figure 1 shows the conceptual model and the directions of the expected effects between the variables nudge effectiveness, threat to autonomy, and reactance proneness. The ‘+’ sign indicates a positive effect and the ‘-’ sign indicates a negative effect.

Figure 1

Conceptual model of the effects of personalization on nudge effectiveness, the mediating effect of threat to freedom, and the moderating effect of reactance proneness on nudge



Method

Design

The current study was part of an overarching study conducted by Tilburg University, called the MAND 2 study. The dependent variable in this was nudge effectiveness and the

independent variables were personalization (personalization vs. no personalization) and transparency (disclosure vs. no disclosure). Other considered variables in this study were nudge acceptability, perceived autonomy, psychological reactance, persuasion knowledge, and self-control. The current study only focused on nudge effectiveness, personalization, psychological reactance, and perceived autonomy.

The current study utilizes an experimental, quantitative between-subject design with *personalization* (yes vs. no) as an independent variable and *nudge effectiveness* (%) as the dependent variable. In addition, this study researched the mediating effect of the independent variable *autonomy: threat to freedom (TTF)* and the moderation effect of *reactance proneness (RP)*. In the current study, reactance proneness is a quasi-experimental variable. The control variables in this study were hunger and BMI since this can cause modifications in food choices (Dalton et al., 2013; Hoefling & Strack, 2010). A major advantage of a between-subject design is that one condition cannot affect the other condition, because participants are exposed to only one condition (Treadwell & Davis, 2010). Participants were randomly assigned to one of the conditions. To ensure that participants were suitable for this study, they filled in an online inclusion questionnaire (see Appendix A) before they could engage in a lab session.

Participants

Inclusion and exclusion criteria

Exclusion criteria for selecting the subjects were dietary restrictions, a present or history of eating disorders, former participation in a MAND study, and no specific food choice motivation. These exclusions were chosen to prevent confounding variables from affecting the results. To enhance homogeneity and prevent translation errors in the questionnaires, this study only focused on participants who spoke Dutch fluently.

Population

The population that the MAND 2 study researches concerns the general university population and people with Type 2 diabetes, all 16 years or older. Data for the current study was jointly collected with the MAND 2 study. The MAND study has a longer research period than the current study. Due to this time constraint for the current study, the sample size for participants with Type 2 diabetes would be too small to draw a valid conclusion about this target group. Furthermore, only examining the general university population increases the homogeneity of the current study. Since a homogeneous population requires a smaller sample size (Treadwell & Davis, 2010), this is advantageous for the current study. Therefore, the current study does not investigate the population with Type 2 diabetes.

This study focused on university students 16 years and older. Furthermore, this population was easy to target for the experimenter, which was advantageous in terms of time constraints. Participants were recruited via the SONA subject pool, where students from the Tilburg School of Social and Behavioral Sciences and the Tilburg School of Humanities and Digital Sciences could register to participate in the study. In addition, posters promoting this study were hung at different places at Tilburg University to recruit students from other departments.

Of the 251 participants who completed the initial screening survey, 65 (25.9%) participants were excluded for not meeting the study criteria. The remaining final sample consisted of 186 participants and they were invited to engage in the lab session. As shown in Table 1, the majority of the respondents were female ($N = 134$, 72%) while 52 participants were male (28%). The majority of participants were between the ages of 20 and 24 ($N = 118$, 63.4%) years while 58 participants were between the ages of 17 and 19 years old (31.2%), and 10 participants were between the ages of 25 - 28 years old (5.4%). Furthermore, most participants' highest educational level was HAVO or VWO (78, 41.9%). 52 participants' highest educational

level was HBO bachelor (28%), while the third most common highest educational level was HAVO / VWO year (78, 41.8%).

Table 1

Demographic data of respondents in sample

Demographic	Items	Number of participants	Percentage
Gender	Male	52	28%
	Female	134	72%
Age	17-19	58	31.2%
	20-24	118	63.4%
	25-28	10	5.4%
Educational level	MAVO	2	1.1%
	HAVO / VWO	78	41.8%
	HBO propaedeutic year	23	12.4%
	HBO bachelor	52	28%
	University propaedeutic year	15	8.1%
	University bachelor	16	8.6%

Power analysis

A statistical power analysis with the G*Power version 3.1.9.7. tool (Faul et al., 2007) was conducted to calculate the minimum sample size needed to detect a medium effect. A meta-analysis conducted by Mertens et al. (2021) showed that the nudge effectiveness of the considered studies had a medium average effect size ($f = .25$), based on Cohen's (1988) standards. Outcomes suggested a minimum sample size of $N = 128$ participants for a Factorial ANOVA with an 80% power for establishing a medium effect and a criterion of $\alpha = .05$. Thus, the total number of participants in this study ($N = 186$) meets the minimum number of participants required for a medium effect size. In total, 92 participants were randomly assigned

to the personalized condition and 94 participants were exposed to the non-personalized condition.

Materials

Mobile application

The manipulation of personalization in the JIT nudges was integrated into a mock supermarket application (i.e., MAND app), developed by Nakko BV. This application enabled participants to do a grocery shopping task. Participants were given 10 food categories from which they could choose one product each. The participants then started with the grocery shopping task, which included the manipulation of personalization (i.e., personalization vs. no personalization). Each participant chose one food item per category. If this food item was in the unhealthy offer trial or mixed offer trial, they were exposed to a healthy JIT nudge. The participant was able to accept the nudge by clicking the button “Good idea!” or reject the nudge by clicking “X”. When the participant chose a food item that was in the filler trail, they were not confronted with a JIT nudge.

When the participant was done with selecting one item per food category, they had ten different food items in their online shopping basket and started the last step of the grocery shopping task. In this step, they got an overview of their online grocery shopping card where the ten selected items were presented. On this page of the mobile app, participants could make final changes to the food items they had chosen. The JIT nudges that they had accepted in essence could also be replaced by another food item. When the participant was satisfied with their ten final choices, they could click "Order". This led to the end of the grocery shopping task and participants saw on the screen that they had succeeded in this task.

Different trials determine if a participant was exposed to a JIT nudge, which will be discussed later. Since reactance proneness is considered a personality trait in this study, this

independent variable did not need manipulation in the mock supermarket application. The MAND app did not have any additional features and was not available for commercial use.

Product stimuli

In total, the application contained 10 food categories, each containing six products, resulting in 60 food items in total (i.e., $10 \times 6 = 60$). Each product belonged to one of three trial types. The first trial is called the *unhealthy offer*, divided into 4 different categories, each containing 6 unhealthy food items. In the second trial, *mixed offer*, there were three healthy food items and three unhealthy food items, divided into five categories. Participants were exposed to a pop-up with an alternative food item when they chose an unhealthy food item in the unhealthy offer or mixed offer. The third trial, the *filler* trial contained three healthy food items and three unhealthy food items but did not show a JIT nudge after selection, aiming to prevent participants from noticing that the study concerned digital JIT nudging. This trial was assigned to one condition.

With the 10 food categories, there were 8 different grocery shopping lists computed which were used during the experiment. Each grocery shopping list had a different order of food categories to prevent participants' personal preferences of food categories from influencing the food choices in the experiment. Furthermore, there were 39 healthier alternatives in the mock application. All food items were inspired by the Schijf van Vijf so that healthier alternatives could be drawn up as JIT nudges. This scientific information model from the Dutch Nutrition Center provides advice on food intake (Voedingscentrum, n.d.). Appendix B shows all product stimuli per category used in this research. As mentioned above, personalized JIT nudges were based on participants' individual purchase motivation (price vs. health) and learning style (verbal vs. visual).

Measures

Demographic data

This study gathered demographic data from the participants to enhance understanding of the sample's background. In addition, this data was used to perform a randomization check to test if the randomization of conditions was successful. The inclusion questionnaire collected participant's age, gender, and educational level. The questionnaire that was filled in after exposure to the experimental condition collected information on participants' weight and length.

Control question and manipulation check

The first question of the questionnaire participants filled in during the lab session measured participants' hunger at that moment. This was meant as a control question since hunger might influence food decisions (Hoefling & Strack, 2010), which may cause changes in their food choices during the grocery shopping task. Hunger was measured with a slider scale from 0 (not hungry at all) to 100 (very hungry). In addition, the lab session questionnaire contained four manipulation check questions (e.g., "The MAND app focused on me as a unique individual.") measuring participant's perceived personalization with a 7-point Likert scale (1 = Completely agree, 7 = Completely disagree). These questions were used in a previous study by Li (2016) and proved to be a reliable scale ($\alpha = .89$).

Nudge effectiveness

Nudge effectiveness was measured by the percentage of accepted nudges per participant. This percentage was calculated by dividing the total number of chosen food items before visiting the shopping cart by the number of chosen healthy food items before visiting the shopping cart, multiplied by 100. The filler trials were not included in this calculation, since they do not show a JIT nudge to the participant.

Autonomy: Threat to freedom

Threat to freedom was measured using an adapted and translated version of the previously validated autonomy subscale of the Basic Psychological Needs in Exercise Scale (e.g., "The products I have chosen are very much in line with my goals and interests."), consisting of a 5-point Likert scale (1 = completely disagree, 4 = completely agree) consisting of eight questions (Vlachopoulos & Michailidou, 2006). The first four questions of this scale measure perceived autonomy, whereas the last four questions measure threat to freedom. Therefore, this study used the last four questions of this scale. Thus, the threat to freedom was measured with a scale, consisting of 4 items on a 5-point Likert scale. The reliability of the scale in the present study was acceptable; $\alpha = .74$ ($M = 2.08$, $SD = .76$). The mean score of the participants will be used during the analysis.

Reactance proneness

Reactance proneness was measured using Hong's & Feadda's (1996) Psychological Reactance 5-item Scale (1 = Completely agree, 5 = Completely disagree) with 11 questions (e.g., "I get angry when my freedom of choice is limited."). The reliability of the scale in the present study was good; $\alpha = .84$ ($M = 2.55$, $SD = .63$). The mean score of the participants will be used during the analysis.

Procedure

Participants who met the inclusion criteria were able to make an appointment for a lab session via the SONA subject pool or email. At the start of the lab session, participants were asked to fill in a consent form and report their hunger at that moment. After that, the experimenter briefly explained the experiment without revealing the researchers' purpose to prevent this knowledge from affecting the results. Every participant received the grocery shopping list they were randomly assigned to. After completing the grocery shopping task, participants completed the Qualtrics survey that measured threat to autonomy and reactance

proneness. Once the participants completed this survey, they received the research debriefing. After the debriefing, the lab session came to an end and participants received an 8 euro or 1 study credit and three food products as a reward for their participation.

Data analysis

Data management and analysis were performed using SPSS 28.0 (2021). The reliability of the scale questions used in the lab session was calculated using Cronbach's alpha.

Randomization check and control variables

The Chi-Square of association was carried out to assess whether the randomization was successful for the categorical demographics (i.e., gender and educational level). One-way ANOVA was used to assess the successfulness of randomization of the continuous demographic age. In addition, One-Way ANOVA was used to test if hunger and BMI should be considered as control variables in the analysis.

Manipulation check

An independent t-test was carried out for the manipulation check of perceived personalization. In this analysis, the personalization type (i.e., personalization vs. no personalization) was the grouping variable and perceived personalization was the dependent variable. This t-test aimed to analyze if participants perceived the personalization condition as they were assigned to. The reliability of the scale was not high, $\alpha = .68$.

Hypothesis test

Descriptive data were generated for all variables. After that, Hayes' Process Macro Model 7 Moderated Mediation Analysis was performed. This model allows the analysis of main effects, mediation effects, and moderation effects. Therefore, Process Macro Hayes is a good model to assess if a) personalization has a direct effect on nudge effectiveness, b) reactance proneness has a direct effect on threat to autonomy c) the effect between personalization and

nudge effectiveness is mediated by perceived autonomy, and d) the effect between personalization and threat to freedom is moderated by reactance proneness.

Results

Randomization check and control variables

The Chi-Square test of Association was conducted to test whether the randomization of participants was successful and did not result in differences between conditions in demographic variables. There was no significant association between educational level and the conditions, $\chi^2(15) = 8.77, p = .89$. The One-way ANOVA was used to assess whether the randomization for age was successful. The One-way ANOVA showed no relationship between the treatment arms and age ($F(3, 182) = .47, p = .70, \eta^2 = .01$). Therefore, it can be assumed that there were no differences between conditions in demographic variables.

The One-way ANOVA was used to assess whether hunger and BMI should be taken into account as control variables during the main analysis. The first One-way ANOVA showed no significant differences between the treatment arms and hunger ($F(3, 182) = 2.13, p = .10, \eta^2 = .03$). The second One-way ANOVA showed no relationship between the treatment arms and BMI, ($F(3, 182) = 2.23, p = .08, \eta^2 = .04$). Thus, there is no evidence that hunger or BMI could affect the results of the main analysis. Therefore, there will be no control variables in the main analysis.

Manipulation check

To test whether the manipulation of personalization was successful, two independent t-tests were conducted. No significant differences ($p = .36$) in perceived personalization were found between the personalized condition ($M = 3.30, SD = 1.05$) and the non-personalized condition ($M = 3.43, SD = 1.06$). The difference represents a small effect, $d = 1.05$. Additionally, no significant differences ($p = .86$) in reactance proneness were found between the personalized condition ($M = 2.55, SD = .70$) and the non-personalized condition ($M =$

2.54, $SD = .55$). The difference represents a small effect, $d = .03$. Thus, it can be concluded that the manipulation of personalization was unsuccessful.

Hypothesis tests

The PROCESS macro (Model 7) from Hayes (2017) was used to the following hypotheses: “*Personalization will have a positive effect on nudge effectiveness in the low reactance proneness group and personalization will have a negative effect on nudge effectiveness in the high reactance proneness group.*” (H1), “*Personalization will result in a higher threat to freedom for participants higher in reactance proneness, resulting in lower nudge effectiveness compared to participants lower in reactance proneness.*” (H2), and “*The effect of personalization on nudge effectiveness is mediated by threat to autonomy.*” (H3). These results are significant at the $p = 0.05$ level.

Assumptions

The data of the non-personalized condition was normally distributed (z-score skewness = $-.64$ and z-score kurtosis = $-.81$). The data of the personalized condition was also normally distributed (z-score skewness = -1.11 and z-score kurtosis = $-.81$). Therefore, the assumption of normality was met. Levene’s test indicated equal variances for reactance proneness ($F = .14, p = .71$). Thus, the assumption of homogeneity was met. Therefore, the p -values are reliable.

Hypothesis tests

The analysis found no significant difference between threat to autonomy ($M = 3.90, SD = .62$) scores of participants higher in reactance proneness compared to participants lower in reactance proneness. Moreover, no significant interaction effect between personalization and reactance proneness on threat to freedom was found ($F(182) = .75, p = .39$). Therefore, H1 stating that reactance proneness will moderate the effect of personalization on threat to freedom, such that the personalized condition will result in higher levels of threat to

freedom for participants higher in reactance proneness compared to participants lower in reactance proneness is not supported by the data. When the reactance proneness is low, the indirect effect is $-.24$, which is not significant ($p = .18$). Conversely, when reactance proneness is high, the indirect effect is $.29$, which is still not significant ($p = .18$). The index of moderated mediation (index = $.42$, 95% CI = $[-1.30/2.23]$) is not significant since the 95% CI does cross zero.

No significant differences in threat to freedom were found between the personalized condition ($M = 3.93$, $SD = .52$) and the non-personalized condition ($M = 3.94$, $SD = .70$), ($b = .01$, $t = .09$, $p = .93$). Thus, H2 stating that the levels of threat to freedom will be higher in the personalized condition compared to the level of threat to freedom in the non-personalized condition is not supported by the data. Moreover, no significant interaction effect between personalization and threat to freedom on nudge effectiveness was found ($F(162) = .70$, $p = .18$). Therefore, H3 stating that the effect of personalization on nudge effectiveness is mediated by threat to autonomy is not supported by the data. In other words, no mediating effect of threat to freedom on personalization and nudge effectiveness was found. Tables 2 and 3 present the results of the moderated mediation analysis. Figure 2 visualizes the results answering the hypotheses.

Table 2

Results of direct effects in the analysis

Direct effect	Unstandardized coefficient	t-values	p-values
Reactance proneness > Threat to freedom	-.28	-1.24	.22

Personalization * Reactance proneness > Threat to freedom	.13	.87	.39
Personalization > Threat to freedom	.01	.09	.93
Threat to freedom > Nudge effectiveness	3.27	1.08	.28
Personalization > Nudge effectiveness	5.01	1.35	.18
Personalization * Threat to Freedom > Nudge effectiveness	.13	.87	.18

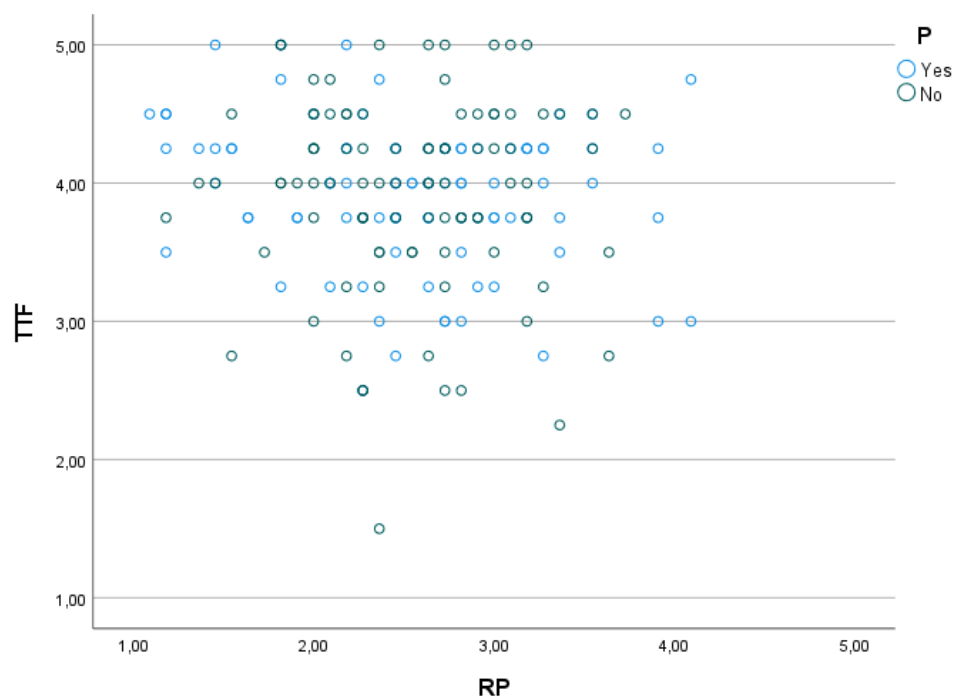
Table 3

Results of indirect effects of the results

Indirect effect	Direct effect	Indirect effect (SE)	Confidence interval low/high
Personalization > Threat to autonomy > Nudge effectiveness	5.01	.03	-.83 / 1.16
Low level of Reactance proneness	-.24	.64	-1.55 / 1.24
High level of Reactance proneness	.29	.73	-1.14 / 2.01
Index of Moderation Mediation	.42	.83	-1.30 / 2.23

Figure 4

Visualization of the effect of personalization (P) on nudge effectiveness (NEF), the mediating effect of threat to freedom (TTF), and the moderating effect of reactance proneness (RP)



Additional analysis

An additional hypothesis analysis was conducted after the extraction of participants who failed the manipulation check (see Appendix D). However, the output remained insignificant. Thus, only selecting cases that passed the manipulation check would not change the results and the complete sample was taken into account in the final hypothesis tests.

Discussion

This experimental study aimed to investigate the effect of personalization on nudge effectiveness. In addition, this study examined the mediating effect of threat to freedom and the moderating effect of reactance proneness. The results of this study did not support the

hypothesis that reactance proneness will moderate the effect of personalization on threat to freedom, such that the personalized condition will result in higher levels of threat to freedom for participants higher in reactance proneness compared to participants lower in reactance proneness (H1). Furthermore, no significant effect on personalization on threat to autonomy was found (H2). This study also did not find evidence that the effect of personalization on nudge effectiveness is mediated by threat to autonomy (H3). These data must be interpreted with caution because the manipulation of personalization was ineffective.

Possible explanations for the results

Surprisingly, this study did not find any evidence that personalization can be an effective way to increase nudge effectiveness. This finding is contrary to previous studies which have suggested that personalization has a positive effect on nudge effectiveness. Several studies in other domains demonstrate a positive link between personalization and nudge effectiveness. Existing evidence can mainly be found in the cybersecurity domain. For example, Péér et al. (2020) and Qu et al. (2022) investigated the effects of personalized online security nudges. Péér and colleagues used role-play in their experiment, in which participants were shown personalized nudges. Qu and colleagues experimented without roleplay. Both personalized the nudges based on the General Decision-Making Style, which takes into account rational, avoidant, dependent, intuitive, and spontaneous styles of decision-making. Both studies used JIT nudges and control groups. Moreover, in the E-commerce context, Desai (2016) found that JIT nudges personalized by utilitarian or hedonic website visiting purposes are effective in increasing nudge effectiveness. Also, this study made use of a control group. Therefore, the current study may be affected by unexpected variables since there was no control group to compare the experimental groups to.

Looking at the healthy food domain, Starke et al. (2021) showed that the personalized nudge type serial position based on individual eating goals resulted in higher nudge

effectiveness. Serial position nudging in this study meant that food recipes chosen by participants were sorted based on their personal eating goals (i.e., high vs. low calorie and fat). This study utilized a control group, in which participants saw a non-personalized nudge. Furthermore, none of the studies mentioned above had based their personalization on motivation (health vs. price) or learning preferences (visual vs. verbal). This may mean that the choice of personalization could have led to insignificant results of personalization of nudge effectiveness. To the best of our knowledge, this study in the healthy food domain is the first to utilize these personalization types. Although previous studies have shown that personalization increases nudge effectiveness with JIT and serial type nudges and General Decision-Making Style personalization parameters, the current study shows that personalizing visibility nudges with learning preference and food choice motivations parameters may be weaker or not effective.

It was hypothesized that reactance proneness will moderate the effect of personalization on threat to freedom, such that the personalized condition will result in higher levels of threat to freedom for participants higher in reactance proneness compared to participants lower in reactance proneness. Additionally, in contrast to the expectations, the results also did not show a significant effect of reactance proneness on the threat to autonomy (H1).

This is in contrast with previous studies investigating the effect of reactance proneness on the threat to freedom. The questions measuring reactance proneness were presented to the participants after they were exposed to one of the conditions. Since the personalized condition can influence reactance levels, reactance proneness as a personality trait should have been measured before participants were exposed to the treatment condition. On the other hand, measuring reactance proneness before the participants were exposed to the condition could have given them an idea about the research objective and affect the choices

made in the task. The knowledge that can be activated by measuring reactance proneness in advance could equally have influenced the results.

Contrary to expectations, this study also did not find a significant effect of personalization and threat to freedom (H2). Additionally, evidence was found that the effect of personalization of nudge effectiveness is mediated by threat to autonomy (H3). A study by Leen Lee (2009) on the effect of personalization on the threat to freedom utilized two conditions where personalization was used in both, but the level of threat to freedom was manipulated. This study took place in the non-food shopping domain. Participants in the high threat to freedom condition were made aware that they would receive personalized recommendations, whereas participants in the low-level threat to freedom were not aware of personalization. They found that when the threat to freedom was high, participants were less likely to accept the recommendation provided by the shopping mall. These results suggest that awareness of personalization might affect the levels of threat to freedom. Therefore, the insignificant results of personalization on autonomy may be explained in part because participants in the present study were not aware of nudge personalization. To the best of our knowledge, little research has been done on the effect of personalization on the threat to freedom.

However, Dong et al. (2023) studied personalization and the threat to freedom in the medical consultation context. Their results show that personalization elicited a threat to freedom. They explained that this result may be due to the topic's sensitivity. Therefore, participants in the present study may not feel sensitive about supermarket food choices, which may have resulted in an insignificant effect of personalization on the threat to autonomy. Thus, using personal information that people rather not share may affect the threat to freedom when confronted with a personalized nudge.

Bartsch & Kloß (2018) conducted research whereby they analyzed the differences in the effectiveness of personalized advertising and non-personalized advertising in the charity

domain. Personalization was manipulated by using participants' names in advertisements, which resulted in higher levels of reactance. In their study, reactance was measured as a motivational state rather than a personal characteristic where threat to freedom was considered to be a component of reactance. In opposition, the current study measured reactance as a personality trait. However, if reactance was measured as a temporary motivational state caused by the condition they were exposed to instead of a personality trait, it may have led to a significant difference between personalized and non-personalized nudge effectiveness.

Limitations

This study acknowledges several limitations that should be noted. First, this study utilized a convenience sample and its sample consisted only of students of Tilburg University. Therefore, generalizability of the results to another population than university students is not possible. For example, individuals' need for autonomy is known to change with age (Dutra-Thomé et al., 2019). Moreover, a study by Woller et al. (2007) showed that age also influences reactance levels, such that younger (18 - 34 years old) and older (55 years or older) individuals have higher levels of reactance proneness compared to middle-aged individuals (35 - 54 years old). Thus, younger or older individuals may react differently to a persuasive message compared to university students. On the other hand, this study conducted experiments with a large homogenous sample. Thus, it can be assumed that the results are reliable and accurate. This provides the opportunity to generalize the results to Dutch university students.

In addition, preferences of motivation to buy a food product (health vs. price) and one's learning preference (visual vs. verbal) were measured on a scale from 0 (no preference) to 100 (complete preference). The level of differences between the preferences could have influenced the results. For example, if a participant scored 90 on health and 91 on price on motivation, the feeling of personalization could have been lower than that of a participant whose scores are further apart.

The manipulation of the independent variable personalization was unsuccessful. More specifically, the majority of the participants in the personalized condition indicated that they had not seen any personalized nudges and vice versa. Since the reliability of the scale measuring perceived personalization was not very high ($\alpha = .68$), it may not have measured what it was supposed to measure. This misunderstanding could have led to participants not responding to the intended condition. As a result, certain effects of the awareness of being confronted with a personalized or non-personalized condition may have disappeared. If participants were aware of personalization, the feeling of privacy invasion, and an increased use of persuasion knowledge (Eisend & Tarrahi; 2021; Zhu & Chang, 2016). These outcomes of personalization awareness can lead to a negative effect between personalization and nudge effectiveness. Since the participants were not aware of personalization, awareness could not have played a mediating or moderating role in the current study.

Besides limitations, this study also showed some strong aspects. For example, during the experiment, this study used a real mock supermarket application and participants received real food products. This application has been a useful tool in creating a realistic online supermarket environment in which participants could do their shopping. Thus, the mock supermarket application may have made participants more immersed, making grocery shopping more authentic for them. Therefore, the results might be more representative of choices participants would have made in real life.

Suggestions for future research

There is abundant room for further progress in determining the effects of personalization on nudge effectiveness in the healthy food domain and what underlying mechanisms may increase or decrease this effect. In future investigations, it might be possible to use manipulations of personalization based on other individual preferences. For example, the General Decision-Making Style (GDMS) recognizes five individual preferences when making

a decision; rational, avoidant, dependent, intuitive, and spontaneous. Results of previous studies suggest that these five preferences might be a good predictor of making a decision and nudges tapping into these decision styles seem to be promising, also in the nudge domain (Malkin et al., 2017; Péer et al., 2020; Qu et al., 2022).

One explanation for the insignificant effect of personalization on the threat to freedom was a lack of awareness that they saw a personalized nudge. Since other studies suggest that transparency might affect threats to freedom, a further study with more focus on personalization awareness and threat to freedom is therefore suggested. In addition, topic sensitivity might explain why people may experience higher or lower threats to freedom when they are confronted with a personalized message. In future investigations, it might be possible to use topic sensitivity as a moderator of the effect of personalization on the threat to freedom. Researching personalization and transparency may provide insight into whether transparency can increase the effect of personalization. These insights can be used to tailor nudges accordingly so that healthier lifestyles can be stimulated in future interventions.

Conclusion

The present research adds to the growing body of literature on personalized nudge effectiveness and the effects of threat to freedom, and reactance proneness. The findings of this study suggest that threat to freedom and reactance proneness do not have an impact on nudge effectiveness in the online healthy food choice domain when comparing personalized and non-personalized JIT nudges. There may be other individual differences such as one's General Decision-Making Style or underlying mechanisms such as transparency that can explain the effects of personalization on nudge effectiveness. Further research was suggested to investigate if other variables can result in significant differences in personalization and nudge effectiveness.

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Appendices

Appendix A: Inclusion questionnaire

Het doel van dit onderzoek is om meer te weten te komen over wat potentiële gebruikers en diverse consumenten vinden van **MAND**, een nieuw mobiel platform voor het boodschappen doen.

Deze online inclusievragenlijst bestaat uit een aantal vragen om te controleren of je voldoet aan de criteria voor deelname aan het onderzoek in het lab, met betrekking tot demografie (bijv. leeftijd) en gezondheid.

Deelname aan de vragenlijst is geheel **vrijwillig**. Je hebt op ieder moment het recht om deelname te weigeren of te stoppen met de vragenlijst zonder reden of negatieve consequenties.

Wanneer je de online inclusievragenlijst invult en blijkt dat je **niet** geschikt bent voor de lab-studie, zullen je antwoorden niet worden opgeslagen en je data zal direct worden verwijderd.

Wanneer je de vragenlijst invult en je blijkt **wel** geschikt, zal je data gebruikt worden om contact met jou op te nemen en opgeslagen te worden zolang dat nodig is (d.w.z. 10 jaar na het einde van het onderzoek).

Bevestig hieronder of je toestemming geeft voor het verwerken van jouw persoonlijke data om te controleren of je geschikt bent voor de lab-studie.

- ☐ **Ja**, ik geef toestemming om mijn data te verwerken
- ☐ **Nee**, ik geef geen toestemming om mijn data te verwerken

Studeer je op dit moment?

- ☐ Ja
- ☐ Nee

Gebruik je op dit moment medicatie (anders dan anticonceptie of paracetamol)?

- ☐ Ja
- ☐ Nee

Eet je bepaalde voedingsmiddelen NIET vanwege persoonlijke overtuigingen, geloofsovertuigingen, of allergieën?

Dit omvat, maar is niet beperkt tot: vlees (rund, varken, kip, etc.), zuivel (melk en melkproducten), gluten, noten, fruit en groenten.

Voorbeelden: vegetarisch, veganistisch, lactose-intolerantie, glutenallergie, notenallergie.

- ☐ Ja
- ☐ Nee

Heb je op dit moment een eetstoornis of heb je in het verleden een eetstoornis gehad?

- ☐ Ja
- ☐ Nee

Heb je eerder deelgenomen aan de eerste MAND studie (in februari - april 2023)?

- ☐ Ja
- ☐ Nee

Geef aan in hoeverre je het eens of oneens bent met de volgende stellingen.

Je eerste indruk is meestal de beste; er zijn geen goede of foute antwoorden.

Ik vind het belangrijk om gezonde producten te kopen.

Slider 0 (helemaal mee oneens) tot 100 (helemaal mee eens)

In een leersituatie (bijv. tijdens een lezing, training of workshop) wordt informatie soms verbaal gepresenteerd (bv. met tekst of gesproken woorden) en soms wordt informatie visueel gepresenteerd (bv. met afbeeldingen, grafieken, of animaties).

Geef je leervoorkeur aan door één van de opties hieronder te selecteren. Je eerste indruk is meestal de beste, er zijn geen goede of foute antwoorden.

- ☐ Veel meer verbaal dan visueel
- ☐ Meer verbaal dan visueel
- ☐ Iets meer verbaal dan visueel
- ☐ Zowel verbaal als visueel
- ☐ Iets meer visueel dan verbaal
- ☐ Meer visueel dan verbaal
- ☐ Veel meer visueel dan verbaal

Wat is je geslacht?

- ☐ Man
- ☐ Vrouw
- ☐ Anders

Wat is je leeftijd (in jaren)?

Open antwoord

Voer je e-mailadres in zodat we binnenkort contact met je kunnen opnemen over deelname aan het onderzoek.

Open antwoord

Appendix B: Product stimuli per food category (N = 10)

Table 1

Dessert Category

Product number	Trial type	Product type (Healthy vs. Unhealthy)	Product options (N=6 per category)	Price (€)
1	Experimental – fixed choice	Unhealthy	Bros krakende mousse (4 x 57 g)	1.99
2	Experimental – fixed choice	Unhealthy	Almhof Choco met echte slagroom wit-vanille (180 g)	1.29
3	Experimental – fixed choice	Unhealthy	Mona Vanillepudding met aardbeiensaus (450 ml)	1.89
4	Experimental – fixed choice	Unhealthy	Campina Vlaflip vanille (1L)	2.09
5	Experimental – fixed choice	Unhealthy	De Zaanse Hoeve Tiramisu 2-pack (160 g)	1.00
6	Experimental – fixed choice	Unhealthy	Solero exotic (3 stuks)	4.45

Table 2*Soft Drink Category*

Product number	Trial type	Product type (Healthy vs. Unhealthy)	Product options (N=6 per category)	Price (€)
7	Experimental – fixed choice	Unhealthy	Coca-Cola Regular (1L)	2.49
8	Experimental – fixed choice	Unhealthy	Fanta Orange (1L)	2.44
9	Experimental – fixed choice	Unhealthy	Lipton ice tea green (1.5 L)	2.99
10	Experimental – fixed choice	Unhealthy	Royal Club Ginger ale (1L)	2.11
11	Experimental – fixed choice	Unhealthy	Red Bull Energy drink 4-pack (1L)	7.49
12	Experimental – fixed choice	Unhealthy	Spa Fruit citron (1.25 L)	1.85

Table 3*Snack Category*

Product number	Trial type	Product type (Healthy vs. Unhealthy)	Product options (N=6 per category)	Price (€)
13	Experimental – fixed choice	Unhealthy	Nakd. Pecan pie fruit- en notenrepen (4 stuks)	2.99
14	Experimental – fixed choice	Unhealthy	Nature Valley Fruit & nut cranberry noten mueslireep (4 stuks; 120 g)	3.09
15	Experimental – fixed choice	Unhealthy	Duyvis Pinda's Gezouten (235 G)	2.36
16	Experimental – fixed choice	Unhealthy	Kanjers Extra grote stroopwafels (320 g)	1.99
17	Experimental – fixed choice	Unhealthy	Bonne Maman Les Petits muffins vanille (235 g)	2.99
18	Experimental – fixed choice	Unhealthy	Pringles Original (165 g)	2.09

Table 4*Dairy Category*

Product number	Trial type	Product type (Healthy vs. Unhealthy)	Product options (N=6 per category)	Price (€)
19	Experimental – fixed choice	Unhealthy	De Zaanse Hoeve Volle melk (1L)	1.19
20	Experimental – fixed choice	Unhealthy	Fage Total Griekse yoghurt 5% (500 g)	3.29
21	Experimental – fixed choice	Unhealthy	Campina Volle yoghurt (1L)	1.79
22	Experimental – fixed choice	Unhealthy	Campina Biologisch volle melk(1L)	1.99
23	Experimental – fixed choice	Unhealthy	Beemster Jong 48+ plakken (150 g)	2.69
24	Experimental – fixed choice	Unhealthy	Old Amsterdam Roomkaas original (125 g)	2.79

Table 5*Bread Category*

Product number	Trial type	Product type (Healthy vs. Unhealthy)	Product options (N=6 per category)	Price (€)
25	Experimental – free choice	Healthy	AH Bruin heel	0.99
26	Experimental – free choice	Healthy	AH Bakkersbol spelt (4 stuks)	2.09
27	Experimental – free choice	Healthy	AH Biologisch Volkoren broodjes met desem bereid (4 stuks)	2.19
28	Experimental – fee choice	Unhealthy	AH Bakkersbol boter (4 stuks)	1.49
29	Experimental – free choice	Unhealthy	AH Extra lang lekker tijger wit heel	1.19
30	Experimental – free choice	Unhealthy	AH Witte pistolets (4 stuks)	1.24

Table 6*Noodles Category*

Product number	Trial type	Product type (Healthy vs. Unhealthy)	Product options (N=6 per category)	Price (€)
31	Experimental – free choice	Healthy	De Cecco Penne rigate integrali nr 41 (500 g)	2.59
32	Experimental – free choice	Healthy	Grand' Italia Salade pasta volkoren fusilli (500 g)	2.85
33	Experimental – free choice	Healthy	Go-tan Whole wheat noodles bio-organic (250 g)	2.99
34	Experimental – free choice	Unhealthy	Grand' Italia Spaghetti all'uovo (500 g)	2.39
35	Experimental – free choice	Unhealthy	Samasaya Fijne Eiernoedels (250 g)	2.89
36	Experimental – free choice	Unhealthy	Honig Macaroni Spelt (550 g)	2.79

Table 7*Breakfast Category*

Product number	Trial type	Product type (Healthy vs. Unhealthy)	Product options (N=6 per category)	Price (€)
37	Experimental – free choice	Healthy	Milner Smeerkaas 20+ naturel (150 g)	2.09
38	Experimental – free choice	Healthy	Quaker Oats express havermout naturel (324 g)	1.99
39	Experimental – free choice	Healthy	Bolletje Lichte crackers volkoren (190 g)	1.79
40	Experimental – fee choice	Unhealthy	Meester & Zn. Runderrookvlees (100 G)	2.89
41	Experimental – free choice	Unhealthy	Quaker Havermout crunchy muesli met noten (350 G)	3.75
42	Experimental – free choice	Unhealthy	Vifit goedemorgen aardbei sinaasappel (1L)	2.39

Table 8*Meat Category*

Product number	Trial type	Product type (Healthy vs. Unhealthy)	Product options (N=6 per category)	Price (€)
43	Experimental – free choice	Healthy	AH Kipgehakt naturel (300 g)	3.79
44	Experimental – free choice	Healthy	AH Kalkoenfilet schnitzel (240 g)	4.02
45	Experimental – free choice	Healthy	De vegetarische slager vegan kipstuckjes (160g)	2.89
46	Experimental – free choice	Unhealthy	AH Greenfields Rundergehakt (300 g)	3.99
47	Experimental – free choice	Unhealthy	Jumbo Grill Burgers (180 g; 2 stuks)	2.35
48	Experimental – free choice	Unhealthy	AH Krokante kipfiletschnitzel 2 stuks (250 g)	4.61

Table 9*Frozen Category*

Product number	Trial type	Product type (Healthy vs. Unhealthy)	Product options (N=6 per category)	Price (€)
49	Filler – no nudge	Healthy	Bonduelle diepvries Broccoli roosjes	1.99
50	Filler – no nudge	Healthy	Doosje Blauwe bes framboos (AH merk; 250 g)	2.39
51	Filler – no nudge	Unhealthy	Kwekkeboom oven bitterballen (12 stuks)	2.85
52	Filler – no nudge	Unhealthy	Mora oven kipnuggets (14 stuks)	3.99
52	Filler – no nudge	Unhealthy	Aviko SuperCrunch originals Franse frites (750 g)	2.29
54	Filler – no nudge	Healthy	Garnalen rauw en gepeld (AH merk; 225 g)	5.09

Table 10*Greens Category*

Product number	Trial type	Product type (Healthy vs. Unhealthy)	Product options (N=6 per category)	Price (€)
55	Filler - nudge attached to healthy product	Healthy	Vers spinazie (AH merk; 400g)	1.65
56	Filler - nudge attached to healthy product	Healthy	Vers worteltjes (AH merk; 300 g)	1.00
57	Filler - nudge attached to healthy product	Healthy	Vers maiskolven (AH merk; 2 stuks)	2.49
58	Filler - nudge attached to healthy product	Unhealthy	HAK gesneden bladspinazie (330 g)	1.89
59	Filler - nudge attached to healthy product	Unhealthy	Bonduelle crispy mais blik (300 g)	1.85
60	Filler - nudge attached to healthy product	Unhealthy	Bonduelle wortels blik (155 g)	1.09

Appendix C: Questionnaire lab session

Welkom bij de MAND 2 studie!

Het doel van dit onderzoek is om meer te weten te komen over wat potentiële gebruikers en consumenten vinden van MAND, een nieuw mobiel platform voor het boodschappen doen.

Beantwoord alsjeblieft onderstaande vraag voordat we gaan beginnen.

Beoordeel de volgende stelling van 0 (Helemaal niet) tot 100 (Heel erg).

Er zijn geen goede of foute antwoorden; je eerste indruk is vaak het beste.

Hoeveel honger heb je op dit moment?

Instructies

Stel je voor dat je boodschappen doet via de MAND app. Wij zullen je een smartphone geven met daarop de MAND app en een boodschappenlijstje waarop 10 productcategorieën staan die je in je winkelmandje moet gaan leggen.

Zoek in de MAND app naar producten van alle categorieën op je boodschappenlijstje door de naam van de categorie in de zoekbalk in te voeren. Zoek naar de categorieën in de volgorde zoals het op je lijstje staat (#1 tot #10) en kies één product per categorie. Als je een product gekozen hebt, krijg je een groen vinkje als bevestiging te zien.

Let op: Wanneer je op  klikt, wordt het artikel direct toegevoegd aan je winkelmandje.

Dus, neem je tijd om alle opties te bekijken voordat je je keuze maakt. Je kunt de namen van

de categorieën van je boodschappenlijstje afstrepen (met een pen) om je voortgang bij te houden.

Nadat je alle categorieën van je boodschappenlijstje hebt afgestreept, heb je de mogelijkheid om je uiteindelijke winkelmandje te zien. Je kunt producten nog vervangen in je uiteindelijke

winkelmandje door de “vervang” knop  naast een product aan te klikken. Vergeet niet op  te klikken wanneer je klaar bent om de MAND app te verlaten!

We zijn geïnteresseerd in jouw individuele en eerlijke antwoorden. Je ontvangt ongeveer een kwart van je gekozen producten (drie producten in totaal; willekeurig uitgekozen) aan het eind van de sessie.

Geef een seintje aan de onderzoeker wanneer je klaar bent om te beginnen. Aarzel niet de onderzoeker aan te spreken wanneer je vragen hebt of iets niet duidelijk is.

Geef een seintje aan de onderzoeker wanneer je klaar bent om met de boodschappentaak te beginnen.

We willen je nu vragen om een aantal vragen te beantwoorden over je ervaringen met het boodschappen doen via de MAND app.

Bevestig wanneer je klaar bent om de vragen te gaan beantwoorden.

- Ik ben klaar om te beginnen!

Threat to Autonomy

Geef voor de volgende opmerkingen aan in hoeverre deze van toepassing zijn op de productkeuze(s) die je zojuist gemaakt hebt in de MAND-app.

Probeer tijdens het invullen van deze vragen zoveel mogelijk uit te gaan van jouw ervaring.

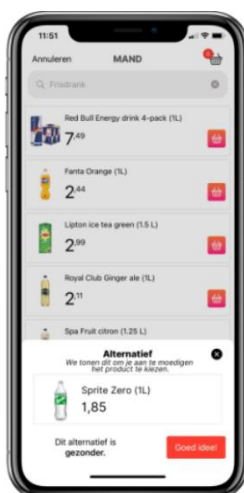
	Helemaal mee oneens	Mee oneens	Neutraal (niet mee eens/niet mee oneens)	Mee eens	Helemaal mee eens
De producten die ik heb gekozen zijn zeer in lijn met mijn doelen en interesses.	☐	☐	☐	☐	☐
Ik heb heel sterk het gevoel dat mijn gekozen producten perfect aansluiten bij mijn voorkeuren.	☐	☐	☐	☐	☐
Ik heb het gevoel dat de productkeuzes die ik gemaakt heb absoluut weerspiegelen wie ik ben.	☐	☐	☐	☐	☐
Ik voel heel sterk dat ik de kans heb gehad om invloed op mijn keuzes te hebben.	☐	☐	☐	☐	☐

In hoeverre ben je het eens met de volgende stellingen? Er zijn geen goede of foute antwoorden.

	Helemaal mee oneens	Mee oneens	Neutraal (niet mee eens/niet mee oneens	Mee eens	Helemaal mee eens
De MAND-app bedreigde mijn keuzevrijheid.	☐	☐	☐	☐	☐
De MAND-app probeerde een beslissing voor mij te maken.	☐	☐	☐	☐	☐
De MAND-app probeerde mij te manipuleren.	☐	☐	☐	☐	☐
De MAND-app probeerde mij onder druk te zetten.	☐	☐	☐	☐	☐

Manipulation check – perceived personalization

Bij het kiezen van
aanbevelingen die eruit



producten gaf de app je soms
zagen zoals hieronder:

	Helemaal mee oneens	Mee oneens	Enigszins mee oneens	Neutraal (niet mee eens/niet mee oneens)	Enigszins mee eens	Mee eens	Helemaal mee eens
De MAND-app was gericht op mij als een uniek individu.	○	○	○	○	○	○	
De MAND-app personaliseerde aanbevelingen op basis van informatie over mij als persoon.	○	○	○	○	○	○	
De MAND-app stemde de aanbevelingen af op basis van mijn voedselvoorkeuren	○	○	○	○	○	○	
De MAND-app stemde de aanbevelingen af op mijn persoonlijke leervoorkeur	○	○	○	○	○	○	

(visueel/verbaal)

Reactance proneness

De volgende uitspraken gaan over hoe je tegen jezelf aankijkt. Het is de bedoeling dat je aangeeft in hoeverre de uitspraken op jou van toepassing zijn.

Je eerste indruk is meestal de beste; er zijn geen goede of foute antwoorden.

	Helemaal mee oneens	Mee oneens	Neutraal (niet mee eens/niet mee oneens)	Mee eens	Helemaal mee eens
Ik raak gefrustreerd wanneer ik geen vrije en onafhankelijke beslissingen kan maken.	☐	☐	☐	☐	☐
Het irriteert me wanneer iemand mij op dingen wijst die vanzelfsprekend zijn voor mij.	☐	☐	☐	☐	☐
Ik word boos wanneer mijn keuzevrijheid beperkt wordt.	☐	☐	☐	☐	☐

Regelgeving roept bij
mij een gevoel van
weerstand op.

☐ ☐ ☐ ☐ ☐

Ik vind het
tegenspreken van
anderen stimulerend.

☐ ☐ ☐ ☐ ☐

Wanneer iets
verboden is, denk ik
meestal, dat is precies
wat ik ga doen.

☐ ☐ ☐ ☐ ☐

Ik verzet me tegen
pogingen van anderen
om mij te
beïnvloeden.

☐ ☐ ☐ ☐ ☐

Het maakt me boos
wanneer iemand
anders als rolmodel
wordt opgehouden
voor mij om te
volgen.

☐ ☐ ☐ ☐ ☐

Wanneer iemand mij
dwingt om iets te
doen, heb ik zin om
het tegenovergestelde
te doen.

☐ ☐ ☐ ☐ ☐

Advies van anderen
beschouw ik als
opdringerig.

☐ ☐ ☐ ☐ ☐

Advies en
aanbevelingen zetten
mij ertoe aan om
precies het
tegenovergestelde te
doen.

☐ ☐ ☐ ☐ ☐

Wat is je lengte (in cm)?

Open antwoord

Wat is je gewicht (in kg)?

Open antwoord

Wat is het hoogste opleidingsniveau dat jij hebt behaald?

- ☐ Geen of basisonderwijs
- ☐ LBO / VMBO (kader- of beroepsgericht) / MBO 1 / VBO
- ☐ MAVO / HAVO of VWO (overgegaan naar 4e klas) / VMBO (theoretisch of gemengd) / (M)ULO
- ☐ MBO 2, 3, 4 of MBO voor 1998
- ☐ HAVO of VWO (met diploma afgerond) / HBS / MMS
- ☐ HBO propedeuse
- ☐ HBO bachelor
- ☐ HBO master
- ☐ universitair propedeuse
- ☐ universitair bachelor / kandidaats
- ☐ universitair master / doctoraal / post doctoraal

Bedankt voor je deelname!

Jouw antwoorden zijn verwerkt.

Appendix D: Additional hypotheses analysis with passed manipulation checks

In total, 150 participants passed the manipulation check. The analysis found no significant difference between threat to autonomy ($M = 4.02$, $SD = .54$) scores of participants higher in reactance proneness compared to participants lower in reactance proneness. Moreover, no significant interaction effect between personalization and reactance proneness on threat to freedom was found ($F(98) = .35$, $p = .34$). Therefore, H1 stating that reactance proneness will moderate the effect of personalization on threat to freedom, such that the personalized condition will result in higher levels of threat to freedom for participants higher in reactance proneness compared to participants lower in reactance proneness is not supported by the data.

No significant differences in threat to freedom were found between the personalized condition ($M = 4.04$, $SD = .44$) and the non-personalized condition ($M = 4.00$, $SD = .62$), ($b = -.03$, $t = 1.01$, $p = .32$). Thus, H2 stating that the levels of threat to freedom will be higher in the personalized condition compared to the level of threat to freedom in the non-personalized condition is not supported by the data. Moreover, no significant interaction effect between personalization and threat to freedom on nudge effectiveness was found ($F(128) = .75$, $p = .09$). Therefore, H3 stating that the effect of personalization on nudge effectiveness is mediated by threat to autonomy is not supported by the data. In other words, no mediating effect of threat to freedom on personalization and nudge effectiveness was found.