Designing a Digital Behavior Change Intervention for Online Grocery Stores: A Randomized Controlled Trial

Leonie Manzke

Friedrich-Alexander-University Erlangen-Nürnberg, Lange Gasse 20, 90403 Nürnberg, Germany

Abstract

Consumers face an abundance of food choices that occur in complex "hyper-choice" environments, making it difficult for individuals to follow through on healthful intentions. With poor diets posing a leading global health risk, behavioral strategies in decision-making settings, such as grocery shopping, should be considered to encourage healthier habits. Limitations in previous research include small or contradictory effects, as well as challenges in applying findings to digital settings, which have become more relevant with the increased prevalence of online grocery shopping. This paper discusses the design and methodology of a randomized controlled trial in a simulated online grocery store that will integrate an intervention grounded in Fogg's Behavior Model. N=800 participants will complete a survey and shopping task, then repeat the task a week later, while being randomized into one of four groups: control, receiving real-time feedback, a personalized reflection prompt, or both. The number of fruit and vegetable portions selected will be the primary outcome. Findings will contribute to the theoretical understanding of food choice and inform the design of effective digital interventions in persuasive systems to promote healthier shopping behaviors.

Keywords

Food Choice, Online Grocery Stores, Fogg Behavior Model, Persuasive Systems, Behavioral Interventions

1. Introduction

Poor dietary habits one of the leading worldwide health risks [1], contributing substantially to the mortality and morbidity associated with noncommunicable diseases [2]. While many individuals across various populations recognize the harmful outcomes of an unhealthy diet and express a desire to adopt healthy dietary habits [3], [4], most struggle to translate these intentions into action, even when equipped with the information needed to make informed choices.

One contributing factor is the overwhelming "hyper-choice situation" [5] inherent in food choice. Each grocery shopping trip involves hundreds of small decisions, where fast and automatic thought processes often dominate decision-making [6], [7]. Some behavioral interventions seek to address this challenge by not only providing the necessary information, but also acknowledging the limitations of human rationality. These interventions aim to simplify the decision-making process and guide consumers toward healthier choices (for reviews, see [8], [9]). One such potential target behavior is fruits and vegetable consumption.

BCSS 2025: The 13th International Workshop on Behavior Change Support Systems, May 5, 2025, Limassol, Cyprus.

leonie.manzke@fau.de (L. Manzke)

0009-0000-4318-9606 (L. Manzke)

While nutrition experts are not unified in their specific recommendations for a healthy diet, there is broad consensus that an increase in fruits and vegetable consumption would be an effective measure to improve public health [10].

There are four main issues with the current state of evidence on behavioral interventions for healthy food choices. Firstly, for one of the most common approaches, educational or information-based interventions, effect sizes and impact tend to be small [9], [11], [12]. Secondly, studies have uncovered contradictory effects for interventions adjusting product placement and availability, which also represent common strategies [12]. Thirdly, the impact of adjustments in product salience (i.e., degree of visibility) or pricing strategies has been found to diminish when applied in a real-world setting [13], despite substantial support from previous randomized-controlled trials [14]. Finally, there is noticeably less research on digitally administered behavioral interventions compared to interventions implemented in brick-and-mortar stores [15], despite an increasing pervasiveness of online grocery shopping (e.g., 14.7 % online market share in the US in 2023 [16]). Along with this trend, opportunities emerge to design and implement persuasive systems to encourage healthy food choices.

For the conceptualization of such systems, Fogg's Behavior Model (FBM) [17] offers a straightforward framework of the relevant mechanisms of action [18], [19], [20]. Behavior can be augmented by accounting for ability, triggers (also called “prompts” in later updates to the FBM) and motivation. Different behavior change techniques contribute to these three components to different extents [18], [21]. Interventions that combine different techniques to consider all three FBM components in their design have the potential to be more effective compared to interventions that only incorporate a single behavior change technique [22], [23], [24].

To make use of this potential, we propose a combination of behavioral interventions that considers all three components of the FBM [17] in an online supermarket setting. Specifically, our study will investigate the combination of real-time feedback (increasing ability), a reflection prompt (providing a trigger) and personalization (fostering motivation).

This research-in-progress manuscript conceptualizes the experimental design for a randomized controlled trial to investigate the following research question: *To what extent can real-time feedback / a personalized reflection prompt or their combination promote fruits and vegetable purchases?*

We present the theoretical foundations for the mechanisms of action in the proposed intervention design and outline anticipated contributions of this research.

2. Related Work and Hypotheses Development

The proposed interventions are designed to promote fruits and vegetable purchases, as the WHO recommends consuming a minimum amount per day to improve overall health and reduce the risk of non-communicable diseases [10]. We define fruits and vegetable consumption as the target behavior in the lens of the FBM. The following section will synthesize literature related to the FBM's mechanisms of action, all of which informed the design of the interventions.

2.1. Ability

One way of supporting consumers in making informed decisions are educational or information-based food choice interventions, which are comparatively inexpensive and easy to implement [11], [23], [25]. These interventions aim to reduce information overload and improve nutritional literacy by providing salient point-of-sale information (see exemplary studies: [26], [27], [28]). However, research indicates that informing decision-makers does not consistently increase the alignment between consumers' healthful intentions and their behavior [11], [29].

Previous research has further identified (perceived) behavioral control [4], [30] and mental load during decision-making [22] as key factors influencing intention-behavior consistency. Interventions that enhance behavioral control or reduce mental load can therefore promote healthy food choices by increasing consumers' ability to act on their intentions. Real-time feedback interventions, for example in the form of a live display of one's shopping basket's saturated fat content, align with this approach but remain underexplored in the context of food choices [31] despite demonstrating notable potential in other areas, such as resource conservation, where studies have shown how citizens saved a substantial amount of energy by having a device displaying feedback on real-time water use during showering [32], [33], [34].

Given real-time feedback can alleviate mental load during a decision-making process and increase a system's persuasive capability, we propose an intervention featuring a real-time display of fruits and vegetable portions in the current basket to give consumers a means to track their own behavior. This allows the system to account for users adjusting their goals during use time and provides users with insights about their own behavior through self-monitoring [20], [35], ultimately increasing their ability to include a sufficient number of fruits and vegetables in their shopping. We hypothesize:

H1: Participants will choose *more* fruits and vegetables when they receive *real-time feedback*, compared to no feedback.

2.2. Prompts

While educational and information-based interventions can influence attitudes and intentions toward healthy eating, their impact on actual behavior often falls short of meaningful effect sizes [9]. This limitation may stem from the habitual nature of food choices that makes intentions weak predictors of behavior, while situational cues play a larger role in driving behavior change [36]. Consistent with this understanding, the FBM emphasizes the need for triggers/prompts to convert motivation and ability into action, enabling the target behavior.

Prompts delivered at the point of decision can encourage reflection or provide information on alternatives to influence behavior. In various studies, such point-of-decision prompts have been successfully employed to increase the healthiness of food choices (see exemplary studies: [37], [38], [39], [40]).

We propose a prompt that invites consumers to reflect on their food choices and provides an opportunity to adapt previous decision-making. Therefore, we hypothesize:

H2: Participants will choose *more* fruits and vegetables when they receive a *reflection prompt* compared to when they do not receive a reflection prompt.

H3: Participants will choose *more* fruits and vegetables when they receive both a *reflection prompt* and *real-time feedback* during shopping, compared to just feedback.

2.3. Motivation

Studies in health education have shown tailored messaging to be superior to non-tailored messaging at motivating behavior [41], [42]. The Elaboration Likelihood Model [43] provides a framework to explain why this is the case. The model distinguishes between two cognitive processing routes: the central and the peripheral route. When messages are personally relevant to the individual, deliberate evaluation of message content through central route processing becomes more likely, provided sufficient cognitive resources are available for engagement. Therefore, tailoring information to individual users or user groups can enhance the persuasive capability of a system [20]. This aligns with studies showing perceived relevance to moderate the effectiveness of message personalization on persuasion [44]. In the lens of the FBM, persuasive messages should foster motivation, while the ability component ensures the availability of the resources necessary to act on this motivation.

However, some studies testing the impact of personalized messaging and point-of-decision-prompts had mixed results [37], [44], [45], and the underlying mechanisms of how personal relevance impacts persuasive effectiveness are yet unclear [45].

Our proposed intervention aims to contribute to this research gap by personalizing reflection prompts to individual study participants (further described in the Method section), aligning with the persuasive systems design principle of tailoring [20]. On the one hand, this allows us to examine how personalization influences the impact of persuasive systems on users, and on the one hand, to leverage the potential boosting effect on our intervention's effectiveness.

3. Methods

3.1. Experimental Design

Participants will complete two online study visits, separated by about 1 week. In the first study visit, participants will provide informed consent to participation, complete a survey, and complete a shopping task with no interventions placed in the store. For the second study visit, they will be randomly assigned to the control group or one of the experimental groups receiving Real-Time-Feedback (to test H1), a Reflection Prompt (to test H2), or the combination of both (to test H3) during their shopping task.

3.2. Setting: Shopping Task in a Simulated Online Grocery Store

The experiment will take place in a simulated online grocery store environment, which is a validated method for food choice research [46], [47]. The experiment platform, constructed with the MERN stack, emulates a well-known brick-and-mortar retailer's website that offers online grocery services. Products and product data were directly obtained from the retailer.

The instructions will specify to shop for a 2-person household, and to make sure that it is enough for 7 days, while staying within a budget range between $100 and $200. Participants will be instructed to choose products they genuinely want. They are informed that 25 randomly selected participants will be contacted to arrange the delivery of their chosen groceries; thus ensuring incentive-compatibility and improving ecological validity.

In order to include participants from areas where grocery delivery is challenging or unavailable, we will implement this raffle by contacting 25 randomly selected winners to arrange the transfer of a digital shopping voucher. At the start of the study, participants will be

informed that some instructions may contain deception to elicit certain behaviors, and after study completion, they will receive a thorough debriefing about the misrepresentation of their chances to win their basket of groceries.

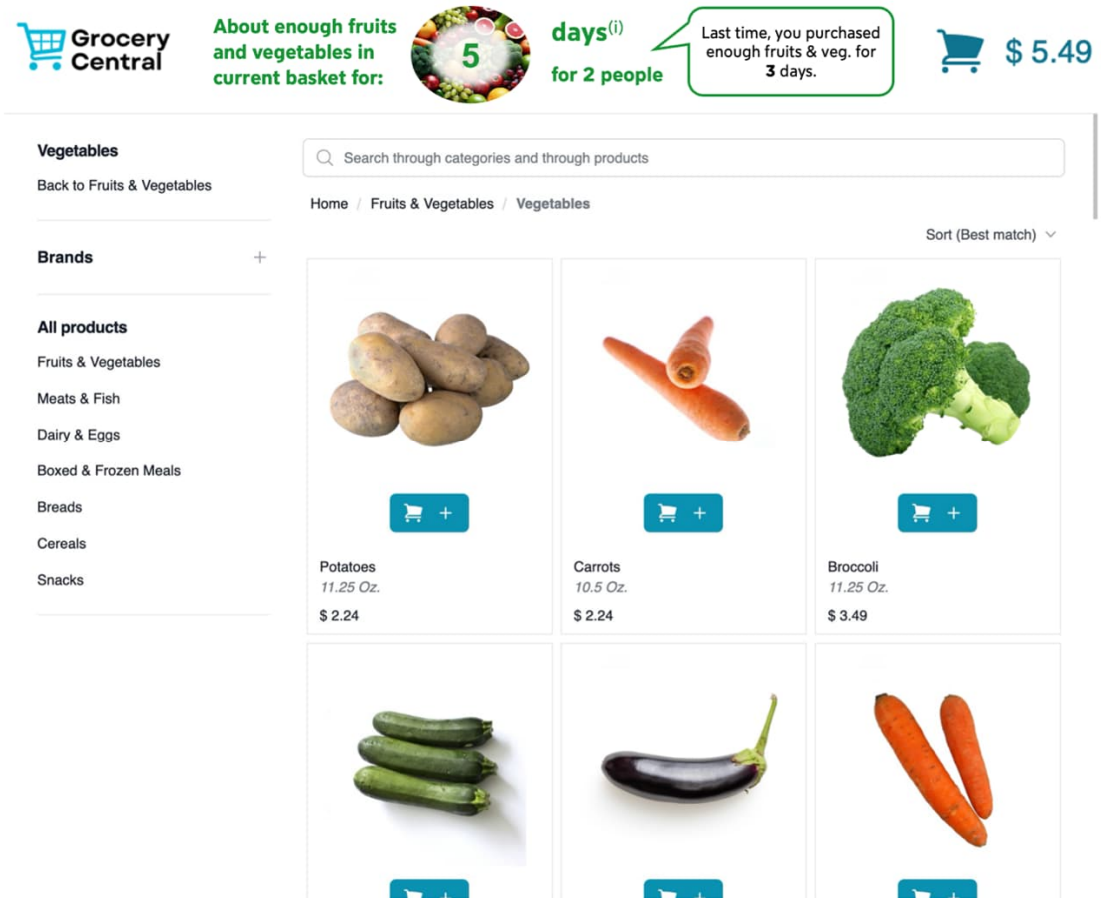

Figure 1: User interface of the simulated online grocery store, showing the combined intervention with real-time feedback (the portion counter) and the personalized reflection prompt (the message to the right of the portion counter).

3.3. Intervention Design

3.3.1. Real-Time Portion Feedback

In order to improve public health, the WHO recommends increasing fruits and vegetable consumption [10]. To support this goal, participants receive real-time feedback through a live counter showing how many fruit and vegetable portions they currently have in their basket, displayed alongside the checkout total. More specifically, the counter estimates how many days the current portions would suffice for a two-person household, which is the household size specified in the shopping task instructions. The target of 5 portions of 80 g per person per day aligns with the World Health Organization's recommendation [10]. This guideline is accessible to participants in the form of a link displayed during mouseover on the (i) symbol.

3.3.2. Personalized Reflection Prompt

The reflection prompt, seen in Figure 1 as the speech bubble next to the portion counter, would be displayed to participants who are assigned to the Reflection Prompt or Combination groups during their second study visit. The text refers to the individual's previous shopping activities, which were observed during the first study visit.

This proposed intervention design is based on three main design principles:

Maximize personal relevance through personalization: As outlined in the Related Work section, personalization has the potential to enhance a system's persuasive capability. Personalization can be implemented by referencing past behavior, which is a strong indicator of attitudes and self-identity [48], [49], and a more reliable predictor of behavior than stated intentions [50]. Online grocery shopping takes place in a system that is capable of accessing an individual's purchasing history, and references to addressed individuals have been shown to increase the persuasive effectiveness of messages [51]. Therefore, the reflection prompt will refer to the shopper's past fruits and vegetable purchasing habits (as seen in Figure 1).

Compared to a generic informative message, a message referring to previous behaviors is more personally relevant to consumers, which can boost engagement according to the Elaboration Likelihood Model [43]. The proposed individual self-reference is a "true" or "strong" personalization approach, compared to a "weak" personalization approach, which would entail tailoring to user segments [52]. Such a true personalization approach is uniquely enabled by the increasing shift of shopping habits towards online grocery purchases.

Employ reactance-conscious communication: The design of persuasive communication needs to consider induced cognitions and emotions, especially reactance, since it can function as a major barrier to persuasion. It is defined as a state characterized by negative emotions and cognitions related to resistance to a perceived or explicit threat to freedom [53]. Consequently, we considered three aspects in prompt message design to minimize reactance: Firstly, the messages should be phrased in a non-prescriptive way to avoid appearing judgmental, in order to increase openness to persuasion [20]. Secondly, autonomy-supportive language can reduce the degree of induced reactance [54]. And finally, perceived intent is known to trigger reactance [54]. Therefore, the prompt should not imply cross-selling as its primary purpose, as consumers may perceive this as manipulative. Instead, the information is presented neutrally, and the overlay of the real-time feedback refers to the recommendations of the World Health Organization as a trusted institution.

Ensure convenient timing: Few studies have previously tested personalized reflection prompts in an online grocery setting [37], [55]. However, there is some evidence in favor of delivering interventions "just-in-time" during decision-making [51], [55], whereas a prompt delivered at checkout might be perceived as questioning the legitimacy of consumers' choices. The prompt in the proposed experimental design will therefore be delivered with shifting user goals in mind [56]. In the beginning stages of shopping, consumers may start their shopping trip by exploring the store's interface or planning their purchases. During such activities, a message that reminds participants of their usual shopping habits may be inappropriate. Therefore, the reflection prompt will only be displayed once they have started adding fruits and vegetables or a certain number of items to their basket.

3.4. Measurements

The main outcome will the portions of fruits and vegetables (FV) in participants' virtual shopping baskets. In addition, variables related to FBM components will be measured (for an overview, see Table 1) and examined for moderating effects in exploratory analyses.

Additionally, manipulation checks and questions related to the representativeness of the simulated store and their shopping behavior will be included to assess the simulated setting's validity.

Table 1

Mapping of variables to FBM components

Related FBM Component	Variable	Example Item	Reference
Motivation	State of change	Are you eating or trying to eat healthier these days?	[57]
Motivation	Health consciousness	I reflect about my health a lot.	[58]
Motivation	Environmental identity	I strive to behave in an environmentally friendly way, even if it involves considerable costs and effort.	[59]
Motivation	Perceived personal relevance	The prompt message seemed to be written personally for me.	[41]
Ability	Subjective mental load during shopping	How much mental activity was required of you to complete the shopping task?	[60]
Ability	Food literacy	How easy would you say it is for you to understand information about why some foods are healthy and others are not?	[61]
Prompt	Habit strength for target behavior	Observed fruits and vegetable purchases in first study visit (assuming habit strength for a behavior facilitates prompting that behavior)	[62]

3.5. Sample

We conducted a power analysis to determine minimum sample sizes for the experimental groups. We will work toward achieving 90 % power to detect a small effect of d=0.3 for between-group differences in fruits and vegetable, leading us to aim for at least n=200 participants, resulting in a total sample of n=800. We will recruit US residents (50% male, 50% female, up to 5% non-binary/undisclosed) from the platform Prolific. The sample will be restricted to people with experience in online grocery shopping, and to people without diet-related health conditions (e.g., heart or kidney disease, cholesterol, for other conditions see [63]) or dietary

preferences (e.g., vegetarianism), as these may predispose consumers to have specific and/or immutable purchasing habits.

4. Outlook

Using the FBM framework for persuasive technology design, we propose a unique combination of behavior change interventions. Next steps include finalizing the implementation of the intervention in the simulated grocery store environment, pre-registering the hypotheses, and obtaining ethical approval for the experimental procedure.

The study design enables the separate analysis of main and interaction effects, which will contribute to interventional research encouraging healthy food choices. Further, the concept of mental load is underrepresented in conceptual models of food choice [64], [65]. Therefore, the exploration of such moderating variables may advance theoretical work by clarifying the impact of mental load on intervention effectiveness.

In summary, the proposed study aims to design and test an innovative combination of interventions for promoting healthy food choices, addressing research gaps and contributing to both theoretical considerations of food choice and interventional research for healthier shopping behaviors.

Acknowledgements

This work is funded by the Bavarian Research Institute for Digital Transformation (bidt), an institute of the Bavarian Academy of Sciences and Humanities, and is made possible thanks to the collaboration with Kevin O'Sullivan (ETH Zurich), whose work is funded by the Swiss National Science Foundation, and the input and guidance of Prof. Verena Tiefenbeck (FAU Erlangen-Nürnberg).

References

[1] A. Afshin *et al.*, "Health effects of dietary risks in 195 countries, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017," *The Lancet*, vol. 393, pp. 1958–1972, Apr. 2019, doi: 10.1016/S0140-6736(19)30041-8.

[2] World Health Organisation, Ed., *Diet, nutrition, and the prevention of chronic diseases: report of a WHO-FAO Expert Consultation ; [Joint WHO-FAO Expert Consultation on Diet, Nutrition, and the Prevention of Chronic Diseases, 2002, Geneva, Switzerland]*. in WHO technical report series, no. 916. Geneva: World Health Organization, 2003.

[3] B. Ewers, M. R. Sørensen, S. Fagt, L. J. Diaz, and T. Vilsbøll, "Intention and Perceptions of Healthy Eating versus Actual Intake Among Patients with Type 1 and Type 2 Diabetes and the General Population," *PPA*, vol. Volume 15, pp. 2027–2037, Sep. 2021, doi: 10.2147/PPA.S325214.

[4] M. S. McDermott *et al.*, "The theory of planned behaviour and discrete food choices: a systematic review and meta-analysis," *Int J Behav Nutr Phys Act*, vol. 12, no. 1, p. 162, Dec. 2015, doi: 10.1186/s12966-015-0324-z.

[5] G. Torma, J. Aschemann-Witzel, and J. Thøgersen, "I nudge myself: Exploring 'self-nudging' strategies to drive sustainable consumption behaviour," *International Journal of Consumer Studies*, vol. 42, no. 1, pp. 141–154, Jan. 2018, doi: 10.1111/ijcs.12404.

[6] S. S. A. H. Blom, M. Gillebaart, F. De Boer, N. Van Der Laan, and D. T. D. De Ridder, "Under pressure: Nudging increases healthy food choice in a virtual reality supermarket, irrespective of system 1 reasoning," *Appetite*, vol. 160, p. 105116, May 2021, doi: 10.1016/j.appet.2021.105116.

[7] D. Kahneman, *Thinking, fast and slow*. 2017.

[8] R. Cadario and P. Chandon, "Which healthy eating nudges work best? A meta-analysis of field experiments," *Appetite*, vol. 130, pp. 300–301, Nov. 2018, doi: 10.1016/j.appet.2018.05.170.

[9] D. De Ridder, F. Kroese, C. Evers, M. Adriaanse, and M. Gillebaart, "Healthy diet: Health impact, prevalence, correlates, and interventions," *Psychology & Health*, vol. 32, no. 8, pp. 907–941, Aug. 2017, doi: 10.1080/08870446.2017.1316849.

[10] World Health Organisation, "Increasing fruit and vegetable consumption to reduce the risk of noncommunicable diseases." Accessed: Sep. 03, 2024. [Online]. Available: https://www.who.int/tools/elena/interventions/fruit-vegetables-ncds

[11] J. Brambila-Macias *et al.*, "Policy Interventions to Promote Healthy Eating: A Review of What Works, What Does Not, and What is Promising," *Food Nutr Bull*, vol. 32, no. 4, pp. 365–375, Dec. 2011, doi: 10.1177/156482651103200408.

[12] J. Hartmann-Boyce *et al.*, "Grocery store interventions to change food purchasing behaviors: A systematic review of randomized controlled trials," *American Journal of Clinical Nutrition*, vol. 107, no. 6, pp. 1004–1016, 2018, doi: 10.1093/ajcn/nqy045.

[13] J. M. Stuber, J. Lakerveld, L. W. Kievitsbosch, J. D. Mackenbach, and J. W. J. Beulens, "Nudging customers towards healthier food and beverage purchases in a real-life online supermarket: a multi-arm randomized controlled trial," *BMC Med*, vol. 20, p. 10, Jan. 2022, doi: 10.1186/s12916-021-02205-z.

[14] J. C. Hoenink, J. D. Mackenbach, W. Waterlander, J. Lakerveld, N. Van Der Laan, and J. W. J. Beulens, "The effects of nudging and pricing on healthy food purchasing behavior in a virtual supermarket setting: a randomized experiment," *Int J Behav Nutr Phys Act*, vol. 17, no. 1, p. 98, Dec. 2020, doi: 10.1186/s12966-020-01005-7.

[15] E. Valenčič, E. Beckett, C. E. Collins, B. Koroušić Seljak, and T. Bucher, "Digital nudging in online grocery stores: A scoping review on current practices and gaps," *Trends in Food Science & Technology*, vol. 131, pp. 151–163, Jan. 2023, doi: 10.1016/j.tifs.2022.10.018.

[16] GroceryDoppio, "January 2023: State of Digital Grocery Performance Scorecard," Performance Scorecard. Accessed: Feb. 13, 2025. [Online]. Available: https://www.grocerydoppio.com/performance-scorecard/january-2023-state-of-digital-grocery-performance-scorecard

[17] B. Fogg, "A behavior model for persuasive design," in *Proceedings of the 4th International Conference on Persuasive Technology*, Claremont California USA: ACM, Apr. 2009, pp. 1–7. doi: 10.1145/1541948.1541999.

[18] M. Armayones, B. Gómez-Zúñiga, N. Robles, M. Pousada, and E. Hernàndez, "Relationship between Behavior Fogg Model and Behavior Change Technique Taxonomy 93 (V1): implications for behavior designers," in *Adjunct proceedings of the 15th International conference on Persuasive Technology*, 2020.

[19] B. Fogg, "Persuasive computers: perspectives and research directions," in *Proceedings of the SIGCHI conference on Human factors in computing systems - CHI '98*, Los Angeles, California, United States: ACM Press, 1998, pp. 225–232. doi: 10.1145/274644.274677.

[20] H. Oinas-Kukkonen and M. Harjumaa, "A Systematic Framework for Designing and Evaluating Persuasive Systems," in *Persuasive Technology*, vol. 5033, H. Oinas-Kukkonen,

P. Hasle, M. Harjumaa, K. Segerståhl, and P. Øhrstrøm, Eds., in Lecture Notes in Computer Science, vol. 5033. , Berlin, Heidelberg: Springer Berlin Heidelberg, 2008, pp. 164–176. doi: 10.1007/978-3-540-68504-3_15.

[21] S. Michie *et al.*, "The Behavior Change Technique Taxonomy (v1) of 93 Hierarchically Clustered Techniques: Building an International Consensus for the Reporting of Behavior Change Interventions," *ann. behav. med.*, vol. 46, no. 1, pp. 81–95, Aug. 2013, doi: 10.1007/s12160-013-9486-6.

[22] V. J. V. Broers, C. De Breucker, S. Van Den Broucke, and O. Luminet, "A systematic review and meta-analysis of the effectiveness of nudging to increase fruit and vegetable choice," *European Journal of Public Health*, vol. 27, no. 5, pp. 912–920, Oct. 2017, doi: 10.1093/eurpub/ckx085.

[23] F. J. A. Perez-Cueto, "An Umbrella Review of Systematic Reviews on Food Choice and Nutrition Published between 2017 and-2019," *Nutrients*, vol. 11, no. 10, p. 2398, Oct. 2019, doi: 10.3390/nu11102398.

[24] A. L. Wilson, E. Buckley, J. D. Buckley, and S. Bogomolova, "Nudging healthier food and beverage choices through salience and priming. Evidence from a systematic review," *Food Quality and Preference*, vol. 51, pp. 47–64, Jul. 2016, doi: 10.1016/j.foodqual.2016.02.009.

[25] A. Glympi, A. Chasioti, and K. Bälter, "Dietary Interventions to Promote Healthy Eating among Office Workers: A Literature Review," *Nutrients*, vol. 12, no. 12, p. 3754, Dec. 2020, doi: 10.3390/nu12123754.

[26] V. Campbell-Arvai, J. Arvai, and L. Kalof, "Motivating Sustainable Food Choices: The Role of Nudges, Value Orientation, and Information Provision," *Environment and Behavior*, vol. 46, no. 4, pp. 453–475, 2014, doi: 10.1177/0013916512469099.

[27] M. De Bauw, L. S. De La Revilla, V. Poppe, C. Matthys, and L. Vranken, "Digital nudges to stimulate healthy and pro-environmental food choices in E-groceries," *Appetite*, vol. 172, 2022, doi: 10.1016/j.appet.2022.105971.

[28] M. Morren, J. M. Mol, J. E. Blasch, and Ž. Malek, "Changing diets - Testing the impact of knowledge and information nudges on sustainable dietary choices," *Journal of Environmental Psychology*, vol. 75, no. August 2020, 2021, doi: 10.1016/j.jenvp.2021.101610.

[29] M. Mazzocchi, W. B. Traill, and J. F. Shogren, *Fat Economics: Nutrition, Health, and Economic Policy*. OUP Oxford, 2009.

[30] M. S. Hagger, M. W.-L. Cheung, I. Ajzen, and K. Hamilton, "Perceived behavioral control moderating effects in the theory of planned behavior: A meta-analysis.," *Health Psychology*, vol. 41, no. 2, pp. 155–167, Feb. 2022, doi: 10.1037/hea0001153.

[31] S. Shin, R. M. Van Dam, and E. A. Finkelstein, "The Effect of Dynamic Food Labels with Real-Time Feedback on Diet Quality: Results from a Randomized Controlled Trial," *Nutrients*, vol. 12, no. 7, p. 2158, Jul. 2020, doi: 10.3390/nu12072158.

[32] V. Tiefenbeck *et al.*, "Overcoming salience bias: How real-time feedback fosters resource conservation," *Management Science*, vol. 64, no. 3, pp. 1458–1476, 2016, doi: 10.1287/mnsc.2016.2646.

[33] V. Tiefenbeck, A. Wörner, S. Schöb, E. Fleisch, and T. Staake, "Real-time feedback promotes energy conservation in the absence of volunteer selection bias and monetary incentives," *Nature Energy*, vol. 4, no. 1, pp. 35–41, 2018, doi: 10.1038/s41560-018-0282-1.

[34] V. Tiefenbeck, A. Wörner, S. Schöb, E. Fleisch, and T. Staake, "Real-time feedback reduces energy consumption among the broader public without financial incentives," *Nature Energy*, vol. 4, no. 10, pp. 831–832, 2019, doi: 10.1038/s41560-019-0480-5.

[35] I. Li, A. Dey, and J. Forlizzi, "A stage-based model of personal informatics systems," in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, Atlanta Georgia USA: ACM, Apr. 2010, pp. 557–566. doi: 10.1145/1753326.1753409.

[36] J. van't Riet, S. J. Sijtsema, H. Dagevos, and G. J. de Bruijn, "The importance of habits in eating behaviour. An overview and recommendations for future research," *Appetite*, vol. 57, no. 3, pp. 585–596, 2011, doi: 10.1016/j.appet.2011.07.010.

[37] K. Arslain, C. R. Gustafson, and D. J. Rose, "Point-of-Decision Prompts Increase Dietary Fiber Content of Consumers' Food Choices in an Online Grocery Shopping Simulation," *Nutrients*, vol. 12, no. 11, p. 3487, Nov. 2020, doi: 10.3390/nu12113487.

[38] C. R. Gustafson, "Comparing the impact of subsidies and health prompts on choice process variables and food choice: The case of dietary fiber," Jan. 27, 2023. doi: 10.31219/osf.io/u4v5c.

[39] O. Tuyizere, C. R. Gustafson, and D. J. Rose, "Health Prompts Affect Consideration of Health but Not Intertemporal Preferences While Promoting Healthier Food Choices," *Nutrients*, vol. 16, no. 10, p. 1454, May 2024, doi: 10.3390/nu16101454.

[40] S. Zumthurm and A. Stämpfli, "A diet-related health prompt with the Swiss Food Pyramid as a nudge to reduce meat consumption," *Food Quality and Preference*, vol. 115, p. 105105, Jun. 2024, doi: 10.1016/j.foodqual.2024.105105.

[41] J. D. Jensen, A. J. King, N. Carcioppolo, and L. Davis, "Why are Tailored Messages More Effective? A Multiple Mediation Analysis of a Breast Cancer Screening Intervention," *J Commun*, vol. 62, no. 5, pp. 851–868, Oct. 2012, doi: 10.1111/j.1460-2466.2012.01668.x.

[42] S. C. Matz *et al.*, "Personality Science in the Digital Age: The Promises and Challenges of Psychological Targeting for Personalized Behavior-Change Interventions at Scale," *Perspect Psychol Sci*, p. 17456916231191774, Aug. 2023, doi: 10.1177/17456916231191774.

[43] R. E. Petty and J. T. Cacioppo, "Source Factors and the Elaboration Likelihood Model of Persuasion," *Advances in Consumer Research*, vol. 11, pp. 668–672, 1984.

[44] A. Dijkstra and K. Ballast, "Personalization and perceived personal relevance in computer-tailored persuasion in smoking cessation," *Br J Health Psychol*, vol. 17, no. 1, pp. 60–73, Feb. 2012, doi: 10.1111/j.2044-8287.2011.02029.x.

[45] A. Oyalowo, K. A. Forde, A. Lamanna, and M. L. Kochman, "Effect of Patient-Directed Messaging on Colorectal Cancer Screening: A Randomized Clinical Trial," *JAMA Netw Open*, vol. 5, no. 3, p. e224529, Mar. 2022, doi: 10.1001/jamanetworkopen.2022.4529.

[46] A. H. Grummon, A. A. Musicus, M. G. Salvia, A. N. Thorndike, and E. B. Rimm, "Impact of Health, Environmental, and Animal Welfare Messages Discouraging Red Meat Consumption: An Online Randomized Experiment," *Journal of the Academy of Nutrition and Dietetics*, vol. 123, no. 3, pp. 466-476.e26, Mar. 2023, doi: 10.1016/j.jand.2022.10.007.

[47] P. E. Rummo, I. Higgins, C. Chauvenet, A. Vesely, L. M. Jaacks, and L. Taillie, "A Standardized Guide to Developing an Online Grocery Store for Testing Nutrition-Related Policies and Interventions in an Online Setting," *Int J Environ Res Public Health*, vol. 18, no. 9, p. 4527, Apr. 2021, doi: 10.3390/ijerph18094527.

[48] F. G. Kaiser, O. Arnold, and S. Otto, "Attitudes and defaults save lives and protect the environment jointly and compensatorily: Understanding the behavioral efficacy of nudges and other structural interventions," *Behavioral Sciences*, vol. 4, no. 3, pp. 202–212, 2014, doi: 10.3390/bs4030202.

[49] J. R. Smith, D. J. Terry, A. S. R. Manstead, W. R. Louis, D. Kotterman, and J. Wolfs, "Interaction Effects in the Theory of Planned Behavior: The Interplay of Self-Identity and

Past Behavior," *Journal of Applied Social Psychology*, vol. 37, no. 11, pp. 2726–2750, 2007, doi: 10.1111/j.1559-1816.2007.00278.x.

[50] F. A. Yamoah, A. Fearne, and R. Duffy, "Exploring supermarket loyalty card analysis to identify who buys fairtrade," *International Review of Retail, Distribution and Consumer Research*, vol. 24, no. 3, pp. 328–346, 2014, doi: 10.1080/09593969.2014.890954.

[51] J. Wang and S. S. Sundar, "Are We More Reactive to Persuasive Health Messages When They Appear in Our Customized Interfaces? The Role of Sense of Identity and Sense of Control," *Health Communication*, vol. 37, no. 8, pp. 1022–1030, Jul. 2022, doi: 10.1080/10410236.2021.1885772.

[52] H. Oinas-Kukkonen, "Personalization Myopia: A Viewpoint to True Personalization of Information Systems," in *Proceedings of the 22nd International Academic Mindtrek Conference*, Tampere Finland: ACM, Oct. 2018, pp. 88–91. doi: 10.1145/3275116.3275121.

[53] S. S. Brehm and J. W. Brehm, *Psychological Reactance: A Theory of Freedom and Control*. Academic Press, 2013.

[54] B. L. Quick, L. Shen, and J. P. Dillard, "Reactance Theory and Persuasion," in *The SAGE Handbook of Persuasion: Developments in Theory and Practice*, 2455 Teller Road, Thousand Oaks California 91320 United States: SAGE Publications, Inc., 2012, pp. 167–183. doi: 10.4135/9781452218410.n11.

[55] R. De Vries, N. Bol, and N. Van Der Laan, "'Just-in-time' but a bit delayed: Personalizing digital nudges for healthier online food choices," *Appetite*, vol. 206, p. 107852, Feb. 2025, doi: 10.1016/j.appet.2025.107852.

[56] K. Y. Tam and S. Y. Ho, "Understanding the Impact of Web Personalization on User Information Processing and Decision Outcomes," *MIS Quarterly*, vol. 30, no. 4, pp. 865–890, 2006, doi: 10.2307/25148757.

[57] S. M. Robson, E. Orsega-Smith, K. Greenawalt, and P. M. Peterson, "The Association Between Fruit and Vegetable Consumption and Fruit and Vegetable Stage of Change in Underserved Communities Engaging With Cooperative Extension Services," *Journal of Nutrition Education and Behavior*, vol. 49, no. 9, pp. 772-776.e1, Oct. 2017, doi: 10.1016/j.jneb.2017.06.003.

[58] S. Rahamat, E. Jeong, S. W. Arendt, and Y. Xu, "Menu labeling influence on purchase behaviors: Applying the theory of planned behavior and health consciousness," *Appetite*, vol. 172, p. 105967, May 2022, doi: 10.1016/j.appet.2022.105967.

[59] A. Diekmann, "Schweizer Umweltsurvey 2007 Analysen und Ergebnisse," 2007, Accessed: Feb. 15, 2024. [Online]. Available: https://www.academia.edu/19500897/Schweizer_Umweltsurvey_2007_Analysen_und_Ergebnisse

[60] S. G. Hart, "Nasa-Task Load Index (NASA-TLX); 20 Years Later," *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, vol. 50, no. 9, pp. 904–908, 2006, doi: 10.1177/154193120605000909.

[61] R. Griebler, D. Schütze, T. Link, and K. Schindler, "Brief instruments for measuring nutrition literacy - the Nutrition Health Literacy Scale and the Self-Perceived Food Literacy Scale Short Form," *Nutr J*, vol. 23, no. 1, p. 73, Jul. 2024, doi: 10.1186/s12937-024-00971-z.

[62] M. van Rookhuijzen, E. de Vet, G. Gort, and M. A. Adriaanse, "When nudgees become nudgers: Exploring the use of self-nudging to promote fruit intake," *Applied Psychology: Health and Well-Being*, vol. 15, no. 4, pp. 1714–1732, 2023, doi: 10.1111/aphw.12464.

[63] U.S. Department of Agriculture, "Diet and Health Conditions," Nutrition.gov. Accessed: Dec. 12, 2024. [Online]. Available: https://www.nutrition.gov/topics/diet-and-health-conditions

[64] P.-J. Chen and M. Antonelli, "Conceptual Models of Food Choice: Influential Factors Related to Foods, Individual Differences, and Society," *Foods*, vol. 9, no. 12, p. 1898, Dec. 2020, doi: 10.3390/foods9121898.

[65] J. Sobal and C. A. Bisogni, "Constructing Food Choice Decisions," *Annals of Behavioral Medicine*, vol. 38, no. suppl_1, pp. s37–s46, Dec. 2009, doi: 10.1007/s12160-009-9124-5.