# Nudging Plant-Based Food Choice

Dissertation
To obtain the doctoral degree
Sustainable Food Systems RTG
The Faculty of Economics
The Georg-August University of Göttingen
(Dr. rer. pol.)

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Göttingen, October, 2024

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# List of Abbreviations

| | |
|---|---|
| AMCE | Average marginal causal effect |
| ANOVA | Analysis of variance |
| BMI | Body mass index |
| CBC | Choice-based conjoint |
| CI | Confidence interval |
| EST | Mediation effect |
| EU | European Union |
| GHG | Green house gass |
| M | Mean |
| Mdn | Median |
| MANOVA | Multivariate analysis of variance |
| NL | Netherlands |
| PMBAs | Plant-based meat alternatives |
| SD | Standard deviation |
| SE | Standard error |
| U.K. | United Kingdom |
| U.S. | United States |
| VAT | Value-added tax |

# 1  General Introduction

## 1.1  Relevance of Plant-Based Foods

The consumption of protein, whether sourced from plants or animals, is central to human diets. However, high levels of animal protein consumption are incompatible with sustainable development (Willett et al., 2019). Patterns of animal protein intake are unevenly distributed globally; while low- and middle-income countries generally have lower levels of animal protein consumption, high-income countries face the issue of overconsumption (Parlasca & Qaim, 2022). This is linked to significant challenges, including a disproportionally large share of agriculture's greenhouse gas (GHG) emissions and biodiversity loss (Henry et al., 2019; Xu et al., 2021). Additionally, certain husbandry systems associated with meat production raise substantial animal welfare concerns (Grethe, 2017). Moreover, consumption of meat is linked to increased risk for poor human health outcomes, such as certain chronic diseases, cancers, and zoonoses (Godfray et al., 2018).

Addressing these challenges necessitates a fundamental shift in our food systems. This transition will be reliant on supply-side changes such as advancements in the agri-food sector and technological innovations—but will also be heavily dependent on shifts in consumer behavior (Parlasca & Qaim, 2022; Poore & Nemecek, 2018; Springmann et al., 2018). Reducing animal protein consumption in favor of plant-based options is crucial, as even the least environmentally impactful animal products still surpass the average environmental impacts of raw plant-based ingredients (Poore & Nemecek, 2018). Consequently, decreasing meat intake, especially ruminant meat, offers substantial benefits for the environment and climate change mitigation. Additionally, in a "less but better" scenario (Resare Sahlin & Trewern, 2022), a decrease in demand for meat could accommodate improved livestock conditions, such as longer lives for animals, free-range husbandry systems, and the use of lower-quality feed that does not compete with human food, while also alleviating negative health outcomes (Parlasca & Qaim, 2022).

Consumers are increasingly aware of the issues associated with meat consumption and express a willingness to reduce their intake primarily for these reasons (de Boer & Aiking, 2022; Hielkema & Lund, 2021; Jürkenbeck et al., 2021). This has led to a growing interest in plant-based meat alternatives (PBMAs) and a corresponding market expansion of the product category (Good Food Institute, 2024). In the past decade, estimated plant-based meat sales in the U.S. have increased three-fold. The market has also diversified significantly, with hundreds of new plant-based meat, seafood, egg, and dairy products hitting the shelves in 2023 (Good Food Institute, 2024). Most of the growth in the plant-based meat sector can be attributed to the increasing adoption of these products by meat-eating consumers. Reflecting this trend, companies like the Vegetarian Butcher (a Netherlands-based brand) actively market to a broad audience, welcoming "all meat

lovers—from vegans to carnivores" (Schwarz et al., 2024). Indeed, 95% of consumers in the U.S. who purchase PBMAs also buy conventional meat products (Good Food Institute, 2024). Many of these consumers identify as flexitarians—individuals who choose to reduce or limit their meat consumption in favor of plant-forward options, a trend that is becoming increasingly common among younger generations (Mascaraque, 2021).

Despite this growth, 2023 marked a turning point, with PBMA sales declining as a result of inflation and reduced consumer engagement (Good Food Institute, 2024). For the market to resume its upward trajectory and to further transition diets toward sustainable protein consumption patterns, a suite of effective, scalable, and robust pathways must be developed to target a broad swath of consumers, rather than just those already motivated to eat sustainably. These pathways should include product reformulations and innovations, educational campaigns, advertisements, and supportive public policies to enhance the appeal and accessibility of plant-based proteins. In sum, PBMAs must improve on key consumer drivers of taste, price, and convenience, by clearly communicating their benefits to consumers.

## 1.2  Literature Review

### 1.2.1  Plant-Based Meat Alternatives

A spectrum of PBMAs exists that aim to replace meat to varying degrees. PBMAs are generally made from whole or processed lentils, pulses, soybeans, algae, or fungi (Jahn et al., 2021; Onwezen et al., 2021). Historically, plant-based proteins like tofu and tempeh, which have been eaten for thousands of years, were primarily associated with vegetarian diets (He et al., 2020). These traditional vegetarian proteins do not closely mimic the sensory properties of meat. However, recent advancements in food technology have led to the development of plant-based meat analogs designed to closely replicate the taste and texture of meat. Innovations using ingredients such as pea protein and heme have enabled the creation of products that offer a more meat-like experience (Hefferon et al., 2023). Such foods can support dietary change without fundamentally disrupting sociocultural norms by upholding the traditional "center of the plate protein" meal structure (de Boer & Aiking, 2019; Douglas, 1975). Some anticipate that these products may facilitate a broader transition toward plant-based diets, with meat-like designs serving as a temporary step toward a more comprehensive protein transition (Schwarz et al., 2024). However, this shift will take time, as consumers gradually adapt to new eating patterns and the market for alternative proteins continues to evolve.

Prominent examples of these plant-based meat analogs include Beyond Meat and the Impossible Burger, made by companies that were born out of a mission to create meat alternatives exclusively. These products have gained widespread attention and are now commonly found in grocery stores and fast-food chains like Burger King and TGI Fridays.

Many leading consumer packaged goods and meat producers are also actively engaged in the alternative protein industry (Good Food Institute, 2024). For instance, industry giants like Tyson and Nestlé have expanded their offerings to include products like plant-based nuggets and meat mince (Good Food Institute, 2024). Among the more innovative offerings, companies like Unilever are expanding the market with products such as plant-based Döner kebab developed in partnership with the German Düzgün Group, targeting traditional kebab shops (Southey, 2023).

Corresponding to the wide range of product offerings, there is significant diversity in the nutritional composition (de las Heras-Delgado et al., 2023) and sustainability profiles of PBMAs (Lindberg et al., 2024). From an environmental perspective, while the plant-based ingredients used in PBMAs have substantially lower GHG emissions compared to conventional animal products—showing up to 93% reductions when replacing beef (Santo et al., 2020)—processed plant-based meat substitutes tend to have a higher environmental impact than less-processed plant protein sources, such as tofu (Smetana et al., 2023). Studies indicate that PBMAs can have environmental impacts 1.6 to 7 times higher than these minimally processed alternatives (Santo et al., 2020). In some cases, meat-mimicking alternatives can have environmental impacts that are comparable to some sources of conventional meat, like chicken (Lindberg et al., 2024), highlighting the importance of focusing on reducing the consumption of red meat as well as improving novel food production and processing technologies.

Nutritionally, PBMAs also vary significantly. Traditional vegetarian alternatives are generally made from whole legumes and grains, offering a nutrient-dense, low-saturated fat option. Others, like meat analogs, can be categorized as ultra-processed foods, which contain added fats, sugars, and sodium to enhance flavor and texture (de las Heras-Delgado et al., 2023). Nevertheless, proponents argue they differ from other foods in this category, such as soda and confections, which have clear negative health impacts (Chapman, 2024). While evidence on the health value of meat analogs and their ability to replicate the nutritional profile of meat equivalents is limited, some studies suggest these foods can be associated with positive health outcomes, and processing whole-plant foods into protein isolates may not necessarily compromise their health value (Flint et al., 2023). Processing also allows for fortification and enrichment, enabling PBMAs to match real meat in important nutrients such as iron and vitamin B12 (van Haperen, 2023). Moreover, substitution with PBMAs can allow for the avoidance of processed red meats, which are linked to an increased risk of certain diseases (Parlasca & Qaim, 2022).

Reflecting their many diverse attributes, labeling and marketing strategies for plant proteins vary widely. Scholars support various promotional strategies, including using "plant-based" rather than "vegan" or "vegetarian" (Ruby et al., 2024), employing meaty terminology (Demartini et al., 2022; Marshall et al., 2022), or not drawing attention to their meat-free nature at all (Berke & Larson, 2023; Hielkema & Lund, 2022; Sleboda et

al., 2024). However, a unique challenge with meat analogs is their simultaneous claim to be like and not like meat (Lemken, 2021b), making it unlikely these products can avoid some form of labeling regarding their juxtaposition with meat. When advertising PBMAs, there is an ongoing discussion about which qualities to emphasize in public communication. Conventional wisdom suggests highlighting the sustainability benefits, as these products clearly outperform meat in this regard (Shanmugam et al., 2023)—a strategy that targets environmentally conscious consumers concerned about the ecological impact of their food choices. Relatedly, some PBMAs are marketed primarily for their health benefits, appealing to consumers seeking nutritious options. On the other hand, some scholars advocate for focusing on taste or hedonic properties as a potentially underutilized strategy to appeal more broadly to consumers (Turnwald et al., 2017; Turnwald & Crum, 2019).

### 1.2.2 Barriers to Consumer Acceptance

Research has identified a range of barriers that affect willingness to incorporate plant-based foods into diets (Ford et al., 2023, 2024; Graça et al., 2019; Hoek et al., 2011; Jahn et al., 2021; Kerslake et al., 2022; Onwezen et al., 2021; Reipurth et al., 2019; Varela et al., 2022). These barriers include sensory, psychological, social, and environmental factors that collectively hinder plant-based consumption. For a comprehensive overview of determinants of consumer acceptance of various PBMAs, see Onwezen et al. (2021). For a visual representation of these barriers, see Figure 1-1.
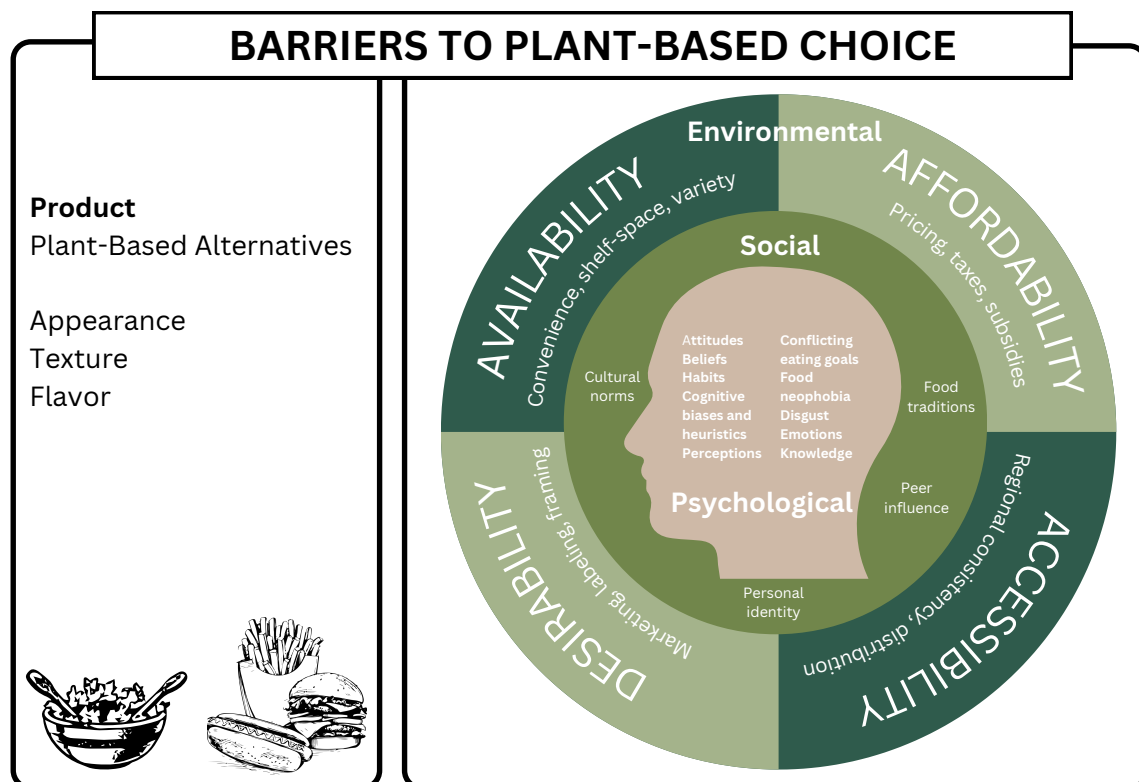


**Figure 1-1.** Barriers to Plant-Based Food Choice

**Product-specific sensory** aspects such as appearance, texture, and flavor play a pivotal role in shaping consumer acceptance. Consumers often perceive PBMAs as having an inferior taste compared to their meat counterparts (Michel et al., 2021; Vural et al., 2023) and express concerns about texture (Elzerman et al., 2013). Given the way meat alternatives are positioned against traditional meat products, these alternatives are generally better accepted the closer they resemble meat (Michel et al., 2021), though acceptance can vary depending on the product type (e.g., tofu vs. meat analog) (Lemken et al., 2019) and meal context (e.g., burger vs. curry) (Elzerman et al., 2013; Graça et al., 2023; Possidónio et al., 2021).

**Psychological** factors related to eating habits and food preferences play a significant role in shaping how consumers perceive PBMAs and when they choose to integrate them into their diets. These factors center around entrenched eating habits and preferences for traditional animal-based foods (Graça et al., 2015; Piazza et al., 2015), attachment to meat (Graça et al., 2015), food neophobia (Hoek et al., 2011), disgust sensitivity (Siegrist & Hartmann, 2019), lack of knowledge about the environmental impacts of meat consumption (Hoek et al., 2011) or the benefits of plant-based consumption (McInnes et al., 2023), lack of know-how (Collier et al., 2021; Pohjolainen et al., 2015) or perceived difficulty in preparing vegetarian foods (Reipurth et al., 2019), political orientations (Yule & Cummings, 2023), and conflicting eating goals associated with plant-based foods (Jahn et al., 2021).

Product category perceptions and expectations further influence how consumers approach PBMAs. People tend to categorize foods into vices (hedonic or indulgent foods) and virtues (functional or healthy foods) (Wertenbroch, 1998), forming performance expectations based on these categories. Individuals often assume an inverse relationship between vice and virtues (Kearney & McElhone, 1999; Luchs et al., 2010; Raghunathan et al., 2006), creating a perceived trade-off that can deter consumers. PBMAs, typically categorized as "virtue" due to their health and sustainability associations (Gonzales et al., 2023), may consequently suffer from lower expectations for sensory performance, sometimes before even being tasted. Indeed, pleasure-seeking individuals tend to be less interested in plant-based eating (Graça et al., 2019).

Paradoxically, while PBMAs are viewed as healthy and sustainable, many consumers simultaneously question their nutritional adequacy. On one hand, PBMAs are generally perceived as healthier options (Gonzales et al., 2023; Ketelings et al., 2023). Yet, concerns persist about their level of processing (Varela et al., 2022), protein content, and ability to provide satiety (Reipurth et al., 2019). Much of this is related to the belief that meat is a necessary dietary component, primarily as a source of protein (McInnes et al., 2023; Pohjolainen et al., 2015).

**Social and normative** barriers relate to societal and peer expectations favoring animal-based diets. Meat holds significant cultural significance, especially in traditional holiday

or celebratory dishes e.g., Christmas and Thanksgiving meals (Collier et al., 2021; Douglas, 1975). Moreover, individuals may find it challenging to choose plant-based options when those around them are eating meat, fearing negative judgment (Markowski & Roxburgh, 2019; McInnes et al., 2023). This is further complicated by the stigma associated with a vegan identity, which is often perceived as restrictive or abnormal (Markowski & Roxburgh, 2019). For men, choosing plant-based foods may be perceived as undermining their masculinity, as meat consumption is associated with masculinity and strength (Ruby & Heine, 2011).

Lastly, barriers related to the physical food *environment* significantly impact demand, relating to the availability, accessibility, affordability, and desirability of PBMAs (Gravely & Fraser, 2018; Jahn et al., 2021; Onwezen et al., 2021). One key structural barrier is the limited availability of PBMAs across various food outlets such as supermarkets, restaurants, schools, and workplaces. These products often occupy less shelf space compared to traditional meat (Gravely & Fraser, 2018), and many restaurants offer only one or two meat-free options. In some cases, restaurants have replaced their sole vegetarian dish with a vegan option to cater to broader dietary preferences, frustrating some vegetarians (Naylor, 2021). This limited variety reduces consumer choice and contributes to the perception that plant-based meals are inconvenient to source (Gravely & Fraser, 2018).

Barriers to accessibility are compounded by inconsistent offerings and distribution across regions and retail environments (Gravely & Fraser, 2018). For instance, fast-food chains like Shake Shack offer plant-based options such as a falafel burger, but only in select regions. Similarly, McDonald's recently discontinued its plant-based burger, contributing to the inconsistency and making it challenging for consumers to know where they can regularly access PBMAs (Castrodale, 2024).

Furthermore, the cost of plant-based foods compared to animal-based products remains high in most cases, particularly for well-known brands, and remains a key pain point for consumers (Jahn et al., 2021). Higher production costs, largely due to unachieved economies of scale, contribute to these elevated prices (Chafin & Larson, 2022). Additionally, food prices do not reflect the "true cost" of environmental and social harms, as animal-based products benefit from subsidies, while plant-based alternatives do not (Katare et al., 2020). This lack of financial support for PBMAs artificially widens the price gap between the two categories.

The desirability of plant-based foods is also hindered by ineffective marketing strategies and regulatory challenges that restrict labeling. In the EU and at national levels, efforts have been made to ban plant-based meat and dairy products from using familiar terms like "burger" and "sausage" (Good Food Institute Europe, 2024a), leaving companies struggling to clearly communicate with consumers (Good Food Institute Europe, 2024b). These restrictions, along with ineffective marketing that highlights conflicting eating

goals, reduce their appeal (Jahn et al., 2021). They also reinforce the perception of meat as the normal status quo, as such labeling positions meat as the default while alternatives are left with unfamiliar and unintuitive names like "plant-based disc" (in place of "burger") (Good Food Institute Europe, 2024a). Coupled with a lack of promotion for plant-based alternatives, these products can be perceived as less attractive or secondary (Gravely & Fraser, 2018).

### 1.2.3 Behavioral Insights in (Un)sustainable Food Choice

Classic policy tools have long aimed to promote healthy and sustainable food choices, though our current food systems demonstrate significant gaps and challenges in achieving widespread adoption and behavioral change. For instance, educational campaigns often lack the depth and reach needed to effectively change long-standing dietary habits and fail to engage diverse populations (Gill & Boylan, 2012; Spiteri Cornish & Moraes, 2015). Informative labeling strategies like the "Nutri-score" may be useful to some already health-conscious consumers, but appear to have limited influence on general audiences (Folkvord et al., 2021; Godden et al., 2023; Temple, 2020a). More restrictive policies, such as outright bans on animal-based foods, are likely to provoke strong resistance, as such mandates can be perceived as threats to personal freedom and deeply ingrained dietary practices (Lombardini & Lankoski, 2013). Scholars advocate for taxing high-carbon-intensive foods like meat to correct for the environmental externalities incurred from production and consumption (Katare et al., 2020). While this approach is being considered in several European countries (e.g., the Netherlands, Germany, and Sweden), low levels of public support make it politically challenging to implement (Douenne & Fabre, 2022; Grimsrud et al., 2020). Therefore, it is evident that traditional policy instruments alone are insufficient to drive the desired behavior change. A more nuanced and multifaceted approach that integrates behavioral insights and innovative strategies is crucial to overcome these barriers and promote sustainable consumption effectively.

Behavioral economics acknowledges that individuals often rely on heuristics or mental shortcuts when making decisions, such as the availability heuristic (how easily information comes to mind), anchoring (placing emphasis on an initial reference point), and the status quo bias (the tendency to stick with the current situation) (Thaler & Sunstein, 2008). Given the up to 200 routine food choices consumers make every day (Wansink & Sobal, 2007), these rules-of-thumb simplify decision-making but can also lead to habitual, less reflective and biased choices, particularly in contexts like food selection.

Against this background, recent research highlights the potential of minimally intrusive **nudges**—strategic redesigns in the surrounding choice architecture—to guide individuals toward more sustainable food choices without restricting their freedom or significantly altering economic incentives (Thaler & Sunstein, 2008). This approach has

gained widespread attention for its ability to preserve consumer autonomy while subtly shaping decision-making environments to promote healthy (e.g., Cadario & Chandon, 2020) and sustainable diets (e.g., Vandenbroele et al., 2020).

In the context of nudging consumers toward PBMAs, various strategies can be employed to make these choices easy, normal, and convenient (Ammann et al., 2023; Attwood, Voorheis, et al., 2020; Meier et al., 2022). Nudges aimed at reducing meat consumption are wide-ranging, leveraging various behavioral insights to influence consumer choices. For example, interventions aimed at improving information delivery related to sustainability dimensions might involve adding "low emissions" symbols to vegetarian dishes on menus (Buratto & Lotti, 2024). Other nudges rely on social norms and salience, such as adding messages to fast-food menus that highlight the popularity of vegetarian options with phrases like "Many here choose green!" (Reinholdsson et al., 2023). Adjustments to the physical choice architecture also play a role, including placing meat substitutes next to their meat equivalents in grocery stores to encourage substitution (Coucke et al., 2022). Incentives and planning tools are another effective strategy, such as allowing shoppers to commit to a low-carbon footprint grocery basket before shopping (Panzone et al., 2024). In the presence of conflicting goals, a commitment nudge helps consumers stay focused by encouraging them to make a specific choice in advance, increasing their motivation to pursue that goal over others (Fishbach & Dhar, 2005; Panzone et al., 2024). Finally, defaults, such as automatically presenting diners with a list of climate-friendly options and providing the full menu only upon request, have shown to be a powerful nudge in influencing food choices (Banerjee, Galizzi, et al., 2023b).

Among these strategies, **default nudges** are particularly effective due to the tendency of individuals to stick with the status quo and can frame plant-based options as the normal choice (Thaler & Sunstein, 2008). A recent review found that plant-based defaults, which require individuals to opt out for meat choices, are nearly universally effective in reducing meat consumption (Meier et al., 2022). Implementing plant-based defaults can result in substantial behavior shifts. For instance, in a study where a vegetarian default was implemented in a conference buffet sign-up form, 89% of participants chose the vegetarian option, compared to just 12.5% in a non-vegetarian default condition (Hansen et al., 2021). This approach can be applied on menus at restaurants, grocery store layouts, and school and workplace lunch plans.

Another powerful strategy is **framing**. Framing involves highlighting specific aspects of relevant information, thereby increasing the chance that individuals will notice, process, and remember the content (Entman, 1993; Tversky & Kahneman, 1985). The framing of messages affects the level of attention it receives (Kreiner & Gamliel, 2018) and influences the emotional valence of how it is perceived (Amatulli et al., 2019). Nudges

harness the power of frames in prompting PBMAs through accompanying information about the product, such as labels, claims, and menu descriptors.

Several studies have examined how to frame messaging around reducing meat consumption (Cordts et al., 2014; De Groot, 2022; Perino & Schwirplies, 2022; Sparkman & Walton, 2017), while others have focused on increasing consumption of sustainable, plant-based foods. Although these strategies are closely linked—since reducing meat intake typically involves increasing plant-based consumption—the framing approaches can be perceived differently by consumers. Meat reduction campaigns often adopt a loss frame (e.g., "Meatless Monday"), whereas plant-based messaging tends to be gain-framed, emphasizing the positive aspects of adding plant-based options. Correspondingly, messaging around meat reduction frequently highlights the negative impacts of meat production and consumption, including animal welfare concerns, health risks, and environmental damage, or at least the avoidance of these negative outcomes (e.g., Cordts et al., 2014; De Groot, 2022; Perino & Schwirplies, 2022). Research indicates that frames emphasizing animal suffering and negative health consequences are more effective at motivating reductions in meat intake than those centered on environmental concerns or personal image (Cordts et al., 2014). However, some caution against relying too heavily on sacrifice-oriented frames when motivating climate-friendly behavior, as they may backfire (Gifford & Comeau, 2011).

In contrast, several studies have examined how positive framing can promote consumer liking and choice of plant-based foods (e.g., Gavrieli et al., 2022; Krpan & Houtsma, 2020; Papies et al., 2023; Possidónio et al., 2021; Reinholdsson et al., 2023; Turnwald & Crum, 2019; Ye & Mattila, 2021). Framing plant-based foods as tasty or indulgent by emphasizing their positive sensory properties has been shown to increase their perceived desirability (Papies et al., 2023; Turnwald & Crum, 2019). This approach can lead to greater consumer interest and choice (Reinholdsson et al., 2023; Turnwald et al., 2017; Turnwald & Crum, 2019). For example, one study found that using sensory-rich dish names, e.g., "Provencal Slow-Roasted Herbal Tomato Soup" (vs. "Tomato Soup") could significantly increase the amount of plant-rich food served in a buffet-style cafeteria (Gavrieli et al., 2022).

Conversely, framing these products as sustainable or healthy leverages the inherent strengths of PBMAs. These frames may work well together given the "sustainable = healthy" intuition consumers often employ in food choices (Lazzarini et al., 2016) and the strong association between healthy and sustainable diets (Van Loo et al., 2017). Still, there appear to be differences in their effects. For example, the ethical frame "Good for the environment and animal welfare" has been found to promote plant-based menu items better than health frames (e.g., "Good for your health—no cholesterol and more fiber") (Ye & Mattila, 2021). Some attribute varying consumer responses to prior beliefs (Vainio et al., 2018), gender (Piester et al., 2020), or political ideologies (Yule &

Cummings, 2023). Given these various consumer orientations, De Boer et al. (2013) propose multiple frames should be used to capture wider acceptance. However, a strategic approach is needed when deciding which frame to use, as ethical and health frames can sometimes backfire by signaling inferior taste (Raghunathan et al., 2006; Schuldt & Hannahan, 2013; Stremmel et al., 2022).

Marketers and policymakers can leverage a combination of these strategies. By structuring choices to ease and simplify the decision-making process, adjusting prices to make plant-based options more affordable, and framing products to align with consumer goals and preferences, they can enhance the attractiveness and market penetration of more sustainable meat-free options. This thesis contributes to the ongoing debate on behavioral insights in public health and consumer policy by examining the effectiveness and underlying psychological mechanisms of such interventions.

## 1.3 Synthesis of Research Contributions

This research addresses the critical issue of reducing meat consumption in affluent nations, where high levels of animal protein intake contribute disproportionately to environmental degradation and health problems (Godfray et al., 2018; Henry et al., 2019; Parlasca & Qaim, 2022; Willett et al., 2019; Xu et al., 2021). Central to the concept of sustainable diets is the reduction of meat consumption in favor of plant-based alternatives (Parlasca & Qaim, 2022; Poore & Nemecek, 2018; Springmann et al., 2018). This dissertation focuses on promoting PBMAs as viable replacements for meat in Western diets. As this transition represents a complex challenge, the research adopts a multifaceted approach, recognizing the need for interventions at multiple levels of society. To this end, the articles within the dissertation explore various factors influencing consumer choice and perception of PBMAs. These factors are examined through the lenses of behavioral and classical economic frameworks, investigating how nudges, framing, pricing strategies, and policy interventions can collectively shape consumer behavior. For an overview and schematic representation of the core concepts from each article and their areas of overlap see Figure 1-2.
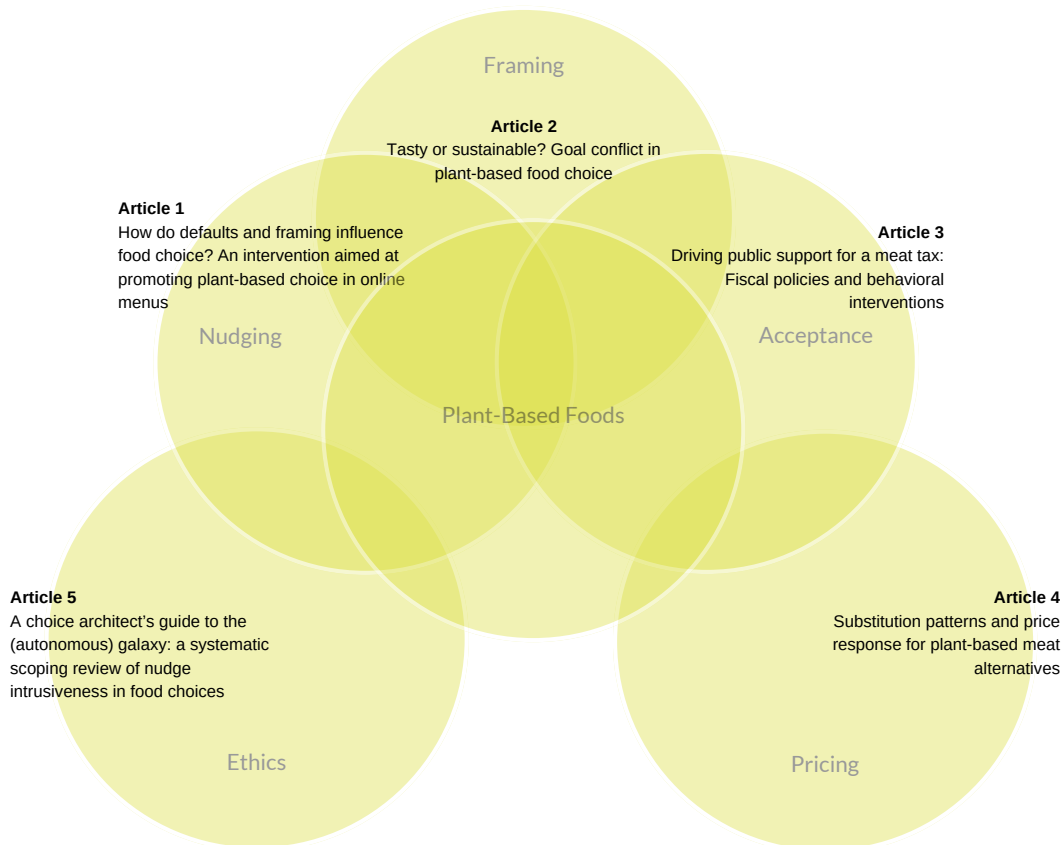
**Figure 1-2**. Schematic Representation of the Core Concepts from Each Article and their Areas of Overlap.

The first two articles focus on how behavioral nudges and framing strategies can enhance the desirability and accessibility of plant-based foods. Among the many nudging interventions available, Article 1 focuses specifically on default nudges (Thaler & Sunstein, 2008). Defaults have been successfully implemented in various contexts promoting healthy and sustainable food choices, including restaurant menus (Gravert & Kurz, 2021; Hielkema et al., 2022; Loeb et al., 2017), digital menus (Hansen et al., 2021; Liu et al., 2022), grocery stores (Chapman et al., 2019; Thomas et al., 2021), dining halls (Radnitz et al., 2023), food stands (van Kleef et al., 2018), and amusement parks (Peters et al., 2016). They have been widely regarded as a promising tool for promoting plant-based diets, with researchers calling for further investigation into their underlying mechanisms (Meier et al., 2022). Responding to this, the study explores how defaulting consumers into plant-based options within online menus impacts their decisions, while also delving into the psychological mechanisms underlying the effectiveness of this nudge. The findings reveal that simply pre-selecting a plant-based option does not significantly increase its selection; rather, the nudge is most effective when combined with framing that emphasizes either the taste or sustainability of the PBMA. This result highlights the importance of both redefining the status quo from meat to plant-based

options and framing these in a way that explains the change in the decision environment and appeals to consumers.

As outlined in the previous section, prior research presents mixed findings regarding the most effective framing strategies to encourage reduced meat and increased plant-based food intake. Commonly discussed frames include hedonic appeal (e.g., Bacon & Krpan, 2018; Papies et al., 2023; Piester et al., 2020; Reinholdsson et al., 2023; Turnwald & Crum, 2019; Ye & Mattila, 2021), sustainability (e.g., Giezenaar et al., 2024; Piester et al., 2020; Ye & Mattila, 2021), or health-related benefits (e.g., Giezenaar et al., 2024; Ye & Mattila, 2021). Article 2 delves deeper into this area, seeking to clarify these mixed results by emphasizing the critical role of goal context. Since consumers often hold multiple, sometimes conflicting (Lindenberg & Steg, 2007) or "fuzzy" (Lee & Ariely, 2006), goals, the effectiveness of a framing strategy depends on whether it aligns with the immediate goals of the consumer. Prior research has demonstrated that goal frames are contingent on contextual factors such as eating time (Boland et al., 2013) and location (Thøgersen & Alfinito, 2020). Therefore, it is essential to tailor messaging to the specific context in which food choices are made, ensuring that the frame resonates with the consumer's current priorities and preferences. This research identifies effective framing strategies for promoting PBMAs across various contexts, contributing to the ongoing debate on how best to encourage plant-based food consumption in different eating scenarios.

In addition to behavioral interventions, this research highlights affordability and accessibility as crucial levers for promoting PBMAs. Economic measures such as pricing strategies and fiscal policies can make plant-based alternatives more competitive with conventional meat products. Research consistently shows that consumers cite price as a major barrier to adopting protein alternatives (Apostolidis & McLeay, 2019; Michel et al., 2021). As previous studies have shown, reducing the cost of PBMAs not only attracts more consumers but also helps lower the demand for meat (Smart Protein, 2021). Therefore, targeted pricing interventions—such as subsidies, discounts, or efforts to lower production costs—are crucial in facilitating the transition toward plant-based diets and encouraging widespread dietary shifts.

While Article 3 explores the economic mechanism of increasing the cost of conventional meat through taxation to reflect environmental externalities, Article 4 focuses on reducing the cost of PBMAs to drive consumer consideration and choice. Although research has shown that taxes on high-emission foods, such as meat, are effective at curbing consumption (Katare et al., 2020), public opposition to meat taxes makes them politically difficult to implement (Grimsrud et al., 2020; Siegerink et al., 2024). Therefore, Article 3 investigates how policy design and framing influence public support for meat taxes. The research indicates that while discrete behavioral nudges may not be enough to sway public opinion in such a context of critically held political beliefs, well-designed

policies that emphasize economic and fairness dimensions can enhance their acceptability.

Conversely, Article 4 shifts attention to consumer behavior in response to price reductions of PBMAs. The findings indicate that lowering the price of PBMAs does increase demand, though significant shifts in consumer behavior are only observed with substantial price cuts (e.g., reducing the price of PBMAs to half the price of meat). This suggests that while some advocates and retail outlets push for price parity between meat alternatives and conventional meat (Chafin & Larson, 2022; Vegconomist, 2023), affordability beyond simple price parity is crucial to driving widespread adoption. Encouragingly, even when consumers do not immediately choose PBMAs after a price reduction, these alternatives enter their consideration set, creating potential for behavior change over time.

Finally, Article 5 offers a conceptual contribution to the nudging literature by conducting a scoping review and developing a typology of the (potential) intrusiveness of nudges within the food domain. While this article does not specifically focus on plant-based foods, it explores the ethical implications of using nudges to influence food choices, emphasizing the importance of preserving consumer autonomy by ensuring both freedom of choice and the capacity for deliberation. Unlike more intrusive interventions, such as the pricing strategies and taxes explored in Articles 3 and 4, this review focuses on less commanding and more widely accepted approaches (Reynolds et al., 2019). It highlights that while nudges can be effective, they should aim to remain transparent and minimally intrusive, allowing consumers to feel in control of their decisions. Notably, research suggests that less intrusive nudges are generally met with higher public support (Lemken et al., 2023). Although more directive policies, like pricing interventions, may be warranted in certain cases, Article 5 underscores the importance of finding a balance between influencing behavior and respecting individual autonomy within the context of nudging strategies.

**Table 1-1.** Content Summary of Articles 1, 2, 3, 4, and 5

| Article | Research Goal | Key Findings | Key Contributions |
|---|---|---|---|
| Article 1: How do defaults and framing influence food choice? An intervention aimed at promoting plant-based choice in online menus | To examine the effectiveness and mechanisms through which defaults and framed defaults influence food choice. | • Pre-selecting a PBMA did not significantly boost plant-based choice.<br>• A significant shift was only observed when the PBMA was additionally framed as the more sustainable or tastier choice.<br>• Default success was mediated by endowment (positively) and implied endorsement (negatively). | • Framed defaults can increase choice of PBMAs.<br>• Endowment is primarily responsible for the positive influence on default acceptance by way of triggering positive thoughts.<br>• Implies that marketers can offer plant-based by defaults without concern that it will lead to reactance. |
| Article 2: Tasty or sustainable? Goal conflict in plant-based food choice | To investigate goal conflict in plant-based food choice and to better understand mechanisms influencing expected taste of PBMAs under various goal frames. | • Aligning hedonic attribute frames with hedonic goals improved product engagement.<br>• Adverse effects on product engagement were found when sustainability frames met hedonic goals.<br>• Taste expectations were identified as a mediator in this process. | • A goal-conflict framework was applied to elucidate acceptance of plant-based alternatives.<br>• Aligning frames with goals is proposed to drive engagement with plant-based alternatives. |
| Article 3: Driving public support for a meat tax: Fiscal policies and behavioral interventions | To investigate how policy design, a framing nudge, and reflection prompt, influence public support for a meat tax. | • Support increased with revenue recycling and broader policy coverage but decreased as costs rose.<br>• Public support remained unchanged by the rationale behind pricing.<br>• Behavioral nudges or reflection treatments did not significantly affect public support. | • Policy design is crucial for increasing support for meat taxes.<br>• "Mere nudges" are ineffective in contexts where critical thinking about beliefs is essential, like policy voting. |

| | | | |
|---|---|---|---|
| Article 4: Substitution patterns and price response for plant-based meat alternatives | To identify which types of PBMAs resonate most with consumers and how pricing affects demand. | • Meat was generally preferred over PBMAs, but there was substantial heterogeneity.<br>• PBMAs comprised 25% of demand when a variety is offered at current market prices.<br>• Considering beef reduced PBMA consideration, but considering one PBMA increased consideration of others.<br>• Lowering PBMA prices boosted their demand, while changing beef burger prices had little effect. | • Demand for PBMAs may increase with the right incentivization.<br>• Affordability beyond price parity is important in catalyzing the shift towards plant-based diets. |
| Article 5: A choice architect's guide to the (autonomous) galaxy: a systematic scoping review of nudge intrusiveness in food choices | To build a typology to support choice architects to discern how nudges might better protect consumer autonomy, and ultimately uphold it in pursuit of behavior change. | • Three mechanisms emerged that, when not considered, could unduly intrude upon autonomy:<br>• The effort to opt-out, delineated along economic and physical sub-dimensions.<br>• Affective influence, i.e., social reference messaging and emotional appeals.<br>• Non-transparency, of the nudge itself and of non-nudged alternative options. | • Contributes to the legitimacy and feasibility of employing nudge strategies.<br>• Resource for encouraging critical thinking and responsible decision-making among choice architects. |

**Table 1-2.** Methodological Summary of Articles 1, 2, 3, 4, and 5

| Article | Studies | Design | Source | Observations | Stimuli | Methodology |
|---|---|---|---|---|---|---|
| Article 1: How do defaults and framing influence food choice? An intervention aimed at promoting plant-based choice in online menus | Main study | One-factorial | Prolific | N = 731 | Meal delivery kit online menu with sausage (pork and plant-based) | Logistic regression, Mediation analysis (using PROCESS Model 4 with 10,000 bootstrap samples; Hayes, 2018) |
| Article 2: Tasty or sustainable? Goal conflict in plant-based food choice | Main study | 3 (attribute frame: hedonic vs. healthy vs. sustainable) ×4 (active goal: hedonic vs. healthy vs. sustainable vs. none) between-subjects | Prolific | N = 743 | Plant-based chicken nugget | ANOVA, Mediation analysis (using PROCESS Model 7 with 10,000 bootstrap samples; Hayes, 2018) |
| Article 3: Driving public support for a meat tax: Fiscal policies and behavioral interventions | Main study | 2 (framing nudge: tax vs. levy) x 2 (reflection: yes vs. no) between-within-subjects conjoint | Panel Inzicht | N = 2,032 | Choice cards with meat tax policy scenarios | Regression, conjoint analysis (using Average Marginal Causal Effects; Hainmueller et al., 2014) |
| Article 4: Substitution patterns and price response for plant-based meat alternatives | Pre-test | One-factorial | Prolific | N = 100 | Burgers (meat analog, semi-analog, and non-analog) | ANOVA |
| | Study 1 | One-factorial | Prolific | N = 1,003 | Burgers (meat analog, semi-analog, and non-analog) | Hierarchical (or mixed) exploded logit model |
| | Study 2 | 2 (relative price: higher vs. lower) x 4 (burger option) plus baseline condition between-subjects | Prolific | N = 1,123 | Burgers (meat analog, semi-analog, and non-analog) | Two-stage multivariate logit model (Amano et al., 2022) |
| Article 5: A choice architect's guide to the (autonomous) galaxy: a systematic scoping review of nudge intrusiveness in food choices | Main study | Conceptual | Web of Science | N = 146 | N/A | Systematic scoping literature review following PRISMA-ScR guidelines |

## 1.4 Abstracts

### 1.4.1 Article 1

Nudging consumers towards plant-based foods by making these choices the default option is a promising strategy for effecting sustainable dietary change. In the hypothetical context of online food ordering in a Northern European country, we examined the underlying mechanisms and effectiveness of swapping the default in menus from meat to a plant-based meat alternative. Results showed that pre-selecting a plant-based option in the online setting was not enough to increase choice of plant-based meals alone. Rather, additionally framing the plant-based default as the more sustainable or tasty option was needed to significantly increase choice. While ease was unimportant and held constant in this online setting, endowment and implied endorsement were found to mediate default success such that the positive influence of endowment outweighed the (surprising) negative effect via endorsement. In contrast to general theoretical expectations of default nudges, an endorsement by an online food provider is unlikely to encourage plant-based choices.

### 1.4.2 Article 2

Marketers and policymakers navigate an evolving landscape where an increasing number of consumers are willing to consider the environmental impacts of meat consumption and shift towards plant-based proteins. This trend is exemplified by the increasing number of individuals who identify as flexitarians, preferring plant-forward diets though still consuming meat. Nevertheless, consumers juggle the conflicting desire for healthy and sustainable choices with the enjoyment of tasty food, which varies across contexts. Consequently, determining the appropriate framing for plant-based meat alternatives — when to emphasize health and sustainability or taste — poses a challenge not adequately addressed by previous research. This study delves into the nuanced impact of modifying goal salience by tailoring product attribute frames to align with contextual consumer goals, offering insights into engaging consumers with plant-based alternatives. These findings reveal that aligning a hedonic attribute frame with an active hedonic goal significantly enhances product engagement. Conversely, introducing a sustainability attribute frame in the presence of an active hedonic goal adversely influences taste expectations, leading to a decline in intentions to engage with the product. These insights offer valuable guidance for navigating the complexities of sustainable food choices and underscore the need to align messaging strategies with consumers' active goals.

### 1.4.3  Article 3

Taxing meat optimally is a first-best policy outcome to internalize environmental harms. However, meat taxes often lack public and governmental support. Recent research indicates that support for meat taxes can be improved by combining behavioral nudges with fiscal measures. In this study, we test this claim in a preregistered between-within-subjects experiment using a representative sample of the Dutch (N=2,032) population. The Netherlands is currently considering a meat tax legislation, thereby making our study timely and policy relevant. Participants were randomly assigned to a treatment condition in a 2x2 experimental setup, varying across a framing nudge ("tax" versus "levy") and a reflection ("yes" versus "no") dimension. Subsequently, all participants engaged in a discrete choice experiment where they selected their preferred meat pricing policy from six sets of choice cards. Each card included random variations in levels of four attributes: meat pricing (costs), revenue recycling, policy coverage, and pricing rationale. We find that policy support increases with greater revenue recycling and broader policy coverage but decreases as costs rise. The rationale behind pricing does not alter public support substantially. Importantly, we find no significant difference in public support across the different behavioral nudge or reflection treatments. Our experimental findings underscore the importance of policy design in enhancing support for meat taxes. The effective design of a meat tax is crucial, as superficial changes, such as behavioral nudges, may not be sufficient to sway public opinion.

### 1.4.4  Article 4

Efforts to promote sustainable resource use through reduced meat consumption, particularly in affluent nations, face challenges as global meat consumption persists. The resistance may be attributed to the lower sales price of meat compared to appealing plant-based meat alternatives (PBMAs). Addressing this, our research delves into the pivotal question of which types of PBMAs resonate most with consumers and how pricing affects demand. In a hypothetical restaurant context, we conducted 2 representative studies among 2,126 individuals to scrutinize preferences for meat, analog, semi-analog, and non-analog burgers. First, in a survey, we assessed rankings of the four burgers, alongside evaluating participants' genuine consideration of these choices to discern a diverse preference distribution. Subsequently, in an experiment, we examined the influence of prices on participants' consideration and choice of PBMAs. Our survey shows that meat has considerably higher utility and consumer preference than all PBMAs on average, but we also find substantial heterogeneity (i.e., some consumers prefer PBMAs over meat). Nonetheless, simulations suggest that PBMAs collectively may account for 25% of demand and may increase that share with the right incentivization. In the experiment, we establish

that the consideration of meat negatively impacts PBMA consideration, though consideration of any one PBMA increases the likelihood of considering other PBMAs. A noteworthy increase in consideration and choice is observed when prices of PBMAs are reduced, while changing the price of the meat burger only has minimal effect on demand. Such findings underscore the importance of affordability beyond price parity in catalyzing the shift towards plant-based diets.

### 1.4.5   Article 5

In seeking to uphold consumer autonomy in the design and implementation of nudge interventions, choice architects must concern themselves with preserving both the availability of options made to consumers (freedom of choice), and the capacity of consumers to deliberate and choose (agency) Several studies aim to examine the extent to which nudges truly uphold autonomy; however, most examine self-reported perceived intrusiveness on autonomy, rather than considering autonomy from the perspective of how nudges are designed. Leveraging a systematic scoping review of nudges related to food choice (N = 146), a common policy arena for nudge interventions, we develop a typology of three mechanisms of nudge design that, when not considered, could unduly intrude upon autonomy: (1) the effort to opt out, delineated along economic and physical sub-dimensions; (2) affective influence, such as social reference messaging and emotional appeals; and (3) non-trans- parency, including of the nudge itself and of non-nudged alternative options. We discuss how each mechanism manifested in reviewed studies, and ultimately offer possible criteria that can be used to evaluate nudge intrusiveness along each mechanism. This typology can support choice architects to discern how nudges might better protect consumer autonomy, and ultimately uphold it in pursuit of behavior change. Our scoping review further provides empirical support for the concept of resistible yet effective nudges.

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## 2  How do Defaults and Framing Influence Food Choice? An Intervention Aimed at Promoting Plant-Based Choice in Online Menus

with Yasemin Boztug and Dominic Lemken[1]

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## 2.1 Introduction

Our current protein consumption patterns are incompatible with sustainable food systems giving rise to a growing momentum for a protein transition (Aiking & de Boer, 2020; Willett et al., 2019). The livestock sector applies pressure on the world's planetary boundaries as animal-sourced foods have a significantly larger environmental and climate footprint than plant-based foods (Poore & Nemecek, 2018). Plant-rich diets are also well aligned with global dietary guidelines and can foster human health as well as improve animal welfare. The global protein supply is not shared equitably and while some regions are characterized by underconsumption, many high-income countries are characterized by over-consumption which must urgently be curbed (Parlasca & Qaim, 2022). Plant-based products similar in sensory characteristics that directly replace meat in meals, i.e., plant-based meat alternatives (PBMAs), can be a convenient approach for consumers who lack the desire or culinary know-how to reduce their meat intake. Still, there remain significant barriers to the acceptance of these alternatives (Michel et al., 2021). Changing routine eating habits can be slow-moving, especially meat-eating, which is deeply ingrained in many cultures with symbolic meaning that surpasses mere nutrition (Fiddes, 1989; Graça et al., 2015; Schösler et al., 2015).

Designing environments that nudge consumers towards plant-based alternatives, by making these choices easy, normal, and convenient, is a promising strategy for effecting change (Ammann et al., 2023; Jachimowicz et al., 2019; Meier et al., 2022). Default nudges, or the pre-selection of an option within a choice set, are a particularly debated tool in policy and marketing and are of increasing interest to researchers as a means of reducing meat consumption. To this end, Meier and colleagues (2022) recently conducted the first systematic review specifically on default nudges and meat consumption. Defaults have been useful in promoting sustainable (Meier et al., 2022), and healthy food choice (Cadario & Chandon, 2020; Peters et al., 2016; van Kleef et al., 2018) in addition to fostering smart decision-making in other areas e.g., organ donation and green energy uptake (Hummel & Maedche, 2019; M. Kaiser et al., 2020; Moseley & Stoker, 2015). The chief mechanisms of action through which defaults operate have been identified as endowment, where individuals attribute greater value to the default option; implied endorsement, where individuals perceive the default as the recommended choice; and effort, as the default option is easier to choose (e.g., Dinner et al., 2011; Jachimowicz et al., 2019; Meier et al., 2022). While these mechanisms form the theoretical framework for understanding defaults, they of rarely measured. An elaboration of these effect mechanisms is provided in Section 2.3.

The aim of this study is to empirically examine the mechanisms through which defaults influence food choice. These insights can help choice architects anticipate effect sizes and rebound effects as well as address ethical concerns, e.g., threatened autonomy and welfare (Hummel & Maedche, 2019; Jachimowicz et al., 2019; Lemken, 2021a). To our knowledge, this is the first study within the food domain to explicitly investigate and empirically measure the mediating role of endowment and implied endorsement in default success. Moreover, we assess the effectiveness of online defaults within menus in the context of meal delivery services—both with and without framing the choice as more sustainable or tasty. This setting was selected as a critical area for action because meat consumption is relatively high in out-of-home food environments (de Vaan et al., 2019; Horgan G. W. et al., 2019; Taufik et al., 2022) and consumers are increasingly making decisions, including food choices, online (Ahuja et al., 2021; Taufik et al., 2022).

## 2.2  Theoretical Framework

### 2.2.1  *Defaults*

Nudges are subtle design modifications in the environment (i.e., choice architecture) that promote prosocial behaviors such that choices are neither restricted nor the economic incentives altered (Thaler & Sunstein, 2008). Defaults are a classification of nudge that structure choice in a way that decision-makers receive a pre-selection automatically (Thaler & Sunstein, 2008), or unless they actively opt-out (Brown & Krishna, 2004). While nudges are intended to encourage good behaviors, choice architecture is not always well thought-out and may be designed with less humanitarian intentions—what Thaler and Sunstein (2021) refer to as "sludge". Restaurants and other eateries typically set meat as the default, either implicitly or explicitly (Taufik et al., 2022). One example is placing vegetarian dishes at the bottom of menus which can signal these choices are not the norm. Bacon and Krpan (2018) found that doing so reduced the likelihood of ordering plant-based by 59% versus when dishes were listed together (also see Krpan & Houtsma, 2020). This design reinforces the mindset that meat is the status quo so many continue to pick familiar meaty favorites and overlook vegetarian options.

Defaults aimed at reducing meat consumption can pre-select a vegetarian meal (Campbell-Arvai et al., 2014; de Vaan et al., 2019; Gravert & Kurz, 2021; Hansen et al., 2021; Hielkema et al., 2022) or alter the default portion size of meat or vegetables (de Vaan et al., 2019; Friis et al., 2017; Reinders et al., 2020; Vandenbroele et al., 2018). The pre-selection of dishes has been implemented by listing vegetarian options on the menu with the option to add meat (de Vaan et al., 2019; Hielkema et al., 2022; Taufik et al., 2022) or swap the default plant-protein for meat on request (Campbell-Arvai et al., 2014). An alternative approach has been to position the vegetarian menu in a more visible location (Lemken, 2021). These

interventions invert today's status quo and successfully reduce meat consumption. However, few studies examine integrative online nudges in this context. Our intervention allows for the manipulation of the user-interface, a uniquely useful design feature of online settings, and the implementation of a readily accessible way for individuals to opt-out—with the click of a button. While most studies nudge healthy and sustainable food choices in general, without specific focus on meat analogues, we anticipate defaults will likewise increase choice of these foods, despite the unique challenge novel foods pose to acceptance. Thus, we formally propose the following hypothesis:

**Hypothesis 1:** Menus with a plant-based default will increase the odds of plant-based choice versus a menu with a meat default.

### 2.2.2  Default Framing

While defaults in the classic sense structure choice, default framing emphasizes an option as the status quo without otherwise pre-selecting options (Lemken, 2021a). Thus, the choice scenario is described rather than structured. In other terms, this distinction can be thought of as *what* choice task is presented versus *how* it is presented (Johnson et al., 2012). Default framing can be employed independently or in combination with structural defaults. Within food choice, framing the plant-based option as the default (e.g., as the "dish of the day") has been found effective (Saulais et al., 2019). Likewise, labeling vegetarian dishes in a neutral fashion rather than as explicitly vegetarian can increase vegetarian choice by framing these dishes as normal (Hielkema & Lund, 2022). Similar studies have combined the "dish of the day" frame with choice structuring, also with good effect (Bergeron et al., 2019; van Kleef et al., 2018). However, few studies investigate how these two interventions interact. A notable exception is a field study by Bergeron and colleagues (2019), in which desserts with more/less fat and sugar were framed as the norm and/or pre-selected on a physical order form. The authors found a synergistic effect when both interventions were combined. While the type of framing (health-focused) and food context is dissimilar to our own (reformulated desserts vs. plant-based meat), we similarly expect the combination of structural defaults with default framing will be more effective than structural defaults alone. We label these foods as the tastier or more sustainable choice as another way to frame them as the status quo. Accordingly, we hypothesize:

**Hypothesis 2:** Menus with a plant-based default plus frame (i.e., taste or sustainability) will increase the odds of plant-based choice versus a plant-based default without a frame.

Framing the choice in this way will activate contrasting consumer goals. With respect to environmental behavior, goal frames can be conceptualized as being motivated by personal interests (hedonic or gain goals) or the interests of a larger group (normative or moral goals)

(Lindenberg & Steg, 2007; Onwezen, 2023). While individuals balance all these goals simultaneously, the hedonic goal frame is innately most salient unless external cues prompt otherwise (Lindenberg & Papies, 2019). Despite the instinctual gravity of the hedonic goal frame and consumers consistently pointing to taste as the driving factor in food choice, plant-based alternatives are often marketed on their sustainability benefits. Sustainability claims have indeed been found to better promote choice of these foods compared to a vegetarian framing (Krpan & Houtsma, 2020). However, it may be that underscoring hedonic (i.e., taste) rather than societal (i.e., sustainability) goals will be more effective in shifting behavior. For example, labels that use taste-focused (vs. health-focused) language promote vegetarian choice and boost post-consumption feelings of enjoyment (Turnwald & Crum, 2019). Therefore, we propose the following:

**Hypothesis 3:** Menus with a plant-based default plus taste frame will increase the odds of plant-based choice versus a plant-based default plus sustainability frame.

### 2.2.3   Default Effect Mechanisms

Research suggests that defaults govern behavior through three main mechanisms: i) *endowment*, ii) *implied endorsement*, and iii) *ease* (Dinner et al., 2011; Jachimowicz et al., 2019; Meier et al., 2022). *Endowment* is the tendency for individuals to place greater value on objects they own than they would if they did not. Traditionally, this is described in terms of loss aversion, i.e., that losses loom greater than gains (Kahneman et al., 1991; Kahneman & Tversky, 1979). Default settings shift the reference point to the default and frame opting out as a loss. We use Query Theory to explain this phenomenon, which posits that preferences are constructed, rather than stored and stable, based on a process of mental querying. Additionally, the order in which individuals query influences preference formation in a way that earlier considerations influence preferences to a greater extent (Dinner et al., 2011; Johnson et al., 2007). Through this lens, the default acts as an "instant endowment" such that individuals use it as a reference point when considering aspects for and against maintaining the status quo. As a result, thoughts in favor of the default (vs. against) both arise earlier in the decision-making process and are more plentiful (Dinner et al., 2011). Building on this theoretical background, direct cues via framing of the default (as tastier or more sustainable) is anticipated to provide a basis for querying such that thoughts regarding taste and sustainability will be more readily accessible in the minds of decision-makers. *Implied endorsement* describes the inclination for individuals to infer that the default is a recommendation by the choice architect (Jachimowicz et al., 2019; Sunstein, 2017). Extending this theory, we posit that framing a structural default with overt messaging will amplify the perceived endorsement of the default. While implied endorsement is assuredly at play in situations where decision-makers have little experience or weak preferences, it is

yet to be tested in everyday food choice. *Ea*se capitalizes on the relative ease with which individuals can accept the default; it is physically or cognitively easier to avoid appraising alternatives (Dinner et al., 2011; Jachimowicz et al., 2019; Meier et al., 2022). While the literature indicates that defaults are effective at promoting prosocial behaviors, this study is the first to empirically examine these effect mechanisms in food choice. This is a gap that Jachimowicz and colleagues (2019) have had to navigate without such information in conducting their meta-analysis on defaults. We focus on endowment and implied endorsement as the choice is easily deliberated in the online setting; opting out can be done with a click of a button. In the present study, ease is held constant across conditions and thus serves as a control. As such, we hypothesize:

**Hypothesis 4a:** Menus with a plant-based default plus frame (i.e., taste or sustainability) will cause greater endowment which will increase default stickiness. That is, endowment will mediate the effect of the default on menu choice.

**Hypothesis 4b:** Menus with a plant-based default plus frame (i.e., taste or sustainability) will cause greater perceived implied endorsement of the default which will increase default stickiness. That is, implied endorsement will mediate the effect of the default on menu choice.

## 2.3  Methods

### 2.3.1  Data Collection

A total of 731 adult participants were recruited from the online Panel provider Prolific. The Ethics Committee at the researcher's university reviewed the authors' methods prior to data collection and confirmed that the research project complied with their ethical standards. All participants gave informed consent before participation. The sample was balanced between males and females. Participants were excluded if they did not complete the entire questionnaire. Participants that failed both of the two attention checks were terminated early in the survey flow such that their responses were incomplete. Therefore, these participants were necessarily excluded from data analysis. Prior to data analysis, participants who followed a vegetarian, vegan, pescatarian, or halal diet were excluded as these diets prohibit pork consumption (pork products were included on all menus). These participants were excluded based on a post-task dietary survey question instead of a pre-screening to avoid priming vegetarian food choice. For the same reason, there was no mention of meat or plant-based foods during recruitment. A total of 543 participants remained after these exclusions.

### 2.3.2 Sensitivity Analysis

To identify statistically significant associations, we conducted a sensitivity power analysis using the Goodness-of-fit tests for contingency tables ($X^2$-test family) sensitivity analysis module in G*Power v. 3.1.9.6 (Faul et al., 2007). Our sample size of 543, with four treatment groups, enabled us to detect significant associations at a small effect size level (Cohen's w = 0.14) (Cohen, 1992) with an alpha level of 0.05 and a power of 0.80.

### 2.3.3 Study Procedure and Design

A between-subject design with one experimental factor with four levels was employed. Participants were randomly assigned to one of the four experimental conditions: 1) *meat default*, 2) *plant-based (PB) default*, 3) *PB default + sustainability frame*, and 4) *PB default + taste frame*. In each condition, participants viewed an online menu offered by a mock meal-kit delivery service. Prior to viewing the menu, participants read a definition of meal kits (i.e., pre-portioned food ingredients with recipes that are delivered to customer's homes). They were instructed to imagine they were selecting a meal for themselves, and that each meal costs the same. We argue that the absence of pricing information on individual meals is plausible in this context given that such subscription services typically charge a flat rate upfront. All menus presented the same dish, an orzo pasta salad, that could be ordered with either a plant-based or a pork sausage on skewers. The dish was selected from a real meal on offer by a popular meal-kit delivery service available at the time the study was designed. Each menu had a pre-selected sausage such that one type of sausage was in the electronic shopping cart upon viewing the menu. In the two conditions with framing, a pop-up message read: "We have selected the most sustainable/tastiest sausage for you". All participants could opt-out by clicking on text that read: "Rather have a plant-based/pork sausage?". Our baseline condition, in which pork was pre-selected, was used to reflect the real-world status quo in which meat is the default in most food establishments. This study did not include any conditions that framed meat as the better option, as the aim of the study was to promote plant-based rather than meat choice. Since plant-based sausages are similar in appearance to their meat counterparts, it was plausible to use an identical image for the two dishes (see Figure 2-1 and 2-2). This was done to avoid the potential confound of variations in stimuli attractiveness. See appendix for the stimuli presented for all treatment conditions.

**Figure 2-1.** Plant-Based Default Stimuli
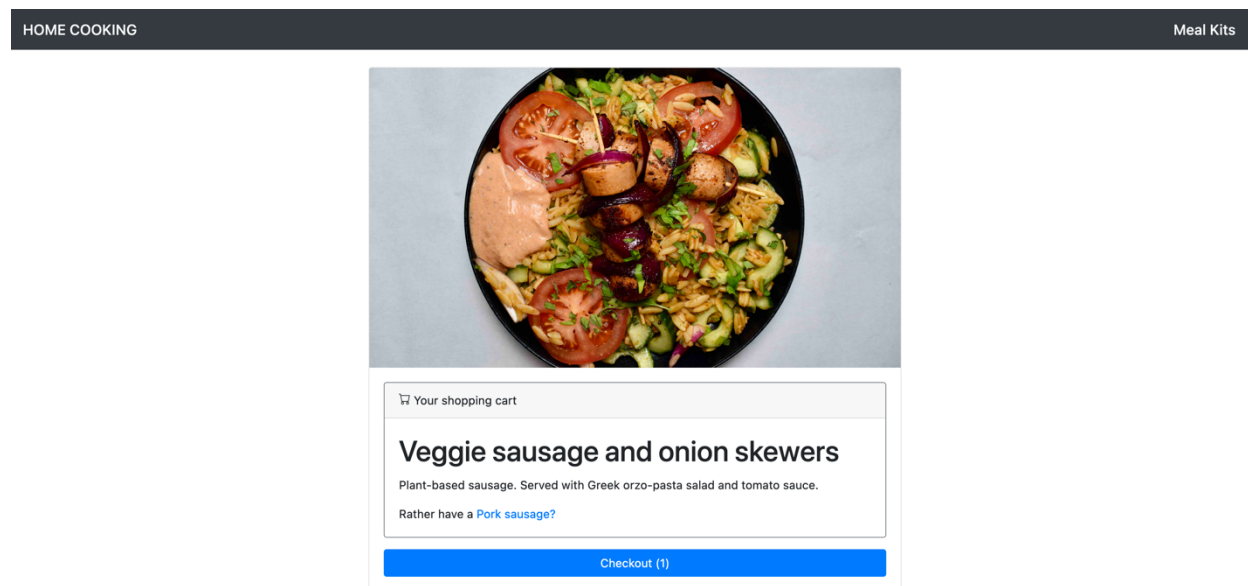


**Figure 2-2.** Meat Default Stimuli
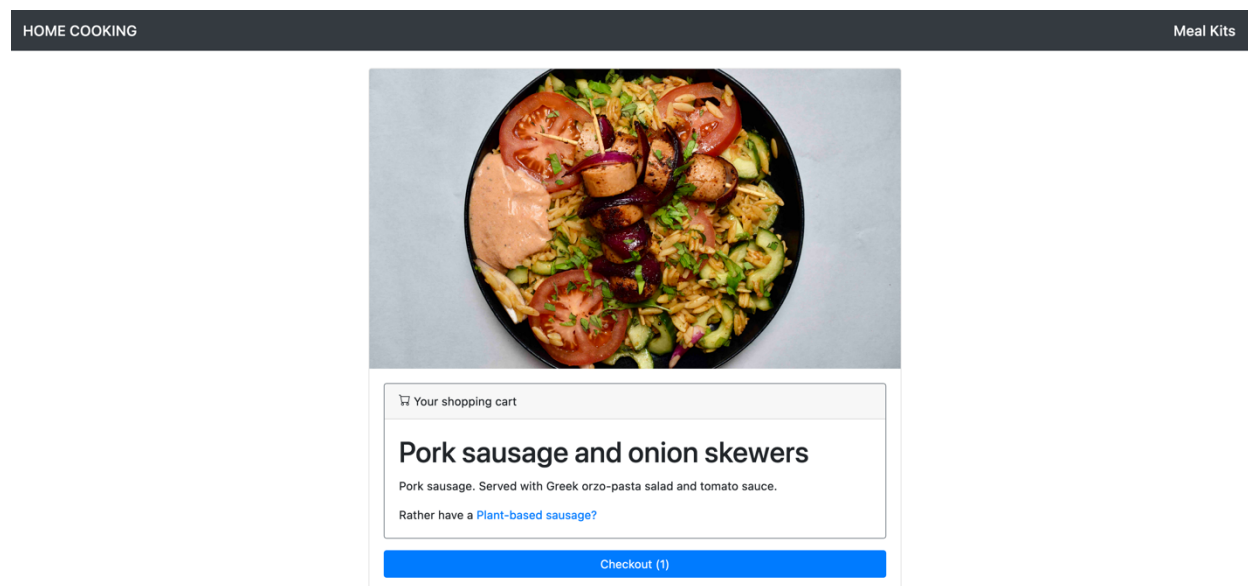


*Note.* Figures 2-1 and 2-2 were originally in another language and have been translated.

After making a choice, participants completed a questionnaire (see section 3.4). All materials were presented to participants in the local language. They were initially produced in English, translated into the local language by native speakers, and then back translated into English.

### 2.3.4  Measures

*Behavioral choice task.* Participants were shown one of the four menus (see section 3.3) and asked to choose one of the two options.

*Endowment.* As a measure of endowment, participants completed an aspect listing task in which they listed all thoughts they had while making their choice and self-coded each statement as positive (negative) about the plant-based (pork) sausage, a method previously implemented by Dinner and colleagues (2011; also see Johnson et al., 2007; Weber et al., 2007).

*Implied Endorsement.* One item measured implied endorsement (i.e., "I think the meal-kit delivery service appeared to want me to select the dish with plant-based/pork sausage") on 7-point Likert scales from "strongly disagree" to "strongly agree".

*Effort.* Three items measured the felt ease in opting-out (i.e., "I felt that choosing the dish with plant-based/pork sausage was a bother", "I felt that the cost in time and effort to select the dish with plant-based/pork sausage was high", "I felt that choosing the dish with pork/plant-based sausage involved less effort") on 7-point Likert scales from "strongly disagree" to "strongly agree" (Cronbach's α = 0.747).

*Food Neophobia*, the aversion to unfamiliar or new foods, was measured with the 8-item Food Neophobia Scale (FNS) (Pliner & Hobden, 1992; Cronbach's α = 0.842), also on a 7-point Likert scale with the same anchor words. Three items on the FNS were reverse coded. The 8-item FNS (Ritchey et al., 2003) was used for the sake of brevity and the translated version in the local language was obtained from Siegrist, Hartmann, and Keller (2013). This was included as a control because higher levels of food neophobia have been cited as a barrier to the acceptance of alternative proteins (Onwezen et al., 2021).

*Familiarity with PBMAs* was measured by asking how often participants eat such foods and possible responses were "never", "less than a few times a month", "a few times a month", "a few times a week", "once a day", and "several times a day".

*Demographics.* All participants were asked to verify their age, gender, dietary preference, highest level of education, and income at the end of the survey.

*Attention checks*. Two attention checks were included within the survey (e.g., "To show that you are paying attention, please select the "neither agree nor disagree" option as your answer").

### 2.3.5 Data Analysis

All data analyses were performed with R. The analysis plan and hypotheses were formulated prior to data collection. To examine the effect of treatment on dish choice, we performed a Chi-Square followed by logistic regression analyses (using the built-in R 'stats' package). Logistic regression was used to determine if plant-based choice significantly differed across conditions. Indicator coding was used for the independent variable (treatment condition) with *meat default* set as the reference category. The analysis was conducted again with *PB default* set as the reference category for comparison between a plant-based default with and without framing. The dependent variable was binary, i.e., plant-based choice. Models including the control variables gender, age, education, familiarity with PBMAs, and FNS (both reference categories) were conducted for a robustness check.

To explore the mechanisms of default success, we performed ANOVA (using the built-in R 'stats' package) and a mediation analysis using PROCESS macro (Hayes, 2018). One-way ANOVA were used to test for significant differences in endowment, implied endorsement, and ease across treatment groups. For the mediation analysis, linear ordinary least squares regressions were used when the consequent variable was continuous and logistic regressions when the consequent variable was binary. Indicator coding was again used to estimate the effect of each plant-based default condition relative to that of *meat default*. For the mediation analysis, the dependent variable was choice of default option rather than choice of plant-based dish to examine default stickiness.

Endowment was operationalized as the order and content of thoughts listed (Cronbach's α = 0.781). Order was indicated by the standardized median rank difference (SMRD):

$$Order = 2 \ (MR_{non\text{-}default} - MR_{default}) \ / \ n \tag{1}$$

where $MR_{default}$ ($MR_{non\text{-}default}$) was the median rank of aspects for (against) the default and *n* were the total number of aspects. Content was specified by the standardized difference of counts for and against the default:

$$Content = (Count_{default} - Count_{non\text{-}default}) \ / \ n \tag{2}$$

Values for both ranged between 1 and -1, where 1 indicated earlier aspects were in favor of the default (Dinner et al., 2011).

All items from the FNS scale were summed into a composite score with a higher value indicating a greater degree of neophobia. Possible FNS scores ranged from 8 to 56.

## 2.4 Results

### 2.4.1 Descriptive Statistics

The sample (N= 543) was 39.78% female, 58.93% male, and 1.29% non-binary. The average age was 30.08 years (SD = 9.76). Concerning education, 11.60% reported having no high school degree, 41.07% a high school degree or equivalent, 24.13% a bachelor's degree, 22.10% a master's degree, and 1.15% a Ph.D. For income, 25.41% reported less than €1.300, 27.62% reported €1.300 - €2.599, 25.60% reported €2.600 - €4.499, 13.08% reported more than €4.499, and 8.29% preferred not to say. Three-hundred and sixty-two participants identified as omnivores and 181 as flexitarians (i.e., mostly plant-based but sometimes eat meat/dairy products). Participants were randomly distributed to *meat default* (n = 126), *PB default* (n = 141), *PB default + sustainability frame* (n = 134), and *PB defaults + taste frame* (n = 142).

The sample was characterized by relatively low levels of food neophobia. FNS scores ranged from 8 (neophilic) to 50 (neophobic). The total sample had a mean of 22.76 ± 7.51 and scores were normally distributed. Though an omnibus test indicated FNS scores were different between intervention groups (*p* = .034), pairwise comparisons indicated no significant differences. A majority (81.95%) were familiar with PBMAs. While 98 (18.05%) indicated they had never tried them, 144 (26.52%) said they ate them "less than a few times a month", 167 (30.76%) "a few times a month", 115 (21.18%) "a few times a week", 15 (2.76%) "once a day", and 4 (0.74%) "several times a day".

### 2.4.2 Dish Choice: Plant-Based versus Meat

The plant-based sausage was selected by 90 (63.38%) participants in *PB default + taste frame*, 84 (62.69%) in *PB default + sustainability frame*, 72 (51.06%) in *PB default*, and 62 (49.21%) in *meat default*. A Chi-Square test indicated the proportion of participants who chose plant-based differed significantly across groups, $X^2$(3, *N* = 543) = 9.245, *p* = .026 (Figure 2-3).

**Figure 2-3.** Bar Plot of Proportion of Plant-Based Choice by Condition
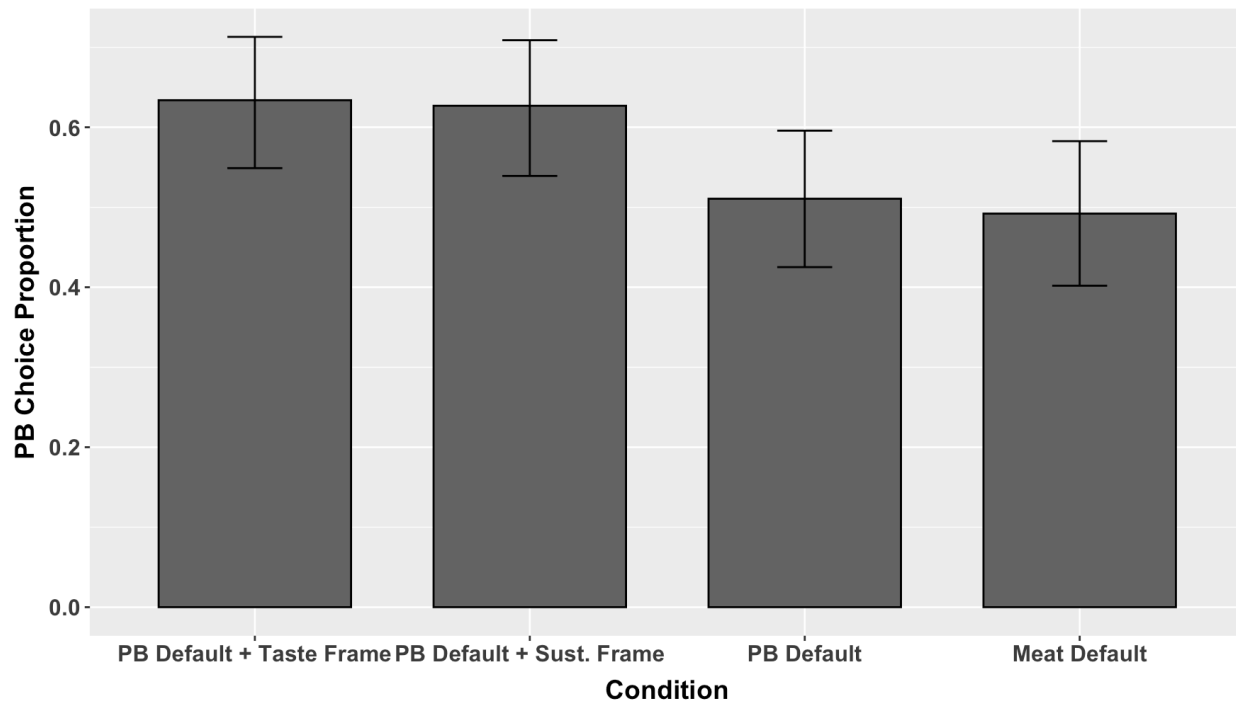


*Note*. Error bars indicate 95% confidence intervals for observed proportions.

A logistic regression determined the effect of default condition (reference category = *meat default,* model 1) on plant-based choice for which the model was significant, $X^2(3) = 9.268$, $p = .026$, Nagelkerke $R^2 = 0.023$. The odds of choosing plant-based were 1.8 times greater (OR = 1.787, 95% CI [1.099-2.921], $p = .020$) for *PB default + taste frame* and 1.7 times greater (OR =1.734, 95% CI [1.060-2.853], $p = .029$) for *PB default + sustainability frame* than *meat default*. There was no difference between *PB default* and *meat default* (OR = 1.077, 95% CI [0.666-1.743], $p = .762$). For the robustness check (model 2), the adjusted model including control variables was again significant, $X^2(12) = 161.54$, $p < .001$, Nagelkerke $R^2 = 0.345$ and showed a similar pattern of results. It was additionally revealed that the odds of choosing plant-based were 2.2 times greater for females (vs. males), **(OR = 2.201, 95% CI [1.457-3.352]**, $p < .001$), and 2.9 times greater for each unit increase in familiarity with PBMAs **(OR = 2.873, 95% CI [2.315-3.617]**, $p < .001$). Age, education, and FNS were not significant predictors of choice. To compare framed defaults to *PB default*, the model was run again with the reference category set as *PB default* (model 3) which was non-significant $X^2(2) = 5.517$, $p = .063$, Nagelkerke $R^2 = 0.018$. However, the adjusted model with the reference category set as *PB default* (model 4) was significant, $X^2(11) = 120.41$, $p < .001$, Nagelkerke $R^2 = 0.338$. The odds of choosing plant-based were 2 times greater (OR = 1.947, 95% CI [1.118-

3.422], *p* = .019) for *PB default + taste frame* and 1.9 times greater (OR = 1.859, 95% CI [1.052-3.322], *p* = .034) for *PB default + sustainability frame* than *PB default* (see Table 2-1).

**Table 2-1.** Logistic Regression Results

| | Model 1 (ref. category = *meat default*) | | | | | Model 3 (ref. category = *PB default*) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coeff. | OR | Lower CI | Upper CI | Sig. Level | Coeff. | OR | Lower CI | Upper CI | Sig. Level |
| ***Treatment Condition*** | | | | | | | | | | |
| PB Default | 0.074 | 1.077 | 0.666 | 1.743 | 0.762 | | | | | |
| PB Default + Sustainability Frame | **0.551** | **1.734** | **1.060** | **2.853** | **0.029*** | 0.476 | 1.610 | 0.997 | 2.613 | 0.052 |
| PB Default + Taste Frame | **0.580** | **1.787** | **1.099** | **2.921** | **0.020*** | 0.506 | 1.659 | 1.034 | 2.675 | 0.037* |
| | Model 2 (ref. category = *meat default*) | | | | | Model 4 (ref. category = *PB default*) | | | | |
| | Coeff. | OR | Lower CI | Upper CI | Sig. Level | Coeff. | OR | Lower CI | Upper CI | Sig. Level |
| ***Treatment Condition*** | | | | | | | | | | |
| PB Default | 0.367 | 1.443 | 0.819 | 2.559 | 0.206 | | | | | |
| PB Default + Sustainability Frame | **0.994** | **2.702** | **1.494** | **4.958** | **0.001**** | 0.620 | 1.859 | 1.052 | 3.322 | 0.034* |
| PB Default + Taste Frame | **1.021** | **2.775** | **1.566** | **4.982** | **< 0.001 ***** | 0.666 | 1.947 | 1.118 | 3.422 | 0.019* |
| ***Age*** | 0.005 | 1.005 | 0.984 | 1.027 | 0.620 | 0.009 | 1.206 | 0.985 | 1.034 | 0.475 |
| ***Gender*** | | | | | | | | | | |
| Female | **0.789** | **2.201** | **1.457** | **3.352** | **< 0.001 ***** | **0.691** | **1.995** | **1.242** | **3.236** | **0.005**** |
| Non-binary | 0.881 | 2.413 | 0.349 | 23.878 | 0.400 | 1.017 | 2.766 | 0.351 | 58.126 | 0.391 |
| ***Education*** | | | | | | | | | | |
| High School or Equivalent | 0.354 | 1.424 | 0.455 | 5.371 | 0.556 | 0.187 | 1.206 | 0.376 | 4.627 | 0.760 |
| Bachelor | -0.102 | 0.903 | 0.338 | 2.810 | 0.844 | 0.027 | 1.028 | 0.377 | 3.245 | 0.959 |
| Master | -0.060 | 0.942 | 0.488 | 1.953 | 0.861 | -0.064 | 0.938 | 0.471 | 1.996 | 0.859 |
| Doctorate | -0.071 | 0.931 | 0.600 | 1.458 | 0.752 | -0.058 | 0.943 | 0.577 | 1.554 | 0.817 |
| ***Familiarity with PBMAs*** | **1.055** | **2.873** | **2.315** | **3.617** | **< 0.001 ***** | **1.072** | **2.920** | **2.274** | **3.821** | **< 0.001 ***** |
| ***Food Neophobia Score (FNS)*** | -0.010 | 0.990 | 0.963 | 1.019 | 0.502 | -0.012 | 0.988 | 0.957 | 1.020 | 0.465 |

*Note.* Categorical variables compared to reference category; for Treatment Condition = *Meat Default*; Gender = Male; and Education = No High School. Age, familiarity with PBMAs, and FNS were included as continuous variables.

### 2.4.3 Mechanisms for Default Success

ANOVA indicated significant differences in endowment, i.e., order ($p < .001$) and content ($p = .002$) as well as implied endorsement ($p < .001$) between conditions. Tukey testing indicated *meat default* significantly differed from *PB default + sustainability frame* in terms of order ($p < .001$) and content ($p = .011$). Likewise, content varied significantly between *meat default* and *PB default + taste frame* ($p = .006$). For implied endorsement, *meat default* was significantly different from all other groups ($p < .001$) as was *PB default* from *PB default + sustainability frame* ($p = .020$). As expected, there were no significant differences in ease across groups ($p = .465$) (Table 2-2).

**Table 2-2.** Results of One-Way ANOVA and Tukey's Pairwise Comparison by Condition

| | Meat Default | | PB Default | | PB Default + Sustainability Frame | | PB Default + Taste Frame | | F-Value | Sig. Level |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD | | |
| Endowment (Order) | -0.22[a] | 0.85 | 0.04[ab] | 0.87 | 0.21[b] | 0.85 | 0.01[ab] | 0.87 | 5.54 | <.001 |
| Endowment (Content) | -0.12[a] | 0.70 | -0.02[ab] | 0.69 | 0.15[b] | 0.66 | 0.16[b] | 0.67 | 5.02 | .002 |
| Endorsement | 4.86[a] | 1.49 | 5.59[b] | 1.20 | 6.02[c] | 1.09 | 5.87[bc] | 1.15 | 22.70 | <.001 |
| Ease | 3.65 | 1.30 | 3.88 | 1.41 | 3.87 | 1.50 | 3.87 | 1.33 | 0.85 | .465 |

*Note.* Tukey's pairwise comparisons made where omnibus test was significant. Mean values that differ significantly are indicated row-wise by superscript.

We tested our conceptual model (Figure 2-4) using a parallel mediation analysis with 10,000 bootstrap samples (model 4 in Hayes, 2018). Results indicated that when the plant-based (vs. meat) menu was the default, participants felt a greater sense of endowment with the default (*PB default: b* = 0.362, *SE* = .172, *p* = .036, 95% CI = 0.024, 0.700; *PB default + sustainability frame*: *b* = 0.696, *SE* = .174, *p* < .001, 95% CI = 0.353, 1.038; *PB default + taste frame*: *b* = 0.509, *SE* = 0.172, *p* = .003, 95% CI = 0.172, 0.847). Subsequently, there was a significant positive effect of endowment on choice of the default menu (*b* = 1.399, *SE* = .103, *p* < .001, OR = 4.05, 95% CI = 1.172, 1.626). At the same time, participants in the plant-based (vs. meat) default conditions also felt a greater sense of implied endorsement (*PB default*: *b* = 0.732, *SE* = .151, *p* < .001, 95% CI = 0.434, 1.029; *PB default + sustainability frame*: *b* = 1.165, *SE* = .153, *p* < .001, 95% CI = 0.864, 1.466; *PB default + taste frame*: *b* = 1.016, *SE* = .151, *p* < .001, 95% CI = 0.719, 1.313). In contrast to endowment, implied endorsement had a significant negative effect on choice (*b* = -0.299, *SE* = .101, *p* = .004, OR = 0.741, 95% CI = -0.501, -0.097). Thus, the likelihood of a participant selecting the default was 4.05 times higher for each unit increase of endowment. In contrast, the odds of a participant choosing the default decreased by a factor of 0.74 for each unit increase in implied endorsement. As expected, ease did not significantly mediate the default effect on choice. Direct effects of default condition on choice were non-significant. See Table 2-3 for the full mediation analysis summary.

**Figure 2-4.** Parameter Estimates
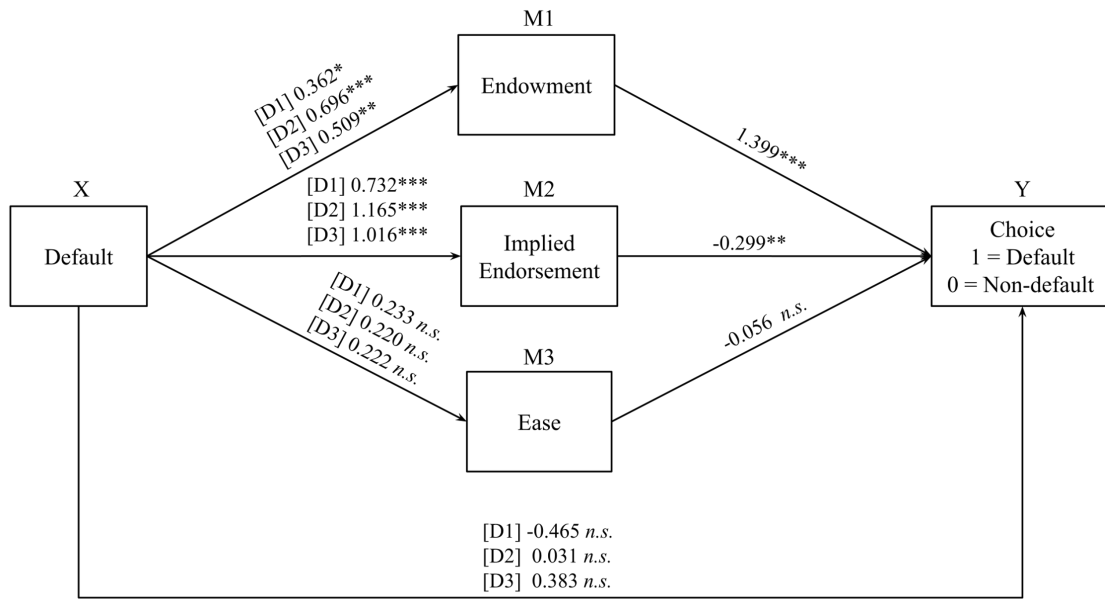


*Note.* D1 = *PB default,* D2 = *PB default + sustainability frame,* D3 = *PB default + taste;*\*\*\*
*p < .001, \*\* p < .01, p < .05, p > n.s.*

**Table 2-3.** Mediation Analysis Summary

| Relationship | PB Default [D1] | | | | PB Default + Sustainability Frame [D2] | | | | PB Default + Taste Frame [D3] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | EST | SE | CI Lower | CI Upper | EST | SE | CI Lower | CI Upper | EST | SE | CI Lower | CI Upper |
| *Direct effect* | | | | | | | | | | | | |
| Default → Choice | -0.465 | 0.342 | -1.135 | 0.206 | 0.031 | 0.366 | -0.686 | 0.747 | 0.383 | 0.342 | -0.287 | 1.052 |
| *Indirect effects* | | | | | | | | | | | | |
| Default→ Endowment→ Choice | **0.506*** | 0.256 | 0.030 | 1.024 | **0.973*** | 0.261 | 0.498 | 1.533 | **0.713*** | 0.257 | 0.244 | 1.259 |
| Default→ Endorsement→ Choice | **-0.219*** | 0.092 | -0.431 | -0.070 | **-0.349*** | 0.134 | -0.645 | -0.120 | **-0.304*** | 0.119 | -0.571 | -0.101 |
| Default → Ease→ Choice | -0.013 | 0.028 | -0.083 | 0.036 | -0.012 | 0.029 | -0.084 | 0.034 | -0.012 | 0.027 | -0.080 | 0.034 |

*Note.* EST = Mediated effect, SE = Bootstrapped standard error, the confidence intervals are the bootstrapped 95% confidence intervals. The independent variable was dummy coded so that the reference group was *meat default*.

## 2.5  Discussion

### 2.5.1  Effectiveness of Defaults

Contrary to previous findings (Gravert & Kurz, 2021; Hansen et al., 2021; Taufik et al., 2022), this study demonstrates that pre-selecting a plant-based option is not always enough to significantly increase choice of plant-based meals alone. We were therefore unable to confirm hypothesis 1. In addition to structurally integrating the plant-based choice as the default, framing this choice as the better option is important. We ascribe this effect to the significance of framing in clarifying and substantiating the alteration in choice architecture. Both taste and sustainability framing appear to sufficiently account for the change in default status, as both resulted in significant increases in plant-based choice. As such, we confirm hypothesis 2 but are unable to confirm hypothesis 3.

While most studies do not distinguish between these two types of defaults (Lemken, 2021a; Taufik et al., 2022; van Kleef et al., 2018), our study compares the success of a sole choice structuring default to that combined with framing. Our findings align with the limited existing research on this topic, such as the study conducted by Bergeron and colleagues (2019), which found that combining environmentally integrated defaults with framing was more effective than framing alone in promoting choice of reformulated desserts. It is important to note that, compared to desserts, meat holds a special status, e.g., as the central and defining component of a meal (Douglas, 1975). The change in

choice architecture will be more salient to diners when meat is displaced versus ingredients that are considered less essential and thus less subject to automatic thought processing. Other studies that have successfully reduced meat choice via choice structuring alone nudged traditional vegetarian meals rather than meat analogues (Campbell-Arvai et al., 2014; de Vaan et al., 2019; Gravert & Kurz, 2021; Hansen et al., 2021; Hielkema et al., 2022). It may be that plant-based alternatives that directly mimic meat pose a unique challenge to the status quo as they both claim to be like and not like meat (Lemken, 2021b).

In this case, both taste and sustainability frames performed similarly; nevertheless, it is crucial to acknowledge that there may be substantial variations in how consumers respond to these frames, depending on the consumption setting (Belei et al., 2012; Michel et al., 2021; Poor et al., 2013) and personal differences (e.g., (Bacon & Krpan, 2018; Graham & Abrahamse, 2017; Hielkema et al., 2022; Vainio et al., 2018; Weingarten et al., 2022; Yule & Cummings, 2023). It is important that frames are credible, culturally relevant, and appropriate to the target group (de Boer & Aiking, 2017). Research has found that individuals with different pre-existing domain knowledge (Vainio et al., 2018; Weingarten et al., 2022), levels of meat intake (Bacon & Krpan, 2018; Hielkema et al., 2022), environmental concern (Graham & Abrahamse, 2017), political ideology (Yule & Cummings, 2023), and values (Graham & Abrahamse, 2017) respond heterogeneously to similar information about meat options and their plant-based alternatives. Moreover, issues of credibility may arise with meat analogs that are framed as tasty but do not measure up to consumers' expectations (Elzerman et al., 2013). While this study was hypothetical, and participants did not actually taste the dish, negative taste expectations may have dulled response to the taste frame. However, as the food industry makes technological strides, and meat replacements become further indistinguishable from their meat counterparts, such claims will be met with less challenge.

### 2.5.2  Default Effect Mechanisms

This study addresses multiple research calls to empirically examine the mechanisms through which defaults operate (Hielkema et al., 2022; Jachimowicz et al., 2019; Lemken, 2021a; Meier et al., 2022; Szaszi et al., 2018; Zlatev et al., 2017). Findings from the mediation analysis buttress the theory that default effects in online food choices result primarily from reference dependence during memory retrieval and preference formation – a cognitive process we hold responsible for the endowment effect. While the mediating effect of endorsement was negative, the positive influence of endowment outweighed this. Thus, we confirm hypothesis 4a and 4b in that these constructs mediate default effects, though implied endorsement exerted a directionally opposite effect than anticipated. We anticipate this effect will hold for most online food purchasing settings and may also apply to other online settings where run-of-the-mill decisions are commonplace, including retail.

In their review, Meier et al. (2022) conclude that endowment is not a central mechanism in the effectiveness of defaults in reducing meat consumption. The authors attribute this to the use of default options in the reviewed studies, (which require active choice or, at minimum, confirmation before receiving the default), rather than default rules (which do not require confirmation and will be received automatically unless actively opt-ed out of). Although all participants were required to confirm their selection via the check-out button in this study, the pre-filled shopping cart presented a greater degree of automaticity than the interventions included in this review and in most off-line settings, where it is generally not feasible to pre-fill shopping baskets.

In this study, ease did not play a significant role since opting-out was visible and effortless.[2] This should hold in other, similar online settings. It will however be an essential effect channel in settings where opting out is difficult. The slightly larger mediated effect on endowment of the defaults with fames (*PB Default + Sustainability Frame*: 0.696; *PB Default + Taste Frame:* 0.509 vs. *PB Default:* 0.362) suggests individuals may more easily retrieve positive thoughts about the default in the presence of a frame. Conceivably, the frames elicited individuals to consider aspects related to taste or sustainability, strengthening the endowment effect.

Increasing the salience of the default and triggering thought through framing may both be more effective and ethical. Given the special status of meat and the high salience of reversing this particular status quo, using additional framing to describe and justify the change is pertinent. Informative frames can encourage decision-makers to reflect, mitigate feelings of loss of control, communicate transparency, and foster autonomy (Lemken, 2021a; Schneider et al., 2020; Smith et al., 2013). Assuming frames are not misleading, they can elicit reflective thinking and reduce concerns that consumers are manipulated. Default effects that result from cognitive biases, such as the endowment effect, are of ethical concern because they can cause consumers' choices to deviate from their true preferences (Brown & Krishna, 2004). Even when choice architects nudge pro-social behavior—fostering consumer welfare—the "libertarian paternalism" advocated for by Thaler and Sunstein (2008) implies that some degree of individual autonomy is lost, at least when cognitive biases are commandeered (Smith et al., 2013). Nonetheless, defaults are unavoidable; defaults, both good and bad, are common in modern consumer life (Brown & Krishna, 2004; Smith et al., 2013). Moreover, this concern assumes individuals always have true preferences. In the view that preferences are dynamically constructed, and thus informed by the surrounding architecture, undesirable defaults (e.g., meal bundles with soda by default) contribute to the formation and reinforcement of unfavorable preferences (e.g., a liking for sugar-sweetened beverages). As such, defaults not only influence individual choices, but also

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[2] As evidence that participants were aware of how to opt-out, most (n = 338, 63.06%) viewed the pop-up window where they had the opportunity to change their selection. Of those who did, 31.66% accepted the default.

lasting preferences through mechanisms like mere exposure and familiarity (Pliner, 1982; Schösler et al., 2012). Where preferences are strongly skewed toward the incumbent status quo, simply removing all defaults will not suffice to curb adverse behaviors (Lemken, 2021a). The inevitability of defaults and inextricable role they have in consumer preference formation demands an ethical responsibility from choice architects to design smart and transparent defaults.

While individuals tend to accept defaults because they believe it is a recommendation (Jachimowicz et al., 2019; Sunstein, 2017), this was not confirmed in our study. It can feel risky to act against the recommendation of a trusted expert (Sunstein, 2017), though this is likely more pertinent in situations where decision-makers have less experience or weaker preferences than in everyday food choices, e.g., selecting an energy provider (Meier et al., 2022). Meier et al., 2022 suggests that even within the context of food decisions, familiarity with the specific setting (e.g., frequent patrons of a restaurant who are familiar with the menu) may be less likely to perceive a default as a recommendation. However, participants were not familiar with our menu, as our setting was fictional. Additionally, this mechanism is contingent on the attitudes towards the choice architect (Jachimowicz et al., 2019). Consumers are aware that private businesses have motives of their own (Wright, 2002) and defaults may be perceived as an attempt to coerce, especially if the default choice is more expensive or set by disreputable vendors (Brown & Krishna, 2004). Reactance can thus occur if decision-makers feel their freedom is unjustly diminished and they may opt-out as a means of restoring it (Brehm, 1966).

### 2.5.3 Implications for Practitioners

Marketers can contribute to the sustainability agenda by redefining the status quo without concern that endorsing plant-based alternatives will lead to reactance—if meat is still on the menu. Companies can offer meat alternatives by default and frame them as the better choice to prompt consumers to consider positive aspects about these products. Since plant-based foods are inherently more energy efficient to produce, price parity is on the horizon as economies of scale will eventually be optimized (Chafin & Larson, 2022). For regular meat-eaters, demand for plant-based meat is more elastic than for classic meat products, indicating these customers will be more receptive to incorporating plant-based alternatives into their diets as prices decrease (Tonsor et al., 2023). Vendors can similarly nudge more familiar vegetarian foods (vs. novel analogs) without changing their offers at a low cost by adjusting menu design (Hielkema & Lund, 2022). Developing a plant-forward business strategy not only represents an opportunity for traditional suppliers to stay competitive when price parity is reached (Chafin & Larson, 2022), but also to communicate sustainability goals to consumers.

## 2.6   Limitations and Future Research

There are significant strengths to our study, including the express measurement of mediating constructs and a realistic menu design. Our menu was designed to closely resemble existing culinary digital ordering interfaces, thereby reducing concerns about hypothetical bias. We consider the online nature of our study to be necessary as digital nudging has become of great relevance and will continue to be important in the discussion of customized defaults (based on personalized information) which lend themselves to online environments (Smith et al., 2013). Still, it is a limitation that actual food consumption was not measured. Future studies should aim to measure actual consumption whenever possible. Reassuringly, however, there is evidence that default effect size is not significantly different between real-world and hypothetical choice settings (Jachimowicz et al., 2019). Another limitation is that default frames were not examined in isolation; therefore, the effectiveness of standalone framing could not be determined. Only one dish was on offer in our menu. Future studies should include other food products and cuisines to ensure generalizability. Similarly, it is possible that residents in other countries will respond differently to nudging PBMAs. This may be especially relevant for countries where income growth and urbanization continue to increase demand for meat.

## 2.7   Conclusion

Our study shows that pre-selecting a plant-based meal, in addition to framing this option as the better choice, can increase choice of these foods. Together, default framing and structural defaults outperformed structural defaults alone, which were not enough to effectively increase plant-based choice in this case. Furthermore, this study addresses the research calls to explicitly examine the effect mechanisms through which defaults operate in general (Lemken, 2021a; Szaszi et al., 2018; Zlatev et al., 2017) and in vegetarian food choice (Hielkema et al., 2022; Meier et al., 2022). Endowment was found primarily responsible for the positive influence on default acceptance by way of triggering positive thoughts about the default. Surprisingly, endorsement showed a negative effect as private online food suppliers are not necessarily perceived as benign choice architects. However, the positive effect of endowment more than offset it. Finally, companies can offer meat alternatives by default without concern that endorsing plant-based alternatives will lead to reactance—as long as opting-out is easy and accessible.

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# 3 Tasty or Sustainable? Goal Conflict in Plant-Based Food Choice

with Steffen Jahn and Yasemin Boztuğ[3]

This manuscript was submitted to *Food Quality and Preference* in December 2023 and was accepted for publication in June 2024:
https://doi.org/10.1016/j.foodqual.2024.105237

**Erhard, A.,** Jahn, S., Boztug, Y. (2024). Tasty or sustainable? Goal conflict in plant-based food choice. *Food Quality and Preference,* 105237.

An earlier version of this paper was accepted at the *Proceedings of the European Marketing Academy* as:

**Erhard, A.,** Jahn, S., Boztug, Y. (2024). Goal Conflict in Plant-Based Food Choice. *Proceedings of the European Marketing Academy*, 53rd[rd].

*Keywords: goal framing, goal conflict, plant-based alternatives*

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## 3.1  Introduction

The over-consumption of animal-based foods is a significant contributor to climate change and can lead to negative health consequences. Addressing these challenges necessitates a fundamental shift toward plant-based diets. Consumers are aware of this and profess a willingness to reduce their meat intake (de Boer & Aiking, 2022; Hielkema & Lund, 2021), primarily based on health, sustainability, and ethical grounds (Bublitz et al., 2023). This is reflected in the growing number of individuals identifying as flexitarians — those who choose to reduce or limit their meat consumption in favor of plant-forward options, particularly in the younger generations (Mascaraque, 2021). Yet, when it comes to food choice, these consumption goals compete with other goals, such as the desire for tasty food (Liu & Haws, 2023). This poses a challenge for plant-based meat alternatives (PBMAs) that are associated with inferior taste to their meat counterparts (Michel et al., 2021; Vural et al., 2023). It will therefore be important for producers to formulate tasty PBMAs, but also for marketers and policy makers to position these products in a way that promotes consumer liking. Positioning plant-based foods as tasty or indulgent, by emphasizing their positive sensory properties, has been found to bolster their perceived allure (Papies et al., 2023; Turnwald & Crum, 2019) leading to heightened consumer interest and choice (Reinholdsson et al., 2023; Turnwald et al., 2017; Turnwald & Crum, 2019). However, certain studies have noted variable success rates in achieving these outcomes (Bacon & Krpan, 2018; Hielkema et al., 2022). Alternatively, focusing on sustainability or health plays into PBMAs' key strengths but may fail to convince consumers about the expected taste. While interventions focusing on sustainability appeals have demonstrated increased attractiveness or general preference (Erhard et al., 2023; Van Loo et al., 2020), others have yielded mixed results (Giezenaar et al., 2024; Piester et al., 2020). As these promotional strategies appear to be conflicting, there is likely no one-size-fits-all approach, and deciding when to employ each remains uncertain for producers and marketers of these products.

We aim to resolve this conflict by proposing a goal-conflict perspective on PBMA promotion. Integrating research streams on goal framing (Lindenberg & Papies, 2019; Lindenberg & Steg, 2007), food intuitions (e.g., Lazzarini, Zimmermann, Visschers, and Siegrist, 2016; Gonzales et al., 2023; Raghunathan et al., 2006), and goal conflict (Belei et al., 2012; Shah et al., 2002), we argue that frame effectiveness depends on its match with salient consumption goals and product-specific intuitions. Our integrative framework allows precise predictions about the conditions under which an attribute frame will be more or less effective. In so doing, we qualify previous findings that support either hedonism-based or health/sustainability-based framing strategies. Specifically, we demonstrate that different attribute framings (hedonic, health, and sustainability) influence consumer perceptions based on the goal context, with a particular focus on the crucial role of taste expectations, PBMA's Achilles heel. Our research delves into the

mechanisms influencing expected taste of plant-based alternatives under various conditions, aiming to contribute valuable insights beyond traditional approaches.

From a practical perspective, our integrative framework offers guidance to both marketers and policy makers aiming to facilitate PBMA consumption. Policy interventions typically revolve around education on healthy and sustainable diets, and so too do the advertising campaigns of many PBMAs, operating on the rational cognitive level. Despite these efforts, unhealthy and unsustainable diets persist, indicating the shortcomings of traditional approaches. We suggest an alternate strategy that intuitively addresses goal conflict by aligning goal frames, offering a fresh perspective on promoting plant-based alternatives.

## 3.2 Theoretical Framework

### 3.2.1 Categorization and Expectation Formation

Consumers tend to categorize foods into vices (hedonic food) and virtues (functional food) (Wertenbroch, 1998) and form performance expectations based on these categories. When we see an ice cream next to a frozen yogurt, for example, we will likely categorize them as relative vice and virtue, respectively (Wertenbroch, 1998), and may form an expectation that the ice cream is tastier, because of the well-documented "unhealthy = tasty" intuition (Raghunathan et al., 2006). Unlike ice cream, PBMAs are often considered virtue foods (Jahn et al., 2021). Consequently, they are commonly associated with sustainability and healthfulness even when considering variations in nutritional profiles and the highly processed nature of some meat-mimicking products (Gonzales et al., 2023; Ketelings et al., 2023). Interestingly, consumers perceive PBMAs to be healthier because of the broad conversation on health risks stemming from meat consumption (He et al., 2020). Additionally, they often employ a "sustainable = healthy" intuition in their food choices (Lazzarini, Zimmermann, Visschers, and Siegrist, 2016), which contributes to health perceptions. The robustness of healthfulness perceptions around PBMAs extends beyond their actual nutritional profiles, suggesting the presence of a health halo (Gonzales et al., 2023).

A downside of these favorable inferences is the expectation that PBMAs have inferior taste than their meat counterparts. Based on the "unhealthy = tasty" intuition that posits an inverse relationship between hedonic and functional attributes in food (Raghunathan et al., 2006), strong health perceptions surrounding PBMAs may contribute to negative taste expectations, even among those who have never tasted them before. The impact of sustainability perceptions on taste is less clear, and it is plausible that sustainability indirectly signals inferior taste through its connection with healthfulness. Ethical food claims, aligned with these intuitions, have been shown to negatively influence expected taste (Giezenaar et al., 2024; Schuldt & Hannahan, 2013; Stremmel et al., 2022), while simultaneously, sustainable attributes may trigger a cognitive bias known as the "virtue

halo" or "eco-label effect," leading to more favorable judgments about overall product qualities, including taste (Sörqvist et al., 2015).

Concluding, there is robust evidence that consumers perceive PBMAs as both highly sustainable and healthy. It is these very benefits, however, that may backfire on taste expectation formation. Research suggests that taste expectations play a pivotal role in food choice, and they may trump sustainability and health perceptions (European Commission, 2020). Because intuitions like the one associating healthful food with inferior taste tend to change slowly, marketers and policy makers interested in facilitating plant-based diets need to find ways to promote PBMAs beyond the traditional trope of appealing to moral values. We argue that well-tailored goal frames may serve as an effective method to improve perceptions of poor taste associated with PBMAs.

### 3.2.2   Goal Framing

While consumers form expectations on foods' healthfulness, taste, and sustainability based on categorization, marketers can proactively promote one of these aspects. In the US, for example, nearly all meat analogs boast some nutritional claim (Lacy-Nichols et al., 2021), illustrated by Morning Star's claims of lower fat percentages than beef. Concurrently, eco-labels have gained widespread adoption, and range from certified sustainability labels such as USDA Organic to industry-led labels such as Quorn's carbon footprint label. Examples of advertising slogans used by companies to promote plant-based alternatives are showcased in Table 3-1.

**Table 3-1.** Advertising Slogans for Plant-Based Alternatives

| Brand | Advertising claim/slogan |
| --- | --- |
| **Moral/functional attribute frames** | |
| Like Meat (United States) | *"Guilt free."* |
| Planted (Germany) | *"Eat better for climate protection."* |
| Just Egg (United States) | *"Plants don't get the flu."* |
| Daring (United States) | *"Chicken is broken."* |
| Beyond Steak (United States) | *"Now cheesesteaks are good for you."* |
| Sunfed (New Zealand) | *"Nutrient dense. High performance nutrition."* |
| **Hedonic attribute frames** | |
| Morning Star Farms (United States) | *"Say hello to big, bold flavor."* |
| Tofurky (United States) | *"Yum for all."* |
| Tyson Foods (United States) | *"100% delicious. 0% compromise."* |
| Beyond Burger (United States) | *"Now even meatier."* |
| Gardein (Canada) | *"Finally, a plant-based burger that looks, cooks, smells, and satisfies like real meat."* |

| | |
|---|---|
| The Vegetarian Butcher (Netherlands) | *"Irresistibly tasty."* |
| **Combined attribute frames** | |
| Quorn (United States) | *"They're delicious and are kind to the planet's resources too. Win Win."* |
| Hungry Planet (United States) | *"When passion for the delicious meets an appetite for a just world."* |
| THIS (United Kingdom) | *"High in protein, waay lower in saturated fat than meat, yet FULL of flavour."* |

Labels and claims can highlight a specific eating goal, and by way of salience-effects, these activated goals frame attention, influence attitudes, and direct goal-oriented behavior (Lindenberg & Steg, 2007). The hedonic goal frame represents the desire for indulgent, satisfying foods, often triggered by "vice foods" like ice cream or in fast-food settings (Maehle, Iversen, Hem, and Otnes, 2015). Functional goal frames relate to improving own resources, such as finances or health (Lindenberg & Steg, 2007). The moral goal frame is driven by individual moral principles and ethical considerations regarding right and wrong (Lindenberg & Steg, 2007; Onwezen, 2023).

Behavioral interventions for promoting sustainable food choices often do not give prominence to the hedonic goal frame; instead, they emphasize the significance of moral goal frames, highlighting the collective aspect over individualistic goals like the functional or hedonic goal frame. This practice seems justified as studies reveal that emphasizing the hedonic goal frame can be counterproductive in promoting sustainable food choices. For instance, in a study manipulating goal framing to influence consumer choices of organic tomatoes, a hedonic goal frame heightened the significance of the tomato's superficial appearance but did not improve overall preference for organic products (Thøgersen & Alfinito, 2020). Another study revealed that individuals expressed lower intentions to purchase sustainable groceries when the hedonic goal frame was more salient (on vacation) compared to less salient (at home) (Doran et al., 2022). These findings underscore the crucial role of fostering a sense of responsibility and moral obligation towards society and our collective future in driving the transition towards sustainable food systems (Bauer et al., 2021; Siegrist & Hartmann, 2019; White et al., 2019).

However, the growing prevalence of flexitarians, a sustainability-minded consumer segment unwilling to compromise on taste, has led to an upsurge in marketing PBMAs with a focus on taste (Smart Protein, 2021). Beyond Meat's CEO, Ethan Brown, recognizes the strategic potential of empowering consumers to associate sustainability with fulfilling their taste preferences, a concept he terms "hedonistic altruism" (Gelles, 2021). Acknowledging this, there is an opportunity to promote consumption of individual

sustainable products by strategically repositioning through a hedonic frame. Notably, taste-focused labels and indulgent descriptions have been found to better promote individual plant-based dishes than a control condition, or health-focused or vegetarian descriptors (Bacon & Krpan, 2018; Erhard et al., 2023; Piester et al., 2020; Turnwald & Crum, 2019).

### 3.2.3  A Goal-Conflict Perspective of Eating Goals and Goal Framing

The previous discussion indicates that consumers form both favorable (e.g., superior health and sustainability) and unfavorable (e.g., inferior taste) expectations about PBMAs, and that attempts at promoting any of these aspects do not yield consistent results. We argue that, in order to resolve this issue, we need to fully consider the individually active eating goals and their interplay with category-based expectations and goal framing. Specifically, the lack of consensus on how to best frame PBMAs may be due, in part, to the varying active goals in consumers' minds during consumption situations. For example, when consumers have a hedonic goal actively guiding their choices, confronting a sustainability frame introduces societal concerns, shifting the focus from individual pleasure-seeking to the broader, collective well-being. Goal conflict arises when multiple competing goals are simultaneously active, often leading to aversive states that consumers seek to resolve by reducing consumption of conflicting foods or avoiding information that causes perceived hedonic loss (Belei et al., 2012; Ramanathan & Williams, 2007). This aligns with humans' self-regulatory capacity to navigate goal conflict through goal shielding—a process where individuals focus on one primary goal at a time while inhibiting alternate goals (Shah et al., 2002). If an active hedonic goal is shielded, for example, moral appeals will necessarily become less effective, implying that promoting a "best of both worlds" product is not always optimal (Belei et al., 2012). The consideration of goal conflict and goal shielding thus sheds light on the found inefficacy of a previous attempt to promote plant-based choices by combining hedonic and moral frames (Reinholdsson et al., 2023).

To reduce goal conflict, a direct approach is to align product attribute frames directly with active goals. When a hedonic goal is active, for example, conflicting health and sustainability frames should be less effective than a matching hedonic frame. This is particularly true for taste expectations. We anticipate that a matching hedonic frame will enhance the perceived taste more effectively than a health attribute frame, given that health cues may inadvertently signal inferior taste (Raghunathan et al., 2006). Additionally, we anticipate that the hedonic attribute frame will outperform a sustainability attribute frame in enhancing taste expectations. This anticipation stems from the potential for sustainability cues to inadvertently imply inferior taste via an association with healthfulness, which is commonly associated with lower taste expectations. Consequently, we formulate our first set of hypotheses:

**H1a:** When a hedonic goal is active, a health (vs. hedonic) attribute frame will decrease taste expectations of PBMAs.

**H1b:** When a hedonic goal is active, a sustainability (vs. hedonic) attribute frame will decrease taste expectations of PBMAs.

When a health goal is active, though, it is the hedonic frame that creates goal conflict, while health appeals avoid it. Using health appeals is not without its own challenges, however. Despite the lack of goal conflict in the case of a goal-frame match, a very salient health signal may limit the effect on expected tastiness due to the "unhealthy = tasty" intuition (Raghunathan et al., 2006). Nonetheless, we expect some positive effect of goal conflict avoidance, albeit small, in the case of an active health goal paired with a health-framed attribute, meaning that the negative effect described in H1a could become a negative-yet-small effect.

To circumvent the undesired taste inference when health is a primary concern, an alternative framing that avoids triggering the "unhealthy = tasty" intuition while minimizing goal conflict can be utilized, such as a sustainability attribute frame. The evident "sustainable = healthy" intuition indicates that health and sustainability goal frames are in alignment (Lazzarini et al., 2016), and do not produce goal conflict when both are made salient. In such a state, the sustainability attribute frame may impart positive perceptions of taste by way of the "virtue halo" effect, which may even fully balance out the advantage of hedonic framing. Therefore, we propose:

**H2a:** When a health (vs. hedonic) goal is active, the negative effect of a health (vs. hedonic) attribute frame on taste expectations will be mitigated.

**H2b:** When a health (vs. hedonic) goal is active, the negative effect of a sustainability (vs. hedonic) attribute frame on taste expectations will be offset.

In a similar vein, when consumers are focused on a sustainability goal, a hedonic frame will evoke conflict when health and sustainability attribute frames will not. Importantly, goal shielding implies that an active sustainability goal may dampen the impact of the "unhealthy = tasty" intuition. Consequently, a sustainability goal paired with a health attribute frame may have the same expected taste implications as a hedonic frame. A sustainability frame, because of the goal-frame match and lack of any undesirable intuition – clearing the way for a strong "virtue halo" effect – may even lead to better taste expectations than the hedonic frame when paired with a conflicting goal. We thus hypothesize:

**H3a:** When a sustainability (vs. hedonic) goal is active, the negative effect of a health (vs. hedonic) attribute frame on taste expectations will be offset.

**H3b:** When a sustainability (vs. hedonic) goal is active, the negative effect of a sustainability (vs. hedonic) attribute frame on taste expectations will be reversed.

Lastly, we expect taste expectations to mediate the effects of framing and goal activation on product engagement. The mediating role of taste expectations is rooted in the repeatedly found relevance of taste in food decision making (European Commission, 2020; Smeding et al., 2023) as well as the strong category-based sustainability and health inferences that are likely to withstand any framing attempts. Put formally:

**H4:** Through taste expectations, framing and goal activation influence product engagement.

## 3.3  Methods

### 3.3.1  Data Collection

A total of 743 American participants were recruited from the online panel provider Prolific. Prior to data collection, the study procedure was reviewed by the Ethics Committee at the university of the first author, and subsequently received ethical approval. All participants provided informed consent before participation in this study. Participants who did not complete the entire questionnaire were excluded from the analysis. Individuals who failed the attention check were prematurely terminated in the survey flow, resulting in incomplete responses and their subsequent exclusion from data analysis. Furthermore, participants adhering to a meat restricting diet (per self-report in a post-task survey question) were paid but excluded to avoid priming vegetarian food choices (no explicit mention of meat or plant-based foods was made during the recruitment process for the same reason). After these exclusions (~9%), 678 participants remained.

The sample consisted of 47.9% women, 48.8% men, and 3.3% non-binary or preferred not to say. The mean age was 37.9 years (SD = 14.2). Most (87.6%) participants reported following an omnivorous diet, followed by flexitarians (12.4%). Regarding the highest level of education, 0.9% preferred not to say or reported some high school or less, 15.8% reported high school or GED, 26.3% reported some college, but no degree, 10.5% reported an associates or technical degree, 32.3% reported a bachelor's degree, and 14.3% reported a graduate or professional degree.

### 3.3.2  Study Design

This study employed a 3 (attribute frame: hedonic vs. health vs. sustainability) x 4 (active goal: hedonic vs. health vs. sustainability vs. none) between-subjects design. Participants were randomly assigned to a goal activation condition via a writing prompt asking them to reflect on how either a hedonic, health, or sustainability goal is important in their own lives, e.g., "Please write at least two sentences indicating why it is personally

important for you to enjoy life and take pleasure in what you eat." For completeness, a control condition was included in which no goal was activated; participants were prompted to reflect on a neutral topic (see Appendix B1 for a complete list of goal activation prompts). This prompt was adapted from the goal priming technique administered by Bryksina (2020).

Following this task, individuals were asked to imagine that they were at a restaurant they regularly visit, and a new dish was on offer. The dish (plant-based chicken nuggets) was presented in an image under the title "Veggie nuggets - Made with whole soybeans" and displayed on a white plate with neutral background (see Figure 3-1 and Appendix B2 for a complete list of all framed stimuli). Participants were randomly assigned to one of the three attribute frames, i.e., the product was labeled as either a tasty, healthy, or sustainable choice. The main dependent variable was product engagement (participants' intentions to recommend, try, and purchase the product).

In selecting the stimuli, we aimed to choose a plant-based product that replaces a universally familiar meat product. The ubiquity of the chicken nugget and availability of plant-based alternatives to the chicken nugget made this product a good example.

**Figure 3-1.** Plant-Based Nugget Stimulus



### 3.3.3 Measures

*Taste, health, and sustainability expectations* were measured on 7-point Likert-scales from "not tasty/healthy/sustainable" to "tasty/healthy/sustainable", each with a single item, i.e., "How tasty/healthy/sustainable would you rate this food?".

*Product engagement* was measured with three items: "How likely would you be to recommend this food to a friend?", "How likely would you be to give this food a try?", and "How likely would you be to order this food?". These items were adapted from established measures of behavioral intentions to try (Pelchat & Pliner, 1995; Sucapane et al., 2021), recommend (Mediano Stoltze et al., 2021), and purchase (Mediano Stoltze et al., 2021) products that have been shown to predict the adoption of novel and healthy foods. Together, willingness to purchase and recommend have been used as

complementary measures to evaluate behavioral intentions to engage with food products (Mediano Stoltze et al., 2021). Answers were provided on a slider scale from 0 - 100, where participants could select values at discrete 10-point intervals (e.g., 0, 10, 20, etc.). Anchor words "extremely unlikely", "neither likely nor unlikely", and "extremely likely" helped define these points.

To verify the unidimensionality of these items, a maximum-likelihood factor analysis was conducted. The analysis confirmed that all three items significantly loaded onto a single factor, with loadings of 0.848, 0.880, and 0.965, explaining 80.9% of the variance, which supports the items' strong association with a single underlying construct of product engagement. The Cronbach's alpha of our three product engagement items was 0.92, indicating a high level of internal consistency.

*Familiarity with plant-based meat alternatives* was measured with a single item, "How frequently do you eat plant-based meat alternatives?", and possible answers were "never", "rarely", "one to three times a month", "one to four times a week" or "everyday or almost everyday", and "multiple times a day". This scale was modeled after an item developed by Lea and Worsley (2001).

*Belief in intuitions were measured on* 7-point Likert-scales from "strongly agree" to "strongly disagree" with statements on the belief that foods that are unhealthy = tasty, sustainable = healthy, unsustainable = tasty. Belief in the unhealthy = tasty intuition was measured with the item taken from Raghunathan et al. (2006) ("Food that is unhealthy generally tastes better"). Secondarily, we included an item with the reverse formulation of this belief: "Food that is healthy is generally not tasty". Belief in the other intuitions were measured with items mirroring this structure. These questions were asked together with questions on belief in other intuitions (such as healthy foods are expensive) to make the intent of these questions less obvious to the participant.

*Socio-demographics* were measured at the end of the survey, at which point all participants were asked to verify their age, gender, dietary preference, and highest level of education.

*Attention check.* An attention check was included in the survey (i.e., "To show that you are paying attention, please select the "neither agree nor disagree" option as your answer").

### 3.3.4 Data Analysis

We descriptively examine belief in intuitions and conduct a model-free examination of product attributes before conducting hypothesis testing. To test our conceptual model, we conducted a moderated mediation analysis with 10,000 bootstrap samples (see Model 7 in Hayes, 2018). Indicator coding was used for the independent variable to

estimate the effect of a health and sustainability framing compared to a hedonic framing. Likewise, indicator coding was used for the moderator to estimate the effect of the activation of health and sustainability goals, as well as the control condition (i.e., no active goal), compared to an active hedonic goal. An active hedonic goal was set as the reference level rather than the control to allow for assessment of goal conflict.

## 3.4  Results

### 3.4.1  Belief in Intuitions

We assessed participants' endorsement of intuitions to ensure alignment with the concept of an inherent conflict between taste and health, as well as taste and sustainability. Furthermore, we sought to confirm the participants' adherence to the belief in the synergy between health and sustainability. MANOVA results revealed no significant multivariate effect of goal activation ($F(12, 1995) = 1.41$, $p = .155$), frame type ($F(8, 1328) = 0.89$, $p = .520$), or their interaction ($F(24, 2664) = 0.54$, $p = .965$) concerning these beliefs. On aggregate, participants expressed a robust belief in the intuition that unhealthy foods are tasty, as indicated by an above-neutral mean rating on the 7-point Likert scale ($M = 5.04$, $SD = 1.46$, $Mdn = 5$) and a left-skewed distribution (see Figure 3-2). Conversely, the reverse formulation (i.e., healthy foods are not tasty) received average ratings below the neutral point ($M = 3.46$, $SD = 1.63$, $Mdn = 3$). Moreover, the correlation of these two items was 0.64 indicating a moderate association. Lastly, participants expressed a belief in the "sustainable = healthy" intuition ($M = 4.82$, $SD = 1.33$, $Mdn = 5$) and held a nearly neutral stance towards the belief that unsustainable foods are tasty ($M = 4.25$, $SD = 1.38$, $Mdn = 4$).

**Figure 3-2.** Distribution of Belief in Intuitions
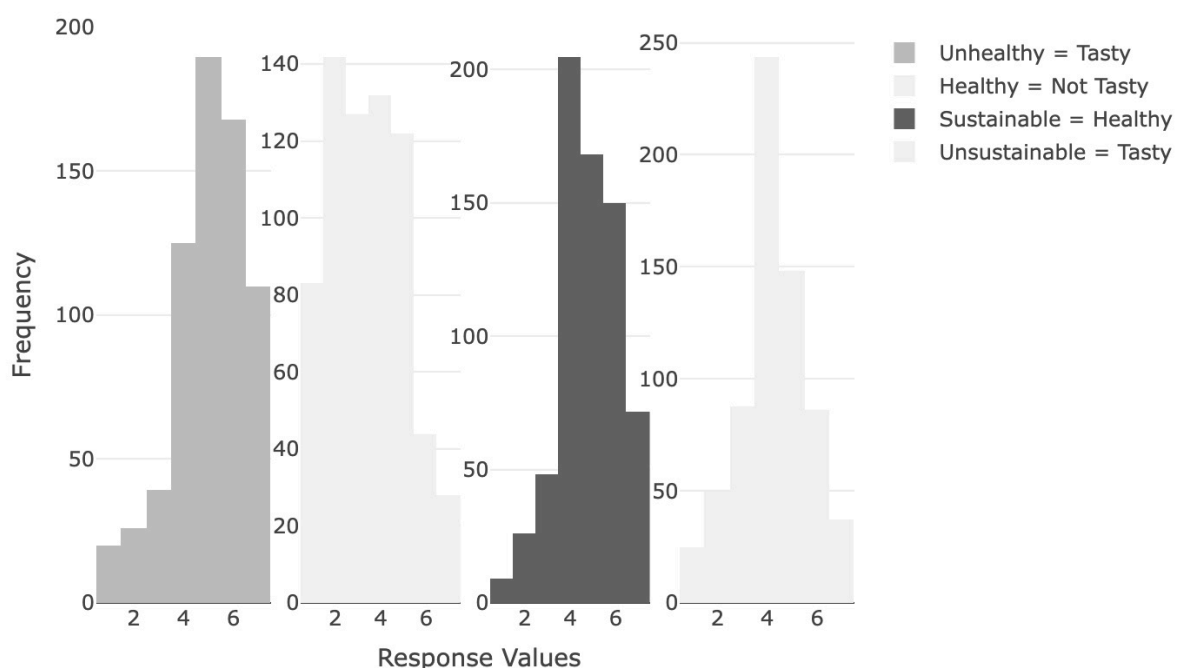
*Note.* Response values were provided on 7-point Likert scales.

### 3.4.2   Model-Free Evidence

On average, the veggie nugget received ratings above the "neutral" benchmark for healthiness (M = 4.65, SD = 1.57) and sustainability (M = 4.89, SD = 1.47). In contrast, participants expected the veggie nugget to be less tasty than the "neutral" benchmark on a 7-point scale (M = 3.46, SD = 1.60). This pattern is in line with our prediction of category-based expectation formation that is further influenced by intuitions. Table 3-2 additionally shows means and standard deviations of attribute ratings across conditions. An initial inspection reveals that taste expectations vary across conditions, while health and sustainability expectations do not. For example, taste expectations are highest in an aligned hedonic goal-frame condition but also an aligned sustainability goal-frame condition (Ms = 3.92 and 3.84, respectively). By contrast, taste expectations are lower in a hedonic goal-sustainability frame as well as sustainability goal-hedonic frame condition (Ms = 3.20 and 3.50, respectively). In a next step, we will examine this pattern in detail.

**Table 3-2.** Means (M) and Standard Deviations (SD) for Taste, Health, and Sustainability Expectations and Product Engagement by Experimental Condition

| | Taste Expectations | | Health Expectations | | Sustainability Expectations | | Product Engagement | |
|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| **Full Sample** | 3.46 | 1.60 | 4.65 | 1.57 | 4.89 | 1.47 | 3.66 | 2.89 |
| **Hedonic Goal** | | | | | | | | |
| Hedonic goal x hedonic frame (N = 62) | 3.92 | 1.58 | 4.87 | 1.44 | 5.05 | 1.48 | 4.50 | 2.98 |
| Hedonic goal x health frame (N = 65) | 3.20 | 1.52 | 4.65 | 1.60 | 4.75 | 1.45 | 3.21 | 2.61 |
| Hedonic goal x sust. frame (N = 54) | 3.20 | 1.76 | 4.78 | 1.77 | 5.00 | 1.78 | 3.40 | 2.97 |
| **Health Goal** | | | | | | | | |
| Health goal x hedonic frame (N = 57) | 3.46 | 1.69 | 4.72 | 1.74 | 4.84 | 1.33 | 3.54 | 2.70 |
| Health goal x health frame (N = 50) | 3.48 | 1.50 | 4.58 | 1.26 | 5.08 | 1.10 | 3.95 | 2.62 |
| Health goal x sust. frame (N = 57) | 3.35 | 1.58 | 4.68 | 1.45 | 4.81 | 1.62 | 3.49 | 2.93 |
| **Sustainability Goal** | | | | | | | | |
| Sust. goal x hedonic frame (N = 46) | 3.50 | 1.64 | 4.39 | 1.86 | 4.76 | 1.65 | 3.73 | 3.06 |
| Sust. goal x health frame (N = 57) | 3.89 | 1.55 | 4.84 | 1.60 | 4.91 | 1.52 | 4.27 | 2.75 |
| Sust. goal x sust. frame (N = 56) | 3.84 | 1.53 | 4.66 | 1.55 | 5.18 | 1.40 | 4.21 | 2.96 |
| **Neutral Goal** | | | | | | | | |
| Neutral goal x hedonic frame (N = 60) | 3.20 | 1.71 | 4.45 | 1.62 | 4.75 | 1.60 | 3.34 | 3.18 |
| Neutral goal x health frame (N = 53) | 2.87 | 1.57 | 4.68 | 1.58 | 4.66 | 1.33 | 2.60 | 2.74 |
| Neutral goal x sust. frame (N = 61) | 3.56 | 1.37 | 4.44 | 1.40 | 4.92 | 1.32 | 3.62 | 2.84 |

*Note.* Product engagement was measured as average intentions to recommend, try, and order the product.

### *3.4.3 Hypotheses Testing*

To jointly examine the influence of attribute framing, the moderating role of active goals, and the mediating role of taste expectations, we use moderated mediation analysis with 10,000 bootstrap samples (see PROCESS model 7; Hayes, 2018). We present results for a model with gender (female = 1), age, and unfamiliarity with PBMAs as covariates but present results without covariates in Appendix Table B1 Notably, consideration of covariates does not affect the interpretation of results.

### *3.4.4 Taste Expectations*

Compared to the baseline condition characterized by an active hedonic goal, health goal activation is not associated with taste expectations (b = −.30, SE = 0.28, t = 1.10, *p* = .273). Sustainability goal activation has a negative, marginally significant effect on taste expectations (b = −.50, SE = 0.29, t = 1.69, *p* = .092), and a neutral goal decreases taste expectations, compared to a hedonic goal (b = −.72, SE = 0.27, t = 2.67, *p* = .008). As expected, a health (vs. hedonic) attribute frame is associated with decreased taste expectations (b = −.64, SE = 0.27, t = 2.41, *p* = .016). Similarly, a sustainability (vs. hedonic) attribute frame is associated with decreased taste expectations as well (b = −.61, SE = 0.28, t = 2.18, *p* = .030). These findings support our hypotheses that a health attribute frame (**H1a**) and a sustainability attribute frame (**H1b**) decrease taste expectations when contrasted with a hedonic frame. In other words, a hedonic frame more effectively increases taste expectations of PBMAs than a health or sustainability frame when consumers have an active hedonic goal.

In terms of moderation, significant interaction effects are found between the health frame and sustainability goal activation (b = 1.09, SE = 0.40, t = 2.74, *p* = .006) as well as the sustainability frame and sustainability goal activation (b = 1.16, SE = 0.41, t = 2.85, *p* = .005). A spotlight analysis indicates that when a sustainability goal is active, the negative effects of the non-hedonic frames on taste expectation are mitigated. Specifically, and in support of **H3a**, a health (vs. hedonic) attribute frame is no longer associated with decreased taste expectations (b = .45, SE = 0.30, t = 1.52, *p* = .130). For the sustainability (vs. hedonic) attribute frame, the positive effect is even marginally significant (b = .56, SE = 0.30, t = 1.86, *p* = .063), indicating a reversal as predicted in **H3b**. Figure 3-3 displays these effects.

**Figure 3-3.** Moderating Effects of Frame and Goal on Taste Expectations

A. Health vs. Hedonic frame

B. Sustainability vs. Hedonic frame



Note: *p < .10, **p < .05, ***p < .01

Note: *p < .10, **p < .05, ***p < .01
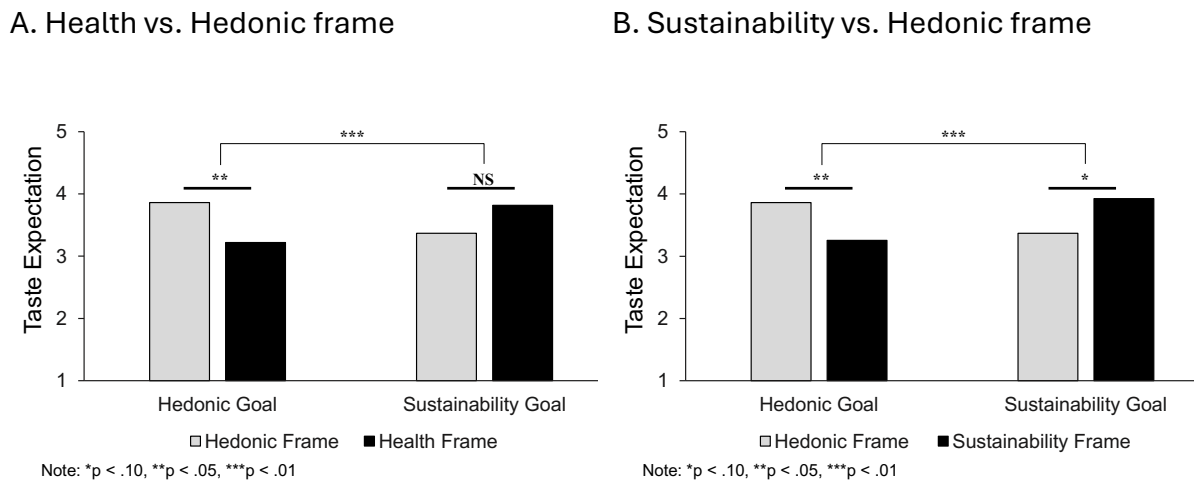
Although we also find non-significant differences in taste expectations between health/sustainability (vs. hedonic) frames when a health goal is active (health frame: b = −.11, SE = 0.29, t = 0.37, *p* = .708; sustainability frame: b = −.22, SE = 0.28, t = 0.77, *p* = .441), the mitigations are too small to indicate significant interactions (health frame: b = .53, SE = 0.39, t = 1.35, *p* = .177; sustainability frame: b = .39, SE = 0.40, t = 0.99, *p* = .325). Thus, the hypotheses that a health (vs. hedonic) goal would mitigate the negative effect of a health attribute frame (**H2a**) and offset the negative effect of a sustainability attribute frame (**H2b**) on taste expectations are rejected.

The interaction between a health (vs. hedonic) frame and neutral goal activation is non-significant as well (b = .50, SE = 0.39, t = 1.28, *p* = .2020). By contrast, we find a positive and significant interaction between a sustainability (vs. hedonic) frame and neutral goal activation (b = 1.01, SE = 0.39, t = 2.58, *p* = .010). The latter finding indicates that when a neutral goal is active, hedonic and sustainability frames are equally effective when it comes to influencing taste expectations of PBMAs (b = .40, SE = 0.27, t = 1.47, *p* = .143).

### 3.4.5  Health and Sustainability Expectations

In terms of health and sustainability expectations, no direct effects or interactions are observed (all *p*s > .08), except for reduced expectations among consumers with little PBMA familiarity (health expectation: b = −.43, SE = 0.13, t = 3.24, *p* = .001; sustainability expectation: b = −.55, SE = 0.12, t = 4.46, *p* < .001).

### 3.4.6  Indirect Effects

Through taste expectations, non-hedonic attribute framing has a negative indirect effect on product engagement when a hedonic goal is active (health frame: *b* = −.81, SE = 0.33, 95% CI [−1.469, −0.182]; sustainability frame: *b* = −.77, SE = 0.37, 95% CI [−1.498, −

0.052]). These results support **H4:** framing and goal activation influence product engagement intentions through taste expectations. When a sustainability goal is active, however, the negative indirect effects are mitigated, as indicated by significant indices of moderated mediation (health frame: index of moderated mediation = 1.38, SE = 0.49, 95% CI [0.424, 2.367]; sustainability frame: index of moderated mediation = 1.47, SE = 0.52, 95% CI [0.462, 2.491]). All remaining indirect effects and indices of moderated mediation are non-significant. Figure 3-4 presents the moderated mediation results comparing the health attribute frame to the hedonic frame, and Figure 3-5 presents the results for the sustainability frame versus the hedonic frame. Table 3-3 summarizes the full moderated mediation results.

**Figure 3-4.** Parameter Estimates for Hedonic vs. Health Frame
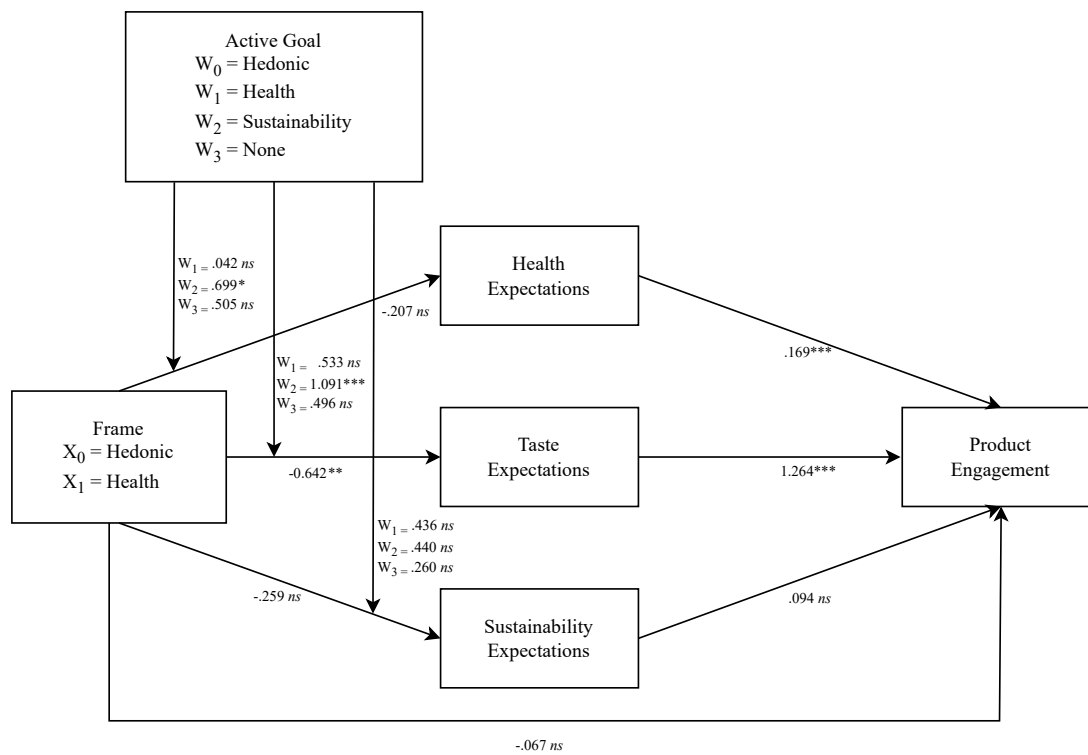


*Note.* *** p < .01, ** p < .05, * p < .10

**Figure 3-5.** Parameter Estimates for Hedonic vs. Sustainability Frame
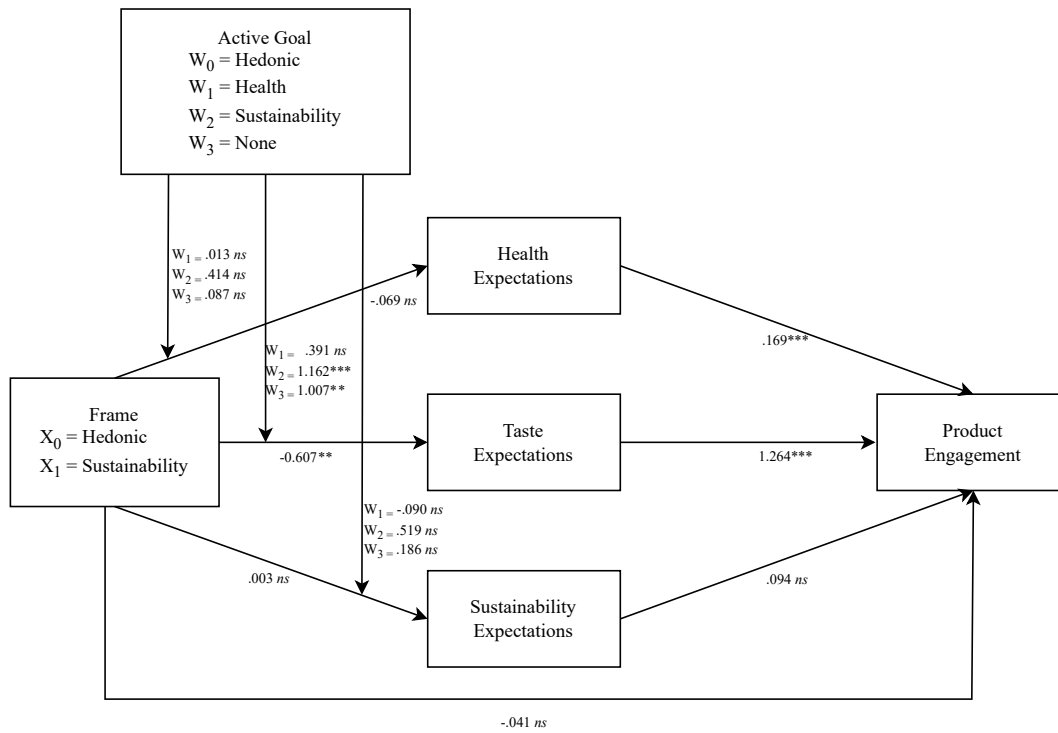


*Note.* *** p < .01, ** p < .05, * p < .10

**Table 3-3.** Results of the Moderated Parallel Mediation Analysis

| | Indirect effect via expected taste | | | | Indirect effect via expected health | | | | Indirect effect via expected sustainability | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | EST | SE | CI lower | CI upper | EST | SE | CI lower | CI upper | EST | SE | CI lower | CI upper |
| **Hedonic Goal** | | | | | | | | | | | | |
| Health Frame | **-0.811** | **0.330** | **-1.469** | **-0.182** | -0.035 | 0.051 | -0.154 | 0.053 | -0.024 | 0.032 | -0.099 | 0.027 |
| Sust. Frame | **-0.767** | **0.368** | **-1.498** | **-0.052** | -0.012 | 0.053 | -0.129 | 0.088 | 0.000 | 0.033 | -0.070 | 0.074 |
| **Health Goal** | | | | | | | | | | | | |
| Health Frame | -0.137 | 0.375 | -0.857 | 0.606 | -0.028 | 0.053 | -0.134 | 0.080 | 0.017 | 0.029 | -0.034 | 0.085 |
| Sust. Frame | -0.274 | 0.383 | -1.010 | 0.491 | -0.009 | 0.054 | -0.123 | 0.097 | -0.008 | 0.031 | -0.074 | 0.059 |
| **Sust. Goal** | | | | | | | | | | | | |
| Health Frame | 0.569 | 0.365 | -0.134 | 1.288 | 0.083 | 0.065 | -0.026 | 0.229 | 0.017 | 0.035 | -0.046 | 0.100 |
| Sust. Frame | 0.702 | 0.369 | -0.029 | 1.416 | 0.058 | 0.063 | -0.055 | 0.200 | 0.049 | 0.043 | -0.019 | 0.148 |
| **Neutral Goal** | | | | | | | | | | | | |
| Health Frame | -0.184 | 0.379 | -0.939 | 0.542 | 0.050 | 0.055 | -0.050 | 0.174 | 0.000 | 0.030 | -0.064 | 0.063 |
| Sust. Frame | 0.505 | 0.341 | -0.174 | 1.169 | 0.003 | 0.049 | -0.100 | 0.099 | 0.018 | 0.030 | -0.034 | 0.088 |

*Notes:* EST = Mediation effect, SE = Bootstrapped standard error, the CIs are the bootstrapped 95% confidence intervals. For the independent variable, hedonic frame was coded as the reference level. Significance is indicated by CIs that do not cover zero; these values are bolded. Covariates age, gender, and familiarity with PBMAs were included but are not shown for simplicity.

## 3.5  Discussion

Our study explores the ongoing discourse surrounding the most effective approach to encourage consumers to transition towards more plant-based diets. A seemingly clear-cut tactic that avoids the need for a paradigm shift involves directly replacing traditional meat with more sustainable PBMAs that resemble meat. Conventional wisdom suggests emphasizing the sustainability benefits of these products, as they clearly outperform meat in this regard. Indeed, life cycle analyses indicate PBMAs are responsible for only a fraction of the carbon emissions, ranging from less than 2 to 14 times lower compared to traditional meat sources (Shanmugam et al., 2023). Following this logic, many producers currently adopt this strategy in their marketing of these products. Proponents of a potentially underutilized alternate strategy recommend highlighting taste instead ((Turnwald et al., 2017; Turnwald & Crum, 2019). Our research sheds light on this debate by providing a nuanced understanding of the optimal strategy for promoting PBMAs. Specifically, we show that the effects of framing meat alternatives are contingent on active consumer goals; notable given that salient goals vary across consumption settings (Boland et al., 2013; Onwezen, 2023; Thøgersen & Alfinito, 2020).

Although consumers generally have positive preconceptions about the sustainability and healthiness of PBMAs, they hold much lower expectations for taste (e.g., Ketelings et al., 2023; Vural et al., 2023). Our findings are in line with this; participants in this study consistently rated taste below the neutral point. Moreover, taste expectations emerged as a significant mediator, influencing the impact of active goals and attribute framing on intentions to recommend, try, and purchase the product. In contrast, health and sustainability expectations did not mediate this relationship, likely due to participants' already robust positive perceptions in these domains, indicating limited room for meaningful improvement in their perception. Conversely, the consistently low taste perceptions indicate a greater potential for improvement within this product category. Our findings also resonate with Mai and Hoffmann (2015) affirming that taste perceptions exert a more substantial influence on food decisions than healthiness expectations. The authors attribute this distinction to taste perceptions relying on implicitly processed sensory evaluations, while health perceptions involve higher-order rational processing.

To enhance taste perceptions, it is evident that food manufacturers must improve product formulations. Nonetheless, it will also be important for marketers to be mindful of how these products are framed, especially considering the context and salient goals of consumers. Failure to do so may elicit goal conflict, where hedonic desires compete with health or sustainability goals, ultimately dampening taste expectations and deterring consumers. At first glance, using hedonic frames to bolster expected taste might seem straightforward. Using descriptive labels has been found to impart a positive

halo around other food categories and has been suggested as a good tactic to introduce novel foods (Wansink et al., 2005). In some cases, hedonic labelling has effectively increased vegetarian food choice (Bacon & Krpan, 2018; Turnwald et al., 2017; Vennard et al., 2019) and improved feelings of enjoyment after eating vegetarian foods (Turnwald & Crum, 2019). Hedonic descriptors may also be a way to mitigate feelings of disgust that some consumers associate with meat alternatives (Michel et al., 2021). Still, there's the potential to leverage the sustainability halo effect, which imparts perceptions of better taste, especially when goal conflict is minimal (Sörqvist et al., 2015). Our research underscores that hedonic attribute frames are most effective when consumers primarily seek a hedonic experience. However, the same framing paradoxically (marginally) decreases taste expectations when individuals approach the product with a salient sustainability goal frame.

While existing literature often focuses on identifying individual consumer orientations with regards to plant-based foods (e.g., Graça et al., 2019; Hielkema & Lund, 2021; Lemken et al., 2019; Malek et al., 2019; Van Loo et al., 2017), our study emphasizes situational goal frames that vary across contexts within individuals. Notably, existing studies demonstrate goal frames differ by setting, e.g., while on vacation or at home (Thøgersen & Alfinito, 2020) and time of day (Boland et al., 2013). Relatedly, other studies demonstrate variations in the assessment of PMBAs concerning naturalness, tastiness, healthiness, and appropriateness across different contexts, such as during special occasions (Elzerman et al., 2013) or when served as part of a meal versus used as an ingredient (Possidónio et al., 2021). Our study contributes to existing literature on goal framing by assessing the interaction between active goals and product attribute framing, identifying areas of goal conflict between the two, as well as contributes to the debate on how to best promote PBMAs.

For marketers, it will be helpful to identify the goal frames elicited in their specific context to choose how to best frame plant-based products and avoid goal conflict. We expand upon the concept of "hedonic utilitarianism," as suggested by Beyond Meat's CEO (Gelles, 2021). Instead of simultaneously promoting both health and taste aspects, focused communication should be tailored to the prevailing goal context. For instance, ideal framing strategies may differ between fast-food and health-food retailers, the produce section and the snack aisle in grocery stores, or fine and casual dining establishments, given the differing goal frames these contexts elicit. Consider the frozen section in grocery stores where ready-made PBMAs are often placed alongside indulgent items like frozen French fries and pizzas, signaling associations with convenience and taste – characteristics commonly associated with vice foods. While labels emphasizing nutritional aspects like "protein-rich," "high in fiber," and "low in saturated fat" are common for frozen PBMAs, a more effective strategy might be to reserve such descriptors for plant-based products located in the refrigerated aisle alongside virtuous

foods like tofu and hummus. Instead, employing hedonic descriptors like "delicious" or "crunchy" may better align with consumer expectations in the frozen section.

For public health officials, tailoring public service announcements around plant-based diets to suit the target situation is important. For example, our findings suggest Veganuary, a campaign that encourages people to try a vegan lifestyle for the month of January, is well-situated during the time of year when many individuals are motivated by health and ethical goals as part of their New Year's resolutions. As part of this campaign, promoting the health benefits of plant-based diets alongside the ethical considerations of reducing animal consumption can be highly effective. Conversely, the holiday season preceding January presents an opportune moment to promote plant-based foods for their hedonic properties. For instance, sharing vegan holiday cookie recipes can capitalize on the festive spirit and appeal to individuals seeking indulgent treats. However, it is also crucial to recognize that eating motives differ across countries due to varying food-related challenges. In regions where food scarcity is prevalent, eating motives will differ significantly from those where nutrient-poor foods are abundant (Liu & Haws, 2023).

Regardless of situation, a challenge lies in aligning hedonic cues with favorable alternatives to ensure that the hedonic appeal promotes more sustainable choices rather than inadvertently encouraging less desirable ones, in accordance with the recommendations of Steg, Bolderdijk, Keizer, and Perlaviciute (2014). Lastly, increasing public awareness that healthy and sustainable foods can be tasty too may bridge the perception gap and reconcile pleasure and sustainable food choices. For example, initiatives like Taste for Life in Denmark, which promotes Epicurean eating (i.e., taking pleasure in food and drink), underscore this approach to culinary pleasure (Schneider, 2021).

## 3.6  Limitations and Future Research

This study, while offering valuable insights, is not without its limitations. First and foremost, the findings may not be entirely generalizable to all PBMAs. Our investigation centered on a specific fast-food product, namely a chicken nugget alternative, which lends itself to a hedonic eating experience. At the same time, the product used in this study contained whole soybeans, which may influence health perceptions compared to more processed alternatives made from soy isolates. Consequently, these results may be more pertinent to products that share similar attributes or consumer perceptions and may not represent the full spectrum of plant-based alternatives, including products perceived to be "utilitarian" in nature, such as tofu. Another limitation lies in the hypothetical nature of the study, as it primarily assessed participants' intentions rather than their actual behaviors. Therefore, the translation of these intentions into real consumer behavior would require further investigation and real-world experimentation.

Finally, it is important to note that this study took place exclusively in the United States. Prior research has demonstrated that the impacts of sensory-oriented labeling can differ among countries with distinct cultural philosophies on the pleasures of food (Chandon & Cornil, 2022).

For future research, it is important to investigate the dynamic interactions between active goals and other prevalent labels within this product category, including "plant-based", "meat-free", "vegan", and "vegetarian". Current research lacks a consensus on consumer preference for these descriptors, with some studies suggesting a positive gain-framing approach like "plant-based" (highlighting what consumers gain) over negative loss-framing labels like "vegan", "vegetarian", and "meat-alternative" (emphasizing the absence of meat) (Carvalho et al., 2022; Sucapane et al., 2021). Conversely, other studies indicate a preference for "vegetarian" or "vegan" labels (Rosenfeld et al., 2022). This variability in preferences may be attributed to salient consumption goals, suggesting the need for further investigation. Further studies may explore how other relevant goal frames, such as animal welfare, interact with various attribute frames. Additionally, future research should consider conducting actual taste tests to explore potential disparities between expected and actual taste perceptions, unraveling the intricacies of how hedonic claims function in this context. Examining these differences could offer a more comprehensive understanding of how hedonic frames operate in shaping consumer preferences for PBMAs.

## 3.7  Conclusion

Our study underscores the importance of understanding and effectively managing the interplay between consumer goal frames, taste perceptions, and product attribute framing in the context of plant-based alternatives. Taste perceptions emerge as a critical factor influencing consumer behavior, acting as a pivotal mediator between active goals and attribute framing. The consistent emphasis on taste as a top priority for consumers underscores the need for the food industry to address and enhance the taste profiles of plant-based alternatives. Strategic product formulations and framing approaches, aligned with the varied consumer goal frames, can bridge the existing gap and drive greater acceptance. Both the food industry and public health initiatives stand to benefit from these insights. Leveraging a nuanced understanding of consumer behavior and preferences, stakeholders can work towards creating a more sustainable and appealing future for plant-based choices.

**Ethical Statement:** Approval for the involvement of human subjects in this study was granted by the leading author's university (26/06/2023).  All participants gave informed consent prior to participation.

**Declarations of Interest:** None.

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# 4 Driving Public Support for a Meat Tax: Fiscal Policies and Behavioral Interventions

With Sanchayan Banerjee and Meike Morren[4]

This manuscript was submitted to the RTG Discussion Paper Series in July 2024 and was published in July 2024.

*Keywords: meat tax, framing nudge, public support*

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## 4.1  Introduction

Sustainable food consumption patterns are likely unattainable without a tax system that adequately captures the "true cost" of environmental damages associated with behaviors that incur environmental externalities, such as eating meat. Yet low levels of public support for fiscal policy interventions makes this path forward politically difficult. Identifying an acceptable meat tax – and  nudging citizens to reflect on it – has the potential to increase political feasibility. A Pigouvian (meat) tax  – designed to correct for negative external effects  – is widely recognized as the first-best response to regulate meat production and consumption optimally (Katare et al., 2020). In its absence, second-best policies like non-Pigouvian environmental taxes can steer us towards socially efficient outcomes by reducing meat demand (Funke et al., 2022). Empirical evaluations show net welfare gains associated with the use of meat taxes (Broeks et al., 2020). However, public acceptability of such "hard" policy interventions continues to stagnate (Douenne & Fabre, 2022; Grimsrud et al., 2020), with mixed evidence on what improves support (Beiser-McGrath & Bernauer, 2019; Douenne & Fabre, 2020; Grimsrud et al., 2020; V. Siegerink et al., 2022). This further puts governments in a bind, who are unwilling to implement them (Bähr, 2015).

Contrary to taxes, softer interventions like "nudges" offer an easier out – nudges are less intrusive, preserve freedom to choose, and are generally accepted but result in smaller behavioral shifts than pricing strategies (Hagmann et al., 2018; Vellinga et al., 2022). As such, nudges are progressively emerging as a policy tool adopted and implemented by government agencies worldwide (Halpern & Sanders, 2016; Whitehead et al., 2014). These interventions have been shown to reduce meat demand by framing food choices differently, both in the field and in online settings. However, their effect sizes are rather small, are difficult to scale-up, and might also reduce welfare in some cases. While for long scholars have pit nudges against taxes, a growing consensus suggests there might be complementarities between them (Osman et al., 2021; Vellinga et al., 2022).

## 4.2  Theoretical Framework

### 4.2.1  Fiscal Policy Design Elements

This study aims to investigate how the policy design elements of a meat tax affect citizen support (*research question 1*). Studies suggest that certain policy design elements can address  hesitance over the fairness and effectiveness of environmental pricing-instruments. These issues are top priorities for citizens and are more indicative of policy acceptance than knowledge about climate change or demographic variables (Bergquist et al., 2022). The perceived fairness will hinge on, for example, the stringency of taxation and who will shoulder the brunt of the tax burden, while perceived effectiveness will be reflected in how tax revenues are spent and the salience of incurred benefits. Taking this

into account, designing holistic policies may be better accepted by the public, and therefore more politically feasible, compared to a stand-alone carbon or meat tax (Fesenfeld et al., 2020; Givoni et al., 2013). When packaged together, citizens make trade-offs between costly market-based instruments with command-and-control policy elements. Policymakers can leverage this compensatory mechanism to garner support for stringent policies that are politically unappealing in their own right (Bergquist et al., 2022; Fesenfeld et al., 2020).

Earmarking revenues for specific purposes (i.e., revenue recycling) can make the advantages of a carbon tax reform more visible than when revenue uses are unspecified, as well as hold policy makers accountable for allocating funds to publicly approved uses. Redirecting dividends to public good services, such as projects aimed at protecting the climate and supporting low-income groups, receive significant backing, although the perceived effectiveness and equity of these efforts vary (Maestre-Andrés et al., 2021). Likewise, subsidizing low-emitting (vegetarian) foods has also been found to increase support for a meat tax (Fesenfeld et al., 2020). Building upon this foundation, we formulate our first hypothesis:

**H1:** Revenue recycling (direct or indirect) will increase policy support compared to no revenue recycling, on average.

The rationale for meat taxation is a subject of ongoing debate (Maestre-Andrés et al., 2021; Perino & Schwickert, 2023). Meat consumption contributes significantly to greenhouse gas emissions and poses environmental threats, with resources used for animal feed better allocated to cultivate plant-based foods for human consumption (Parlasca & Qaim, 2022). Laypersons are aware of this and may be inclined to support a meat tax, driven by environmental concerns (de Boer & Aiking, 2022; Ford et al., 2023; O'Keefe et al., 2016). While a carbon tax on meat primarily targets carbon emissions associated with climate change, it has broader implications, positively impacting areas such as human health (e.g., Godfray et al., 2018; Nelson et al., 2016; Parlasca & Qaim, 2022) and animal welfare (e.g., Parlasca & Qaim, 2022).

Overconsumption of meat is linked to heightened risks of chronic diseases (Godfray et al., 2018; Nelson et al., 2016; Parlasca & Qaim, 2022), with processed meats, in particular, being associated with specific forms of cancer (Bouvard et al., 2015). Highlighting human health as a rationale for the meat tax draws parallels with examples like the sugar tax in the UK, potentially making the concept more familiar and acceptable to the public. Despite these considerations, conflicting perceptions persist, as meat is acknowledged as a valuable contributor to a healthy diet and commonly viewed as *natural, normal, necessary,* and *nice* (Piazza et al., 2015). The strong positive

associations with the healthfulness of meat may consequently diminish health considerations as a primary motive for supporting a meat tax.

Industrial animal agriculture is tied to poor animal rearing conditions, presenting another potential leverage point for meat tax support. This concern has gained prominence beyond small (vegetarian and vegan) consumer segments in recent years, with more individuals adopting a "less is better" ethos in their meat consumption to improve farm welfare (Eating Better Alliance, n.d.). Indeed, recent evidence indicates that taxing meat under the banner of animal welfare garners greater support than climate change mitigation (Perino & Schwickert, 2023). This is consistent with insights gleaned from experimental and survey data focused on labeling and information provision – individuals appear more moved by arguments centered around animal welfare than arguments emphasizing climate protection (Cordts et al., 2014; Koistinen et al., 2013; Palomo-Vélez et al., 2018; Van Loo et al., 2014). This preference may be linked to the potent emotional responses evoked by appeals to animal welfare, tapping into deep-seated empathy and compassion as powerful catalysts for behavioral change. Individuals may also anticipate additional personal benefits by associating higher welfare standards with healthier or tastier meat products (Perino & Schwickert, 2023). This dual appeal, grounded in ethical considerations and perceived product quality, further enhances the viability of leveraging animal welfare motives in the discourse surrounding a meat tax. To this end, we formally propose the following hypothesis:

**H2:** Policy proposals motivated by animal welfare will increase policy support compared to other rationales (environmental quality and/or health), on average.

### 4.2.2 Behavioral Design Elements

Beyond design of the fiscal instrument itself, we will also explore how a framing nudge – the simple re-framing of the policy as levy versus a tax – impacts support (*research question 2*). In general terms, framing refers to how a message is communicated, necessarily emphasizing certain aspects of an issue over others, thereby influencing people's perception (Entman, 1993). Across various contexts, studies have found that framing policies in different ways, even with slight changes in wording, have significant policy implications (Fesenfeld et al., 2022; Osaka et al., 2021; Roh & Niederdeppe, 2016). For example, substituting the term "sugar-sweetened beverage" with "soda" has been found to elicit significantly different levels of support for a sugar tax depending on ideological group identity, due to differing concept associations (Roh & Niederdeppe, 2016). In an adjacent literature stream, behavioral "nudges" have been widely used to reduce demand for meat by subtly reframing or altering the presentation of choices without imposing any bans or altering the economic incentives (Bianchi et al., 2018; Meier et al., 2022). Specific to our policy context, the negative connotations associated

with the "t-word" may be mitigated by framing the policy as a "levy" versus "tax" (Perino & Schwickert, 2023). We expect the term "tax" more readily accesses associations with monetary burden due to its frequent use in that context. Consequently, we posit the following hypothesis:

**H3:** Policies framed as a "levy" will increase policy support compared to policies framed as a "tax", on average.

In our final research question (*research question 3*), we investigate the impact of encouraging citizens to reflect on the policy implications of a meat tax. This exploration is contextualized within the ongoing discourse surrounding the ethical delivery of climate nudges and the cultivation of agency (Bovens, 2008). Grounded in the notion of empowered participatory governance, current scholarly inputs have examined how encouraging deliberation before decision-making can foster prosocial behavior change (Banerjee, Galizzi, et al., 2023b; Banerjee & John, 2024). This approach involves prompting decision-makers to reflect and justify their perspectives, commonly referred to as a "think". Such reflective practices reveal unfounded opinions and promote considerations for the public good over self-interests (John et al., 2009). Reflective thinking encourages individuals to move beyond their initial, often self-interested, reactions and consider the broader implications of their choices. This is particularly relevant in the context of climate policies, which require collective action for the common good. A recent study targeting carbon emissions associated with meal choices found that deliberate pledging to an environmentally friendly diet before a default nudge resulted in a 40% decrease in intended meal emissions, compared to the nudge alone (Banerjee, Galizzi, et al., 2023b). Termed "nudge+", this combined approach integrated both a deliberative "think" and a classical nudge.

In our study, we anticipate that deliberation over the policy proposal will heighten the salience of framing effects. We specifically anticipate that this reflective practice will amplify the difference in support between different policy frames. While the term "tax" often carries negative connotations and is perceived as burdensome, reflection can engage individuals' System 2 processing, allowing them to move past initial biases. This deeper cognitive engagement helps individuals evaluate the policy on its merits rather than relying on quick heuristics or emotional responses. Conversely, the term "levy" is less negatively tainted and may naturally elicit a more neutral or positive initial reaction. Through reflective thinking, individuals are prompted to consider the rationale behind the policy, its goals, and its potential benefits for the public good. This process can mitigate the automatic negative response to the term "tax" by fostering a more nuanced understanding and appreciation of the policy's broader implications. However, we expect that reflection will be more effective in increasing support for the "levy" frame

compared to the "tax" frame, due to the absence of negative connotations associated with "levy." Aligned with this theory, we propose the following hypotheses:

**H4:** A nudge+ policy frame will increase policy support compared to a pure nudge policy frame, on average.

**H5:** Reflection will increase policy support more for the "levy" frame compared to the "tax" frame, on average.

## 4.3  Methods

We employed a 2 (framing nudge: tax vs. levy) x 2 (reflection: yes vs. no) between-within subject discrete choice experiment to identify a carbon tax on meat that is most acceptable to the public. This resulted in four experimental groups: Nudge (levy + no reflection), Think (tax + reflection), Nudge+ (levy + reflection), and control (tax + no reflection). The experiment was administered online to a representative sample from the Dutch (N = 2,032) population. The experiment was pre-registered with Open Science Foundation (https://osf.io/arzm2/) and conducted between July and October 2023. Participant recruitment was carried out through the online panel provider Panel Inzicht. Ethical approval for the study was obtained from the VU University Review Board, and all participants provided informed consent.

### 4.3.1  Experimental Design

To offer a comprehensive overview of the online survey and experimental design, please refer to Figure 4-1. The survey was administered using the Qualtrics platform. After completing initial survey items concerning socio-demographics, food consumption behaviors, altruism, reciprocity, risk aversion, and political orientations, participants were randomly assigned to one of two framings: "tax" or "levy". Furthermore, participants were instructed to reflect on the policy proposal or placed in a control group without this reflection.

**Figure 4-1.** Diagram of Experimental Design
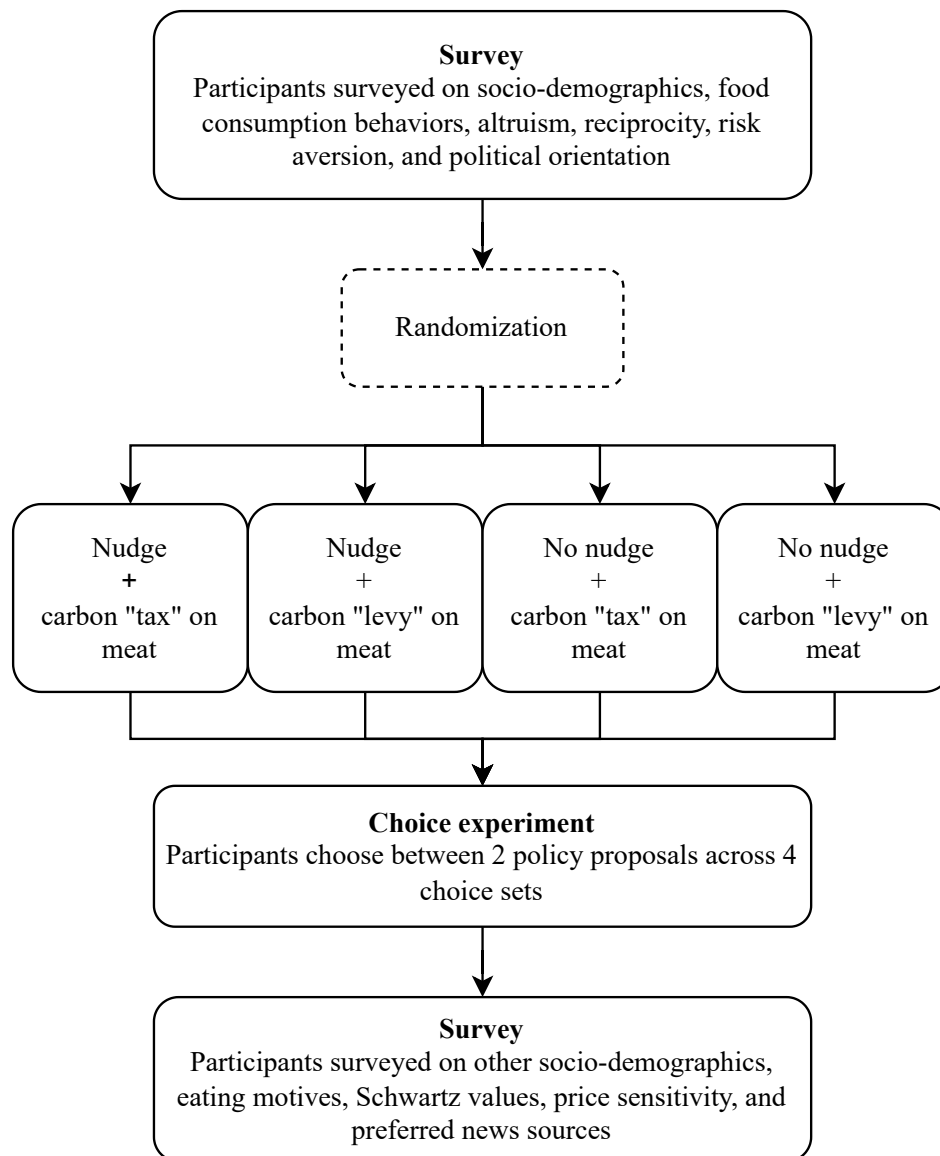


In all groups, participants were introduced to the policy context prior to the reflection element (Appendix C1). The framing nudge was embedded into this introductory text such that the pricing instrument was referred to as either a tax or levy according to treatment group assignment. They were informed that the Dutch government was considering a price increase on meat and provided with a description of key policy features:

i.   **Tax rate:** The proposed tax rates were 10%, 40%, 70%, and 100% of the external costs associated with meat production. These rates were designed to reflect a percentage of the actual external costs of meat, including factors such as greenhouse gas emissions, other emissions contributing to environmental

pollution, land use-related impacts on biodiversity, and livestock diseases (Robert Vergeer et al., 2020). The tax schemes varied among different meat products, with higher charges applied to beef, followed by pork, and chicken (i.e., a differentiated tax scheme). Accordingly, it was explained that these meat products would be taxed at different rates. This approach was chosen over a uniform scheme (i.e., where all meat products are taxed at the same rate), as it is considered more effective from an environmental standpoint and previous research has shown no discernible difference in support between these strategies (Perino & Schwickert, 2023).

ii. **Revenue recycling:** The revenues from this tax could be allocated to subsidize fruits, vegetables, and legumes, support low-income families, or remain unallocated for any specific purpose. Earmarking revenues for specific purposes can make the advantages of a tax reform more visible than when uses are unspecified and hold policy makers accountable for allocating funds to publicly approved uses. This approach has shown positive effects in previous studies on the acceptance of a meat tax (Fesenfeld et al., 2020; Maestre-Andrés et al., 2021).

iii. **Policy motivation:** The proposed policy aims to improve environmental quality, personal and public health, or animal welfare. While the primary target of a carbon tax on meat is to reduce carbon emissions and address climate change, it can also have positive effects in areas such as animal welfare and human health. Recent evidence suggests that framing the tax with a focus on animal welfare can garner greater support than emphasizing climate change mitigation (Perino & Schwickert, 2023).

iv. **Policy scope:** The tax could be implemented either at a national level or on a broader scale throughout the European Union. Previous research on general carbon taxes has indicated that support can be influenced by the behavior of other EU member states (Beiser-McGrath & Bernauer, 2019).

Following the policy proposal presentation, participants were randomized into a reflection condition. Those in the reflection condition were asked to reflect on this policy proposal and write down their honest opinion in a few lines, while those in the control conditions were not given this task (see Appendix C1 for reflection prompt).

Subsequently, participants were presented with two tax proposals, side by side, across a total of 6 choice sets. Each choice task presented all attributes listed in the policy introduction. For tax rate, the cost of beef, pork, and chicken were displayed with imagery of these three products as they would be found in the grocery store. The pre-tax price was visible alongside the price inclusive of the tax. All other attributes were displayed in the same manner as described in the policy introduction. An example of one choice task can be found in Appendix Figure C1. The levels for each attribute were

randomly selected with equal probability within each profile in accordance with methodology developed by (Hainmueller et al., 2014). Attribute and level order were randomized between participants to minimize carry-over effects between choice tasks and profile-order effects within a choice task. Identical profiles were intentionally avoided. For each choice task, participants were asked to choose the option they supported more (i.e., forced-choice), as well as rate on an 11-point scale, how likely they would be to support each policy scenario if implemented by the government.

Upon completing the choice tasks, participants were questioned about their perception of the likelihood that the government would introduce a meat pricing policy in the next term. This assessment was conducted to account for potential hypothetical bias in participant responses. The survey was concluded with questions related to participants' motives for their eating behavior, utilizing the Eating Motivation Survey (Renner et al., 2012). Schwartz values (Schwartz et al., 2015), price sensitivity, information on their preferred news sources, and socio-demographics (those not previously used for quota determination at the start of the survey) were also collected. Attention checks were incorporated into the survey to ensure participant engagement and data quality. All materials were first developed in English and then translated to Dutch by a native speaker.

### 4.3.2  Sample

Our study involved a sample (N = 2,032) of adult respondents from the Netherlands. To ensure the sample's representativeness, we applied quotas based on age, gender, and education. Only participants that did not adhere to a meat-restricting diet were recruited. Individuals that failed the first stand-alone attention check at the beginning of the questionnaire were terminated from the survey flow. Appendix Table C2 provides a summary of the demographic characteristics of our sample. To assess the balance of the treatment groups, we conducted group balance checks and found that the experimental groups were well-balanced.

### 4.3.3  Statistical Analysis

For all statistical analyses, we used the statistical software R (version 494). Each participant evaluated two policy profiles across 6 choice sets, resulting in a total of 24,384 policy evaluations (i.e., 2,032 participants × 2 policy profiles × 6 choice pairs). We estimated the Average Marginal Causal Effects (AMCEs) for policy design elements, which quantify the average impact of each attribute level on participants' support for a policy profile. To this end, we employed least squares regression to model policy choice as a binary outcome. We represented the attribute using sets of indicator variables, designating one level of each attribute as the reference category. Additionally, we clustered the standard errors by respondent for our analysis (Figures 4-2 and 4-4 in

results). For balance checks, we performed bartlett test (age) and chi square (categorical variables) to inspect the balance of age, gender, rural-city residence, and education across experimental conditions, which were found to be balanced (see Appendix Table C2). No statistically significant differences were observed among the groups.

## 4.4  Results

### 4.4.1  Influence of Hard Policy Design on Public Support for a Meat Tax

We examined pre-registered hypotheses regarding the impact of specific attributes of a meat tax on public support. Figure 4-2 illustrates the primary outcomes derived from the conjoint experiment conducted on the overall sample, as captured by the forced-choice responses. The AMCEs provide insight into the average change in the probability of garnering support when altering the attribute value from the baseline to the listed value. Significantly, the cost factor emerges as a pivotal determinant influencing support levels. Elevating the tax rate from the lowest (10%) to the highest (100%) leads to an approximately 25% reduction in support. Notably, each incremental increase in the tax rate corresponds to diminishing support. Furthermore, participants exhibit sensitivity to the utilization of tax revenues. Both direct and indirect recycling of revenues yield a 13-14% increase in policy support compared to leaving revenues unallocated without a specified purpose. Lastly, a distinct trend emerges regarding the jurisdiction of implementation, as participants demonstrate a stronger preference for an EU-wide meat tax policy over a national one. However, support remains unaffected by the rationale behind taxation, as evidenced by comparable AMCEs for environmental, health, and animal welfare policy justifications.

**Figure 4-2.** Average Marginal Component Effects (AMCEs) for Pooled Sample
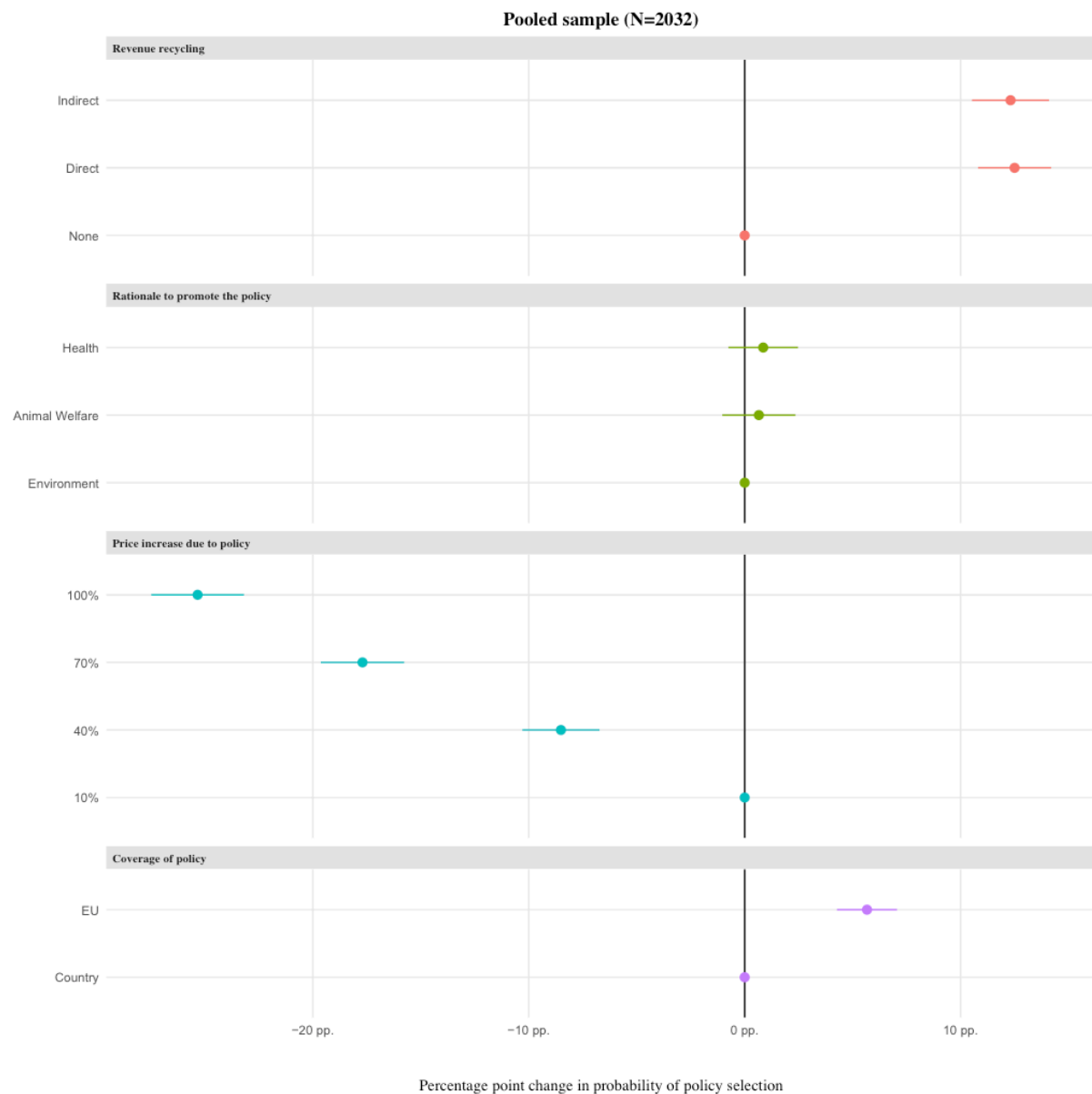


*Note.* Reflection and framing nudge groups are pooled. AMCEs displayed as percentage points.

In Figure 4-3, we present the distribution of citizen support for meat tax proposals at varying taxation levels, both within the Netherlands and the European Union (EU), as captured by Likert-scale responses. Responses scoring above the neutral point (5) were coded as indicative of support for the policy. Consistent with the trends observed in the AMCE results, the percentage of individuals supporting the policy tends to increase as the tax rate decreases, regardless of whether it is implemented nationally or at the EU level. Importantly, support is generally higher when the tax is implemented EU-wide compared to a national implementation. Moreover, the positive impact of revenue recycling on citizen support is evident across all tax rates and policy coverages. While

support declines with increasing tax rate, at a 40% tax, over 50% of voters still support it, regardless of whether revenue recycling is direct or indirect.

**Figure 4-3.** Support for Meat Tax Across Policies
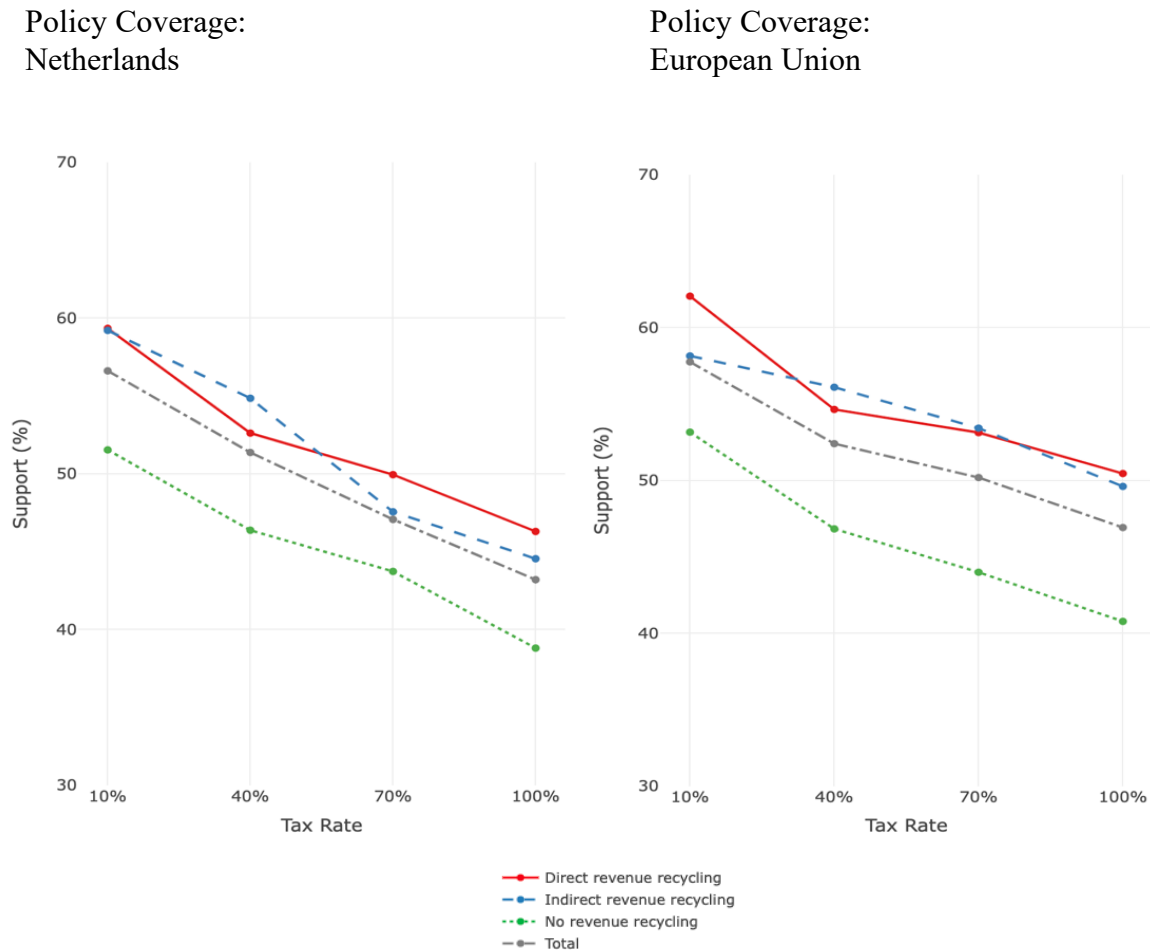


*Note.* Data points show the percentage of participants that chose the policy at each tax rate, as captured by the Likert-scale responses. Reflection and framing nudge groups are pooled.

### *4.4.2  Influence of Soft Policies on Support for a Meat Tax*

Upon examination of the AMCEs within each treatment group as captured by the forced-choice responses, our analysis reveals no significant differences between the Nudge (levy + no reflection), Think (tax + reflection), Nudge+ (levy + reflection), or control (tax + no reflection) treatments, as illustrated in Figure 4-4. This indicates that the incorporation of soft policy interventions had no discernible impact on policy support. To reinforce this observation, Table 4-1 presents the results of linear regression analyses, providing further confirmation of the absence of statistically significant effects.

**Figure 4-4.** Average Marginal Component Effects (AMCEs) Across Treatment Groups
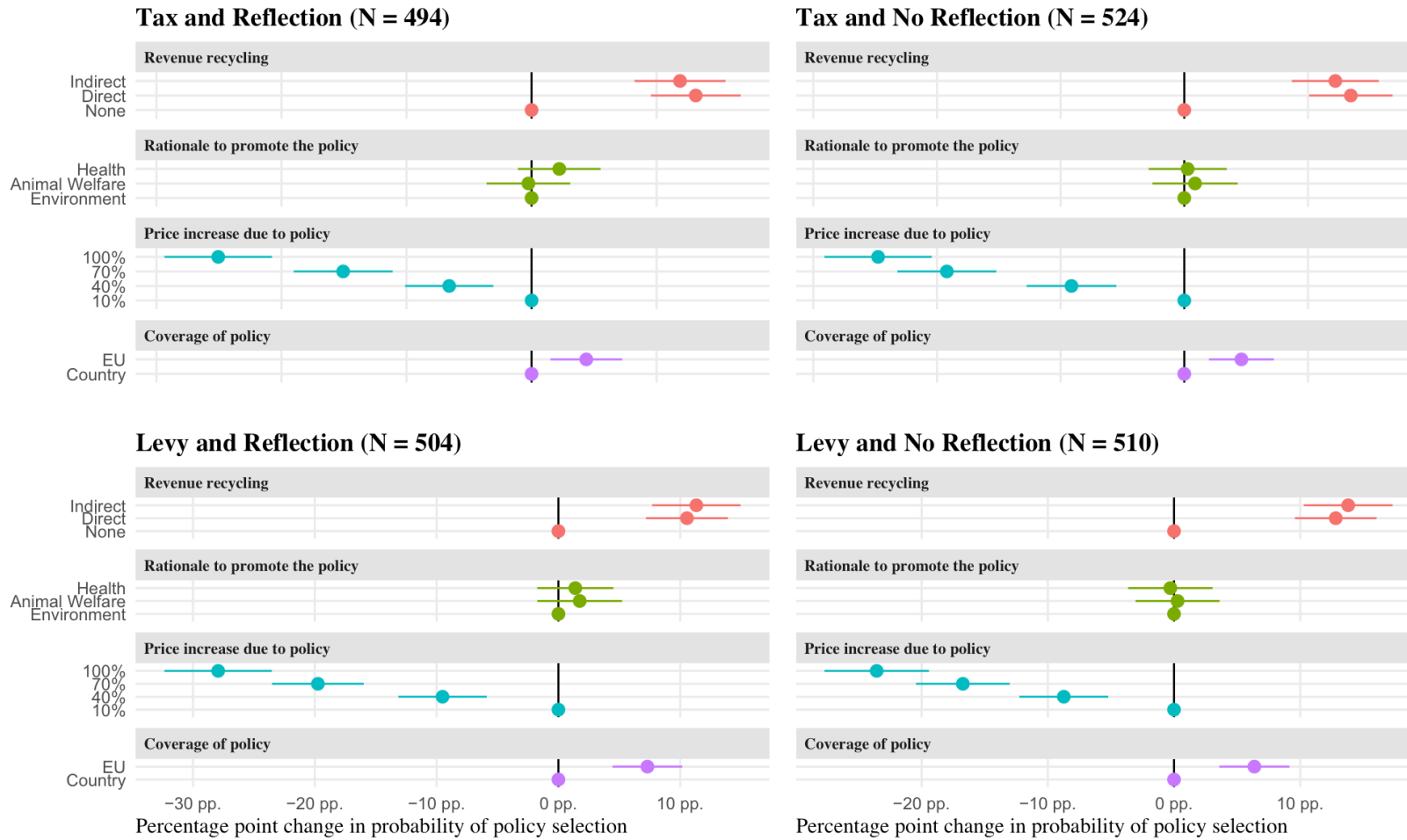


*Note.* AMCEs displayed as percentage points, as captured by the forced-choice respons

**Table 4-1.** Regression Results

|  | AMCE | P-value |
| --- | --- | --- |
| (Intercept) | 0.519 | > 0.001 |
| *Cost* |  |  |
| 40% | **-0.091** | **> 0.001** |
| 70% | **-0.192** | **> 0.001** |
| 100% | **-0.247** | **> 0.001** |
| *Recycling* |  |  |
| Direct | **0.135** | **> 0.001** |
| Indirect | **0.125** | **> 0.001** |
| *Coverage* |  |  |
| EU | **0.048** | **> 0.001** |
| *Motivation* |  |  |
| Health | 0.003 | 0.847 |
| Animal welfare | 0.009 | 0.552 |
| *Nudge* |  |  |
| Levy | -0.017 | 0.527 |
| *Reflection* |  |  |
| Reflection | -0.015 | 0.580 |

*Note.* Linear regression with robust standard errors clustered at the respondent level, as captured by the forced-choice responses. The reference level is the missing attribute level, i.e., 10% for cost, none for revenue recycling, NL for policy reach, environment for motivation, levy for frame, no reflection for nudge.

## 4.5 Discussion

### *4.5.1 Implications for Strategic Policy Design*

Our study highlights the central role of policy design in shaping public support for a meat tax. Participants' preferences were significantly influenced by fiscal elements of the proposed meat tax policy, underlining the need for careful consideration in formulating effective environmental taxation strategies. Public support for a meat tax appears primarily driven by economic factors and considerations of fairness, which include perceptions of equitable burden-sharing and the economic justification of the tax. These finding aligns with previous research, indicating that individuals are more likely to endorse such policies when they perceive them as equitable and economically justifiable (Beiser-McGrath & Bernauer, 2019; Fesenfeld et al., 2020).

As expected, the level of taxation emerged as a critical factor in shaping public opinion. Higher tax rates were found to be less acceptable, highlighting the balance required to implement effective but palatable taxation on meat products. To navigate this balance effectively, it may be prudent to consider an incremental approach, starting with a modest tax rate and gradually increasing it (e.g., Perino & Schwickert, 2023).

Consistent with prior research on meat taxes and general carbon taxes, our findings affirm that earmarking tax revenues contributes to an overall increase in support for a meat tax (Beiser-McGrath & Bernauer, 2019; Fesenfeld et al., 2020; Maestre-Andrés et al., 2021). In particular, our results are in line with findings from Fesenfeld et al. (2020), who found no significant differences in support for a meat tax between different revenue recycling uses (in their case, environmental and climate protection programs, aid for low-income households, and the reduction of income taxes). However, in a study that examined a greater breadth of recycling options, revenues allocated to assist low-income families garnered greater support for a carbon tax compared to various other uses, including reducing corporate taxes, which notably decreased overall support (Beiser-McGrath & Bernauer, 2019). This would imply that revenue recycling should be geared towards what makes sense in a given context.

The observed difference in support can be ascribed to the reassurance earmarking provides regarding the fairness and effectiveness of environmental tax schemes. While citizens may harbor doubts about the efficacy of the tax itself, there is a perceptible belief in the effectiveness of targeted climate programs. Specifically earmarking revenues for low-income support directly addresses voter concerns regarding the regressive nature of a meat tax. These concerns are substantiated, given that low-income households, allocating a larger share of their income to food, bear a disproportionate burden from food taxes. Encouragingly, research suggests that regressivity can be alleviated in most cases through non-targeted revenue recycling, accomplished via uniform per capita transfers. Additionally, the reduction of Value-

Added Tax (VAT) on fruits and vegetables is identified as a measure to tackle regressivity, although it may not entirely eradicate the issue (Klenert et al., 2023). However, evidence from countries with existing carbon tax rebate programs reveals that partisan affiliations and low visibility of rebates can lead to an underestimation of refunds, weakening support for the carbon policy. The authors emphasize that sustained communication efforts will be essential to enhance support through this approach, indicating that a one-time information dissemination may not be sufficient (Mildenberger et al., 2022).

Public backing for meat taxes was found to be sensitive to broader European Union contexts, a trend consistent with the insights shared by Beiser-McGrath & Bernauer (2019). Their work indicates that the rationales guiding environmental policies are shaped by the conduct of neighboring countries, an observation that can also be interpreted through the lens of fairness concerns. Recognizing these cross-border dynamics is imperative for formulating policies that are effectively harmonized within the EU.

Contrary to expectations, the underlying motivation behind the meat tax policy did not meaningfully impact public support. This finding contradicts previous research, which suggested that animal welfare could be a more effective motive for imposing a tax on meat compared to environmental or human health concerns (Perino & Schwickert, 2023). Compared to this seminal study in Germany, where an animal welfare label is only now being considered, our study took place in the Netherlands, where the Animal Welfare Label (The Better Life label) has been around since 2007. Alternatively, our findings may stem from individuals perceiving the rationale as ethically abstract, lacking tangible real-world implications. In contrast, other dimensions of the policy design were perceived as carrying more concrete economic and fairness ramifications, shaping public perception to a greater extent. This suggests that citizens, in their evaluation of a meat tax, were more attuned to the practical and immediate implications rather than the abstract ethical motivations, highlighting a rational approach to decision-making in this context.

It is important to recognize that, for feasibility reasons, the internalization of external costs in our study was calculated to reflect environmental harms rather than human health and animal welfare dimensions. Participants were informed of this, which may have led them to perceive the tax as primarily aimed at improving environmental outcomes. Additionally, participants were made aware that the hidden costs of meat were lower for chicken than for beef, which holds true for environmental and health impacts. However, this does not account for animal welfare, as significantly more chickens need to be killed to produce the same amount of protein as a single cow, and chickens are generally raised in worse conditions (Ritchie, 2024). This discrepancy may have influenced participants' focus on the economic and environmental aspects of the tax rather than the ethical motivations related to animal welfare. Despite this,

we do not expect the average consumer to be aware of the environmental-animal welfare trade-offs.

### 4.5.2  Limitations of Behavioral Policies

While behavioral interventions are widely embraced as policy tools due to their potential for cost-effective solutions, they are not suitable in every context. We found that the effectiveness of "soft" behavioral interventions, including framing nudges and reflective elements, in influencing public support for a meat tax was limited. While more intrusive nudges, such as defaults, have demonstrated the ability to shift behavior in favor of climate-friendly choices (Berger et al., 2022), our study indicates that less intrusive cosmetic and reflective nudges are insufficient to significantly influence support for a meat tax. This calls into question the applicability of "mere nudges" to policy contexts where individuals think critically about their beliefs, such as when voting a policy into action.

While our study finds null effects of the behavioral interventions, there was no evidence of a negative impact. Prior research suggests that nudges can have rebound effects, resulting in unwanted outcomes (Damgaard & Gravert, 2018; Sunstein, 2017). Relatedly, research indicates that nudges, specifically those aimed at reducing carbon emissions (e.g., a green energy default nudge), can potentially diminish support for a general carbon tax (Hagmann et al., 2019). This concern arises because such interventions provide only limited progress while creating the illusion of substantial change, potentially undermining support for more comprehensive and effective policies (Fishbach et al., 2006). However, this phenomenon requires individuals to be aware of the nudge and recognize both the nudge and tax as working toward the same goal. In the case of Hagmann and colleagues (2019), participants were presented with a description of a default green energy nudge and a carbon tax before deciding on policy implementation. In situations where citizens are not actively attending to or scrutinizing a nudging intervention as an alternative to a tax, as observed in our study, support for the tax can remain stable. Consequently, even though these nudges were ineffective, at the very least, they did not erode support for a meat tax.

Although our study highlights the limitations of behavioral interventions, it is important to note that we do not dismiss their utility within the policy toolkit. Nudges, thinks, and the combined approach of nudge+ have demonstrated greater efficacy in influencing more routine and intuitive decisions, particularly in contexts where individuals may not be deeply engaged in deliberative decision-making processes, such as daily food choices (Banerjee, Galizzi, et al., 2023b, 2023a; Bauer & Reisch, 2019; Erhard et al., 2023; Lohmann et al., 2022; Meier et al., 2022; Vellinga et al., 2022). In the realm of daily food choices, individuals frequently rely on heuristics and routines (Cohen & Babey, 2012) and may not have formed strong contemplative preferences, making them more responsive to subtle nudges or reflective prompts (de Ridder

et al., 2022). The stability and reflective nature of political beliefs make them less amenable to the subtle interventions that have proven effective in other contexts.

Still, it may be that simple re-frames could exert positive effects even in policy choices if substantial enough. Frames can vary greatly in the degree to which they reframe concepts related to an issue. While some frames leverage polarizing aspects, others minimally change the wording of a message using synonyms with fewer connotations, as we did in our study. For example, framing climate policy in terms of avoiding future losses rather than gains can significantly increase willingness to pay for such policies (Svenningsen & Thorsen, 2021). Similarly, framing the benefits of clean energy policies by emphasizing climate change, air pollution, or energy security has swayed support, particularly among Republicans in the US (Feldman & Hart, 2018). Nonetheless, on the whole, our findings suggest that a more effective approach than relying solely on behavioral economic interventions involves designing a meat tax that individuals can support in its own right.

### 4.5.3   Limitations and Future Research

Though our study contributes valuable findings, certain limitations highlight areas for future research. Firstly, our examination of revenue recycling options for a meat tax specifically focused on subsidizing plant-based foods and directing funds to support low-income groups. This limited scope suggests that there may be additional revenue recycling mechanisms worth exploring, such as earmarking funds for innovative climate-projects. Thus, future research could extend this inquiry to encompass a more comprehensive range of revenue recycling options to capture the nuanced preferences and impacts associated with different approaches. Secondly, the application of conjoint survey experiments, while robust, may be susceptible to social desirability bias. Our study employed a forced-choice design to capture the trade-offs individuals are willing to make, requiring respondents to choose between presented options. However, this design does not account for opt-out preferences, potentially overestimating the acceptability of the presented options, which could be incorporated in future studies. Furthermore, our study focused on the Dutch context, where a meat tax was under consideration. Given the substantial variability in attitudes and support for a meat tax across different countries due to cultural and contextual factors, future research could employ our experimental design to conduct cross-national comparisons. This approach would contribute to a more comprehensive understanding of the diverse determinants influencing public support for meat taxes on an international scale. However, one challenge in doing so will be accounting for semantic differences and varying familiarity with terminology across languages, such as with the term "levy," which may not have a direct equivalent or may carry different connotations in different cultural contexts. Lastly, of note is the recent change in the political landscape of the Netherlands, where a conservative party secured victory in the national elections. Given this party's opposition to a meat tax, reassessing public support in this altered political context is essential. Future research should investigate how this political

shift influences policy preferences and public attitudes towards a meat tax, providing updated insights into the evolving dynamics of meat tax support in the Netherlands.

## 4.6  Conclusion

A global transition towards plant-based diets is necessary to curb the greenhouse gas emissions associated with current food systems. A tax on meat will be a powerful tool to facilitate this transition, yet limited public support renders its political implementation challenging. To address this dilemma, we conducted a conjoint experiment aimed at discerning the most acceptable attributes of a meat tax policy and assessing the potential leverage of insights from behavioral economics to cultivate public support. Our findings illuminate the pivotal role of policy design in influencing support for meat taxes, emphasizing the imperative of striking a balance between economic considerations, fairness, and an understanding of contextual factors shaping public opinion. Furthermore, our study demonstrates the limitations of soft behavioral interventions; neither a mere framing nudge nor encouraging citizens to reflect on the policy contents exhibited any discernible effect. As countries such as the Netherlands, Germany, and Sweden contemplate the implementation of meat tax policies, our results offer valuable insights to inform policy discussions. Policymakers can draw on these findings to craft meat tax policies aligned with citizen preferences, navigating the complexities of public opinion and advancing sustainable dietary transitions on a broader scale.

# 5 Substitution Patterns and Price Response for Plant-Based Meat Alternatives

With Steffen Jahn and Daniel Guhl[5]

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This chapter has been removed due to publication restrictions.

Please refer to the following publication for full details:

Jahn, S., Guhl, D., and Erhard, A. (in press). Substitution patterns and price response for plant-based meat alternatives. *Proceedings of the National Academy of Sciences*.

# 6   A Choice Architect's Guide to the (Autonomous) Galaxy: A Systematic Scoping Review of Nudge Intrusiveness in Food Choices

With Dominic Lemken and Simone Wahnschafft[6]

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## 6.1 Introduction

In 1962, former US president J.F. Kennedy formulated the Consumer Bill of Rights. The bill introduced the right to choose, defined as the right "to be assured, wherever possible, access to a variety of products and services at competitive prices". The principle of consumer autonomy has been built on this right to choose and remains a foundational principle of liberal democracies today. In this context, Thaler & Sunstein's (2008) "Nudge," defined as "any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives," emerged with the powerful promise to design interventions that respect consumer autonomy but manipulate the status quo of decision making in order to shift behavior.

Since the original definition, the concept of nudging has been further refined. Hansen (2016) extends the definition by emphasizing that nudges are intentional attempts to influence behavior in predictable ways by leveraging cognitive boundaries, biases, routines, and habits that often hinder rational decision-making. He argues that nudges exploit these inherent characteristics independently of forbidding or adding rationally relevant choices, changing incentives, or providing factual information and rational argumentation.

While nudging has become influential in recent years, it is not without controversy. Indeed, the extent to which nudges truly preserve consumer autonomy has become a key point of most ethical discussions in the scientific literature. A recent systematic review stated that 86% of ethical contributions to the nudging topic address autonomy (Kuyer & Gordijn, 2023). The concept of autonomy in decision-making encompasses at least two integral aspects: freedom of choice and agency (Vugts et al., 2020). These facets, while distinct, are intricately connected, collectively contributing to the overall understanding of consumer autonomy.

*Freedom of Choice* entails the absence of restrictions on available options. In this context, it is important to consider whether, and to what extent nudges provide individuals with a genuine opportunity to resist the influence of a nudge (Kuyer & Gordijn, 2023; Saghai, 2013). This discussion sometimes pits effectiveness against autonomy, arguing that nudges can be either highly effective or easily resistible (Floridi, 2016; Mills, 2018). However, this dichotomy oversimplifies the issue, as there are instances where nudges can be easily resisted and still prove effective, leading to the question of how to navigate this trade-off. This scoping review provides further empirical support of resistible, yet effective nudges.

*Agency* refers to an individual's capacity to deliberate, critically reflect, and make choices (Vugts et al., 2020). Dold & Lewis (2023) further illuminate this distinction between these two aspects of autonomy by introducing the concepts of "opportunity freedom" (availability of choices) and "process freedom" (capacity to make reasoned decisions). While opportunities alone do not necessarily make one feel in control of their life, process freedom allows for control over the choice process and fosters the sense of being the "author of one's life". This

is not necessarily the same as a rational decision outcome (Engelen, 2019). Outcome rationality pertains to evaluating the most rational decision irrespective of the decision-making process, while process rationality seeks to understand the feasibility of a rational reflective process in the context of a given decision. The latter is what agency-respecting choice architects can strive to do. Nudges that undermine a decision-maker's ability to reason threaten the agency dimension of autonomy (Vugts et al., 2020).

In summary, autonomy requires not only having options, but also the internal capacity to reflect on those options and freedom to act on them to achieve personal goals (Kuyer & Gordijn, 2023). Increasing agency through nudging can enhance desirable outcomes. For example, a study on charitable giving found that offering a list of donation options along with a default amount resulted in higher overall donations compared to providing just a single default option (Banerjee, John, et al., 2023). As Sunstein (2015) has long advocated, effective nudge design can preserve both agency and freedom of choice, ensuring that the success of the nudge, such as increased donation amounts, does not come at the expense of individual agency.

There remains a substantial gray area with regard to determining when a nudge does or does not, as well as to what extent, preserve autonomy. "Perceived intrusiveness" has emerged as a key construct to investigate the concept in survey research on nudge approval, with researchers regularly prompting consumers to indicate the extent to which they believe a nudge intrudes upon their capacity to choose - essentially their agency in the choice (Evers et al., 2018; Hagman et al., 2015, 2022; Yi et al., 2022). Up to 30% of the differences in approval of nudges is estimated to be explained by perceived intrusiveness alone, making it a very important concept to predict acceptance (Evers et al., 2018). However, "perceived intrusiveness" is not an ideal concept to judge the preservation of autonomy. For instance, when it comes to certain nudges, the level of controversy often stems from the fact that people tend to either strongly favor or strongly oppose their perceived intrusiveness, leading to polarized opinions among many individuals (Lemken et al., 2023). A judgment based on mean values of opinions would ignore a substantial group of citizens who voice concern or support with respect to autonomy. Moreover, it is worth noting that citizens may blend their views regarding the legitimacy of the nudge's objective with their perception of its intrusiveness. This has been evidenced, for instance, in the case of Dutch public servants who generally support behavioral interventions but perceived simple reminders as paternalistic in an application targeting a behavior deemed unnecessary (Dewies et al., 2021). Additionally, the approach of having survey participants assess hypothetical scenarios rather than immersing them in real-life nudged decision-making situations is extremely sensitive to the specific wording employed. Consequently, there is a need for a more concrete and universally applicable conceptual framework in this regard.

The idea of this article, therefore, is to develop a typology of how nudges may hinder autonomy. The resulting typology will assist choice architects, policymakers, and other relevant

stakeholders in critical thinking and systematic evaluation of nudges with respect to autonomy. Importantly, it provides the dimensions along the lines that choice architects have to think about when assessing or altering nudge design in pursuit of maintaining autonomy. Guided by the typology, choice architects may be able to identify nudge interventions that balance both respect for individual autonomy and effectiveness, or alternatively be poised to acknowledge the limits of nudging principles as to argue why more intrusive policy measures are demanded (Lades & Delaney, 2022; Sunstein & Reisch, 2013).

We note a caveat for our investigation: while we are focusing on autonomy, there are additional aspects influencing the ethicality of nudges beyond the scope of this study. The Nudge FORGOOD framework does address autonomy under "respect," acknowledging the importance of autonomy and the freedom to choose (Lades & Delaney, 2022). However, the framework also mentions other ethical concerns, such as the fairness of a policy's redistributive effects, the availability of alternative policy options, citizens' opinions on the goals addressed with a nudge, and the legitimacy of the choice architect to act out the role (Nys & Engelen, 2017). Furthermore, some authors have counted in the concept of self-constitution to the fundamental principles of autonomous decision-making (Vugts et al., 2020). Presently, there remains uncertainty regarding whether nudges can actually impact higher-order preferences that make up self-constitution or if nudging someone to make a choice against their higher-order preferences merely serves to make the manipulation more apparent (Nys & Engelen, 2017). The ongoing debate on this subject has yet to reach a definitive conclusion, and it presents challenges in terms of operationalization at this stage, which are not considered in the typology of this study.

The typology is developed and discussed in the context of nudges related to food choice. The rationale for focusing specifically on nudges related to food choice is three-fold. First, the food we eat can either support or threaten human health and environmental sustainability, thereby carrying a major impact on our well-being (Willett et al., 2019). As such, it is vital to understand how nudges impact our autonomy in this context in order to avoid undue infringement over basic human needs. Second, food is not just a matter of practical sustenance, but also an emotional, cultural, and moral aspect of our lives. Nudging food choices can therefore be particularly sensitive, and have the potential to be perceived as more intrusive than nudges applied in other behavioral domains (Sunstein et al., 2019). Finally, nudges on food choice address daily routine decisions that are made intuitively and instinctively (i.e., according to 'System 1' thinking) making them capable of greatly impacting individuals' daily lives and habits (Wansink & Sobal, 2007). Taken together, nudges aimed at influencing food choices have the potential for far-reaching implications.

The manuscript is structured as follows. In the method section, we provide an account of our approach to conducting a scoping review, where we delve into food nudging studies to identify the mechanisms that underlie autonomy and their representation in the empirical literature. In the results section, we demonstrate the ways in which nudge studies can impact autonomy

and introduce a typology to better understand the nudge elements relevant to an autonomy assessment. The discussion section will then expand upon how these typologized dimensions have been addressed within the scientific literature and suggest potential applications for the typology in future research.

## 6.2  Methods

In the following, we describe the eligibility criteria, search procedure, title and abstract screening, data extraction and data synthesis of the scoping review:

*Eligibility Criteria*: The current review adhered to the scoping review methodology recommended by the PRISMA-ScR reporting guidelines. An overview of the article selection process is illustrated (Figure 6-1). We included articles published in peer-reviewed journals, excluding reviews, pertaining to empirical research on nudging individuals to choose healthy and/or sustainable foods, across any food consumption setting. Only articles that explicitly described their interventions as nudges were considered. Articles using the term "nudging" informally to denote behavior influence, without aligning their interventions with nudge terminology, were excluded. The publication date criterion considered studies published within the last ten years of the search period (01/2014 to 12/2023). Additionally, only articles written in the English language were included in our search.

**Figure 6-1.** PRISMA-ScR Flow Chart
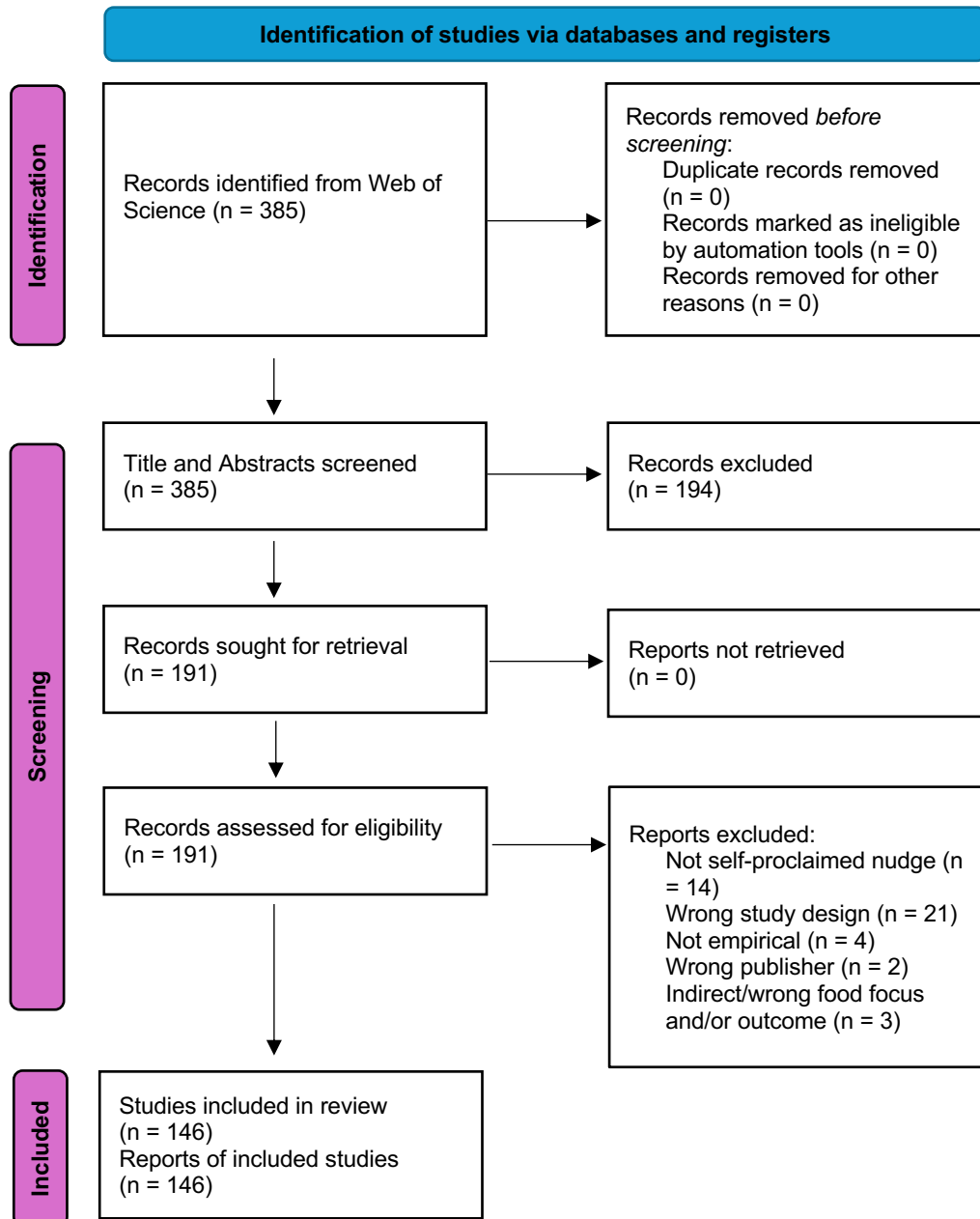


*Search Procedure:* After initial screening procedures, a systematic search was carried out on the Web of Science platform in January 2024. Various combinations of Boolean search terms were used in alignment with the research questions and defined research boundaries. Specifically, the search criteria included ((“Nudg*" OR "Choice Architecture”) AND (“Health*” OR “Sustain*”) AND (“Food” OR “Diet”)) within the topic field. Documents published in MDPI journals were omitted, resulting in the removal of 55 articles. The search was focused on the most pertinent Research Areas, which yielded over forty studies each. i.e., (("Behavioral Sciences" OR "Psychology" OR "Food Science Technology" OR "Public Environmental

Occupational Health" OR "Business Economics" OR "Nutrition Dietetics" OR "Environmental Sciences Ecology")), thereby removing 87 articles. The systematic search yielded 385 articles.

*Screening:* The selected articles underwent a title and abstract screening process by the three investigators based on predefined inclusion/exclusion criteria. Article were excluded if they: i) were commentaries or theoretical contributions to the literature, ii) were not aimed at health or sustainability outcomes or were aimed at sustainability outcomes indirectly related to sustainability in food systems (i.e., reducing packaging or plastics, improving recycling), or iii) the study design did not allow to observe individual behavior. We considered various outcome measures, such as dietary outcomes (e.g., food choice), health metrics (e.g., BMI, weight, nutrient status), economic parameters (e.g., sales), and sustainability indicators (e.g., GHG emissions). In full-text screening, we also excluded studies i) combining nudges with non-nudge interventions, including a number of combinations with pricing strategies, ii) qualitative studies without empirical effectiveness examinations or without testing a nudge altogether, iii) studies lacking a nudge setup description or not yet implementing the nudge. A total of 146 articles remained for data extraction after the screening.

*Data extraction, synthesis, and typology development:* A single author (AE or SW) conducted data extraction utilizing a software for managing systematic reviews, with open-ended questions on each study (Supplementary file S1), outlining the i) study population ii) target behavior addressed with the nudge and choice setting, iii) status quo or control choice architecture, iv) nudge description, and v) nudge type — as campaigns, commitments, information mechanisms, transactional shortcuts, improved design strategies, warnings and reminders (Thaler & Sunstein, 2008), vi) the classification of nudges according to the intrusiveness typology developed in this article, and lastly vii) whether the study observed significant, non-significant results with regard to the main outcome measure(s). The process of classifying nudges according to intrusiveness mechanisms involved assessing the nudge description to determine if it influences a mechanism relevant to autonomy. Subsequently, for those that do affect a mechanism, the assessment determines if this influence could potentially hinder autonomy. Any uncertainties identified by the authors were annotated and subsequently cross-verified by a second review author. For the typology of mechanisms that can hinder autonomy, we consolidated a preliminary set of identified studies. Each nudge was discussed amongst the research team to identify key mechanisms underpinning intrusiveness common across studies. The initial typology development was facilitated by an exercise amongst the authors, where a subset of the preliminary studies was considered for how the nudge design could be hypothetically modulated to reflect lower and higher degrees of intrusiveness. In addition, anonymous reviewers and colleagues with expertise in the field have commented on the initial typology, which has greatly helped to further develop it.

The typology was integrated into the review process to evaluate a systematically selected set of studies to discern whether the typology appropriately captured the intrusiveness of the included nudge designs, or whether the definition needed to be expanded. While the overall

typology was found to appropriately encompass intrusiveness mechanisms, the process proved useful for refining sub-dimensions within each mechanism. In the result section, we provide example studies that call into question the preservation of autonomy concerning the typologized mechanisms. Additionally, the complete set of studies, encompassing further examples and the authors' classification for intrusiveness, is also accessible (see Appendix E1 Supplementary file S1). Furthermore, we identified key criteria to operationalize a measurement of intrusiveness by sub-dimensions to facilitate critical thinking as to how nudges might be modulated to mitigate intrusiveness. Although we may not establish a definitive threshold for determining minimal or high intrusiveness, the criteria we outline can assist choice architects in making better evaluations.

## 6.3 Results

The total sample of food nudge studies (N=146) encompassing 251 interventions was reviewed and evaluated by intrusiveness on individual autonomy. We delineate the overarching mechanisms of nudges that might alter an individual's autonomy: (1) the effort to opt out; (2) the affective influence, and (3) non-transparency (see Figure 6-2).

**Figure 6-2.** A Typology of Nudge Intrusiveness
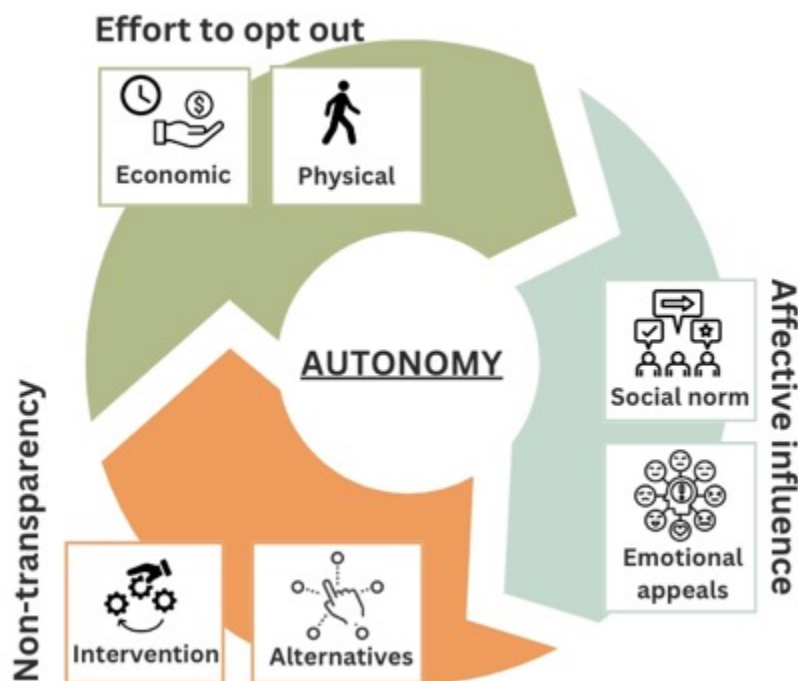


Of the 251 interventions reviewed, 74 (29.4%) altered the effort to opt out, 127 (50.6%) leveraged affective influence, and 164 (65.3%) exhibited non-transparency. Of those interventions that altered the effort needed to opt out of the nudged option, the majority (70.3%) acted upon this mechanism in such a way that did not pose threats to autonomy;

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however, just under a third (29.7%) of these studies employed obstacles to opting out that run the risk of hindering autonomous decision-making, either by the degree of physical ($N_i$=11) or economic effort ($N_i$=11) required to realize preferences against the nudged option. The majority (88.3%) of interventions that leveraged affective influence did not pose threats to autonomy; however, a handful of these studies posed threats to autonomous decision-making by either the extent of their exploitation of social norm influence ($N_i$=5) or emotional appeal ($N_i$=10). Finally, of those studies that posted risks to autonomy under the umbrella of non-transparency, the bulk were characterized as imperfect due to non-transparency of the intervention itself ($N_i$=125), and a few were marked as threatening autonomy due to non-transparency of alternatives ($N_i$=4). Additionally, we provide an indication of intrusiveness relative to the nudge type, namely campaigns, commitments, information mechanisms, transactional shortcuts, improved design strategies, warnings and reminders (see Supplementary file S2)

These intrusiveness mechanisms, and their respective sub-dimensions, are not necessarily independent, and rather can interact. In addition to the examples highlighted in our results, which pose minimal risk to autonomy, there are nudges that operate independently of our defined intrusiveness mechanisms. For example, information provision or self-nudging emerged as interventions that do not align with any intrusiveness mechanism. In one such study, participants were informed about nudges before autonomously selecting their own, such as a reminder to increase fruit consumption (van Rookhuijzen et al., 2023). As another example, a few studies added options to the choice set (Attwood, Chesworth, et al., 2020; T. Gill et al., 2022), which does not intrude via any mechanism. However, it is important to note that, while these were self-proclaimed nudges, such interventions do not necessarily adhere to the definition of a nudge, as they alter the choice set. In the remainder of this paper, we draw upon examples from the literature that act upon a mechanism relevant to autonomy to better illustrate each concept (see Table 6-1 for a summary).

**Table 6-1.** Example Food Choice Nudges Identified in the Scoping Review Organized by Intrusiveness Mechanism

| Intrusiveness mechanism | | | Example nudge | | | |
|---|---|---|---|---|---|---|
| Mechanism | | Definition | Reference | Target behavior and setting | Control | Nudge description |
| Effort to opt out | Economic | Modulating the time and/or monetary resources required to opt out | Coffino et al., 2020 | Healthier grocery purchases in online grocery store | Provision of nutrition information before purchasing groceries online, without pre-filled shopping cart | Pre-filled online shopping cart containing a selection of groceries tailored to meet participants' personalized nutritional needs with the option to delete, add, exchange, or keep items before finalizing their purchase |
| | | | Lai et al., 2020 | Choice of white (vs. chocolate) milk in school lunchroom | Status quo lunchroom | Glow-in-the-dark bracelet (worth $0.20) attached to white (but not chocolate) milk cartons |
| | Physical | Modulating the physical resources required to opt out | Campbell-Arvai et al., 2014 | Choice of vegetarian meal in university cafeteria | Dining facility menu with both vegetarian and non-vegetarian options listed on the same menu. | Vegetarian default menu, with patrons informed verbally and in writing about second menu containing meat posted 3.5 meters away |
| | | | Baskin et al., 2016 | Snack consumption in the workplace | Snack station located 2 meters from the beverage station | Snack station located 5.3 meters from the beverage station |
| Affective influence | Social norm | Activating social norms | | | | |
| | | | Loeb et al., 2017 | Choice of healthier breakfast menu for child at community center | Unhealthy default breakfast menu with unhealthy items and neutral video shown to parents prior to | Video shown to parents with messaging, e.g., "Making health easy for your child means making the best choices for him or her", followed by presentation of a default menu offering an unhealthy breakfast combo, where healthy options were listed in smaller font at the bottom and available upon request |
| | | | Policastro et al., 2017 | Healthier beverage choice in college food retail setting | No messaging | In a dining hall, posters displayed messages on calorie savings and/or charity donations, i.e., if customers chose fountain water over soda, the proceeds would go to a local soup kitchen |
| | | Eliciting a salient emotional response | Caso et al., 2023 | Self-reported future meat consumption in online survey | No messaging | Text provided that either focused on the irreversible consequences of a high intake of red and processed meat in terms of death, capturing the influence at a global, or individual level, i.e. increased risk of cancer and other chronic diseases |
| | | | Mecheva et al., 2021 | Healthy snack choice in school | Healthy (banana) and unhealthy (Chocolate cake) snack displayed side by side | Healthy (banana) and unhealthy (Chocolate cake) snack displayed side by side and a happy, green smiley face |

| | | | | | placed next to healthy snack and red sad face next to unhealthy one |
|---|---|---|---|---|---|
| **Non-Transparency** | Non-Transparency of intervention | Modulating visibility of the presence and/or purpose of an intervention | Kroese et al., 2016 | Choice of snack in train station snack shop | Unhealthy snacks placed next to cash register, with healthy snacks available elsewhere in the shop | Healthy snacks placed next to cash register, with unhealthy snacks available elsewhere in the shop; a sign was posted near the register saying "we help you make healthier choices" |
| | Non-Transparency of alternatives | Modulating the visibility of available alternatives | Diaz-Beltran et al., 2023 | Choice of fast-food meal combo in a hypothetical fast-food restaurant | Traditional combo menu, featuring unhealthy side and drink combined with main meal, whereas healthy alternatives were included separately on the menu | Healthy default combo menu, featuring healthy sides and drinks combined with main meal, whereas unhealthy alternatives were included separately on the menu; no clear instructions were provided on the menu about the option to modify combos free of additional charge |
| | | | Mikkelsen et al., 2021 | Healthy beverage purchases in vocational school canteen | Status quo beverage cooler | Sugar sweetened beverages were placed at the bottom of beverage cooler, where they were less visible and a frosted film covered the glass front |

*Note.* Examples provided in Table 6-1 represent a sub-sample of studies selected from the larger sample of review studies (N = 146) for illustrative purposes.

**Mechanism 1: Effort to Opt Out**

The effort to opt out refers to the resources demanded of individuals in order to realize a preference against the nudged option. This requisite effort can be modulated along two sub-dimensions that are relevant to autonomy—(a) economic and (b) physical. The former consists of both time and monetary resources, as both underpin economic thinking. The second sub-dimension includes various physical activities such as walking, reaching, and carrying. Substantial effort—either physical or economic—would constitute a restriction to individual agency.

**Economic resources.**

By definition, nudging explicitly promises to keep economic incentives constant (Thaler & Sunstein, 2008). This conceptualization of economic incentives must include time, as it is a vital tenet of economic thinking (DeSerpa, 1971) and is closely connected to monetary resources. Despite this reality, altering the time it takes to opt out of a nudge is frequently employed in nudge designs. For example, one study in a corporate cafeteria limited access to all-inclusive payment terminals where all items could be purchased, but not to the payment terminal where only designated low-calorie and mostly meat-free items could be purchased. In effect, this could increase wait times for the non-nudged alternatives by considerable amounts in what the authors refer to as the "hassle factor" (Bauer et al., 2021).

Besides obvious examples where researchers directly manipulate time resources, there can also be more hidden time costs in opting out of nudged options. In digital environments, for instance, opting out of a pre-selected option is just a quick click away. While this alone is not intrusive, the cumulative effect of facing numerous preselected items, each demanding individual action for removal, can become significant. In two studies, online grocery shopping carts were pre-filled with nutritious groceries such that shoppers could delete, add, exchange, or keep items in their cart. With upwards of twenty items preloaded into the carts, the time investment required to opt out of each individual selection could become considerable, unless efficient design features enable the selection of multiple options at once (Coffino et al., 2021).

Considering the over 200 food choices we make on a daily basis (Wansink & Sobal, 2007), even a five minute demand to opt out can be a significant ask. In contrast, durations of less than one minute — such as the time required to request an alternative from a restaurant server (e.g., Ferrante et al., 2022; Gravert & Kurz, 2021; Radnitz et al., 2023)—should be considered negligible and can hardly be avoided in the implementation of any decision.

Monetary incentives are seldom associated with nudging due to their general exclusion from the nudge framework, with the exception of near negligible (dis)incentives that are easy and cheap to avoid (e.g., 5 cent plastic bags in supermarkets) (Hansen, 2016). Therefore, pricing strategies are only considered as complements to be used with nudging tools (Kraak et al., 2017). Nevertheless, some nudges can indirectly influence the monetary cost of opting out. For example, the bundling of products, changes in portion sizes, and use of non-monetary rewards can lead to increased relative purchasing costs of non-nudged options. Imagine a scenario where a burger is either bundled with a side of fries or a side salad. In cases where it is not possible to switch the bundled side free of charge, or if the information regarding this option is not readily evident (Diaz-Beltran et al., 2023), customers may end up paying extra to add on the additional desired side. In this self-proclaimed nudge instance, the current state of affairs determines how a basic marketing strategy—the bundling of options—alters financial incentives on the decision-making process.

Regarding portion sizes, a restaurant intervention increased the default portion size of vegetables and decreased the portion size of meat in their dishes (Qi et al., 2022). In this scenario, the original size of components needs to be offered at the same price to avoid any monetary incentives. This particular study did not grant this alternative to the default option, effectively restricting choice.

Rewards or gifts employed as nudges, though potentially negligible in monetary value, may limit personal autonomy. Consider an intervention in which glow-in-the-dark bracelets of relatively low material value were affixed to white (but not chocolate) milk cartons in a school cafeteria (Lai et al., 2020). In this scenario, choosing chocolate milk incurs a financial disadvantage, particularly for young children who might place excessive value on such items. This issue is echoed by the long-standing debate in the US concerning toy incentives in kids' meals at fast-food establishments, with some advocating for their prohibition due to concerns about limited autonomy and the negative influence on children.

Conversely, this review included multiple studies that successfully employed economic incentives without casting doubt on the preservation of individual autonomy. These approaches included strategies such as monetary framing (Carroll et al., 2018; Policastro et al., 2017; Yi et al., 2022), e.g., healthy food bundles offered without a discount, framed as "5 items for $5" (Carroll et al., 2018), or scarcity cues (Fennis et al., 2020; van Rookhuijzen & de Vet, 2021) (e.g., "available while supplies last").

**Physical resources**.

Physical effort has been identified as a key component of the desire for "convenience" that drives food choices (Wales, 2009). Campbell-Arvai and colleagues (2014) leverage this desire for physical convenience by serving a default vegetarian menu at the tables,

while informing verbally and in writing of a second menu with meat options posted on the wall approximately 3.5 meters away from their table, observing significant increases in the percentage of patrons selecting vegetarian meals relative to the control condition. Baskin and colleagues (2016) also observe significant declines in snacks selected by employees in a large company when the snack station was placed an additional 2 meters away from the beverage station in the company break room. Other changes that require seemingly small shifts in physical effort navigating the space available, such as placing healthy (unhealthy) items closer (further) within reach (Knowles et al., 2019; Quinn et al., 2018; Seward et al., 2016; van Rookhuijzen & de Vet, 2021) can result in significant changes in behavior. Less obvious applications within this category are changes to encourage smaller portion sizes, such as providing smaller spoons or plates for self-service. The degree of physical effort required to opt out of the nudged option distinguishes between a minor rearrangement of choices and a more intrusive one that may compromise individual agency to choose freely against the nudged option.

## Mechanism 2: Affective Influence

Engaging emotionally-laden eating goals through "healthy eating calls" and "hedonic enhancements" have been classified as affectively-oriented nudging (Cadario & Chandon, 2020). We build upon this consideration of nudges that aim to influence decision-making through affective means—i.e. emotions—to also include social norm nudges. Social norms possess the capacity to encroach upon personal autonomy in decision-making situations where privacy or discretion is lacking, thereby making individuals feel unable to opt out of a nudge due to peer pressure and fear of social judgment.

### Social norms.

Social norms serve as codes of conduct to guide socially appropriate action and have been found to strongly influence food choice, including quantity, healthiness, and hedonic evaluation of food consumed (Higgs & Thomas, 2016). By conforming to social norms, individuals experience positive emotions associated with social acceptance and belonging. In the case of sustainable consumption, for example, individuals have been found to experience feelings of satisfaction when they choose ethical or environmentally-friendly foods, in what is called "warm glow" (Iweala et al., 2022). Conversely, fear of social judgments around non-conformity can also have powerful steering effects on individuals (Higgs, 2015). The effect is moderated by group identity (or lack thereof) (Liu et al., 2019).

Social norms can be cued by setting defaults (e.g., Coffino et al., 2021; Dalrymple et al., 2020; Diaz-Beltran et al., 2023; Gravert & Kurz, 2021; Hansen et al., 2021), which individuals tend to view as an implicate recommendation or normative option (Everett et al., 2015). Alternatively, re-configuring menu designs to position or otherwise frame

certain choices as the normal option (e.g., Boronowsky et al., 2022; Campbell-Arvai et al., 2014; van Kleef et al., 2018) and altering default portion or plate sizes (Davidson et al., 2021; Libotte et al., 2014; Qi et al., 2022; Zhang et al., 2024). Social norms can also come in the form of explicit messaging that conveys a descriptive norm (Gottselig et al., 2023; Jesse et al., 2021; McGrath, 2023; Otto et al., 2020; Reinholdsson et al., 2023; Suleman et al., 2022) such as signage that reads "most people choose fruit and vegetables" (Bauer et al., 2022) or a recommendation or injunctive norm such as "improve your score" when grocery shopping (De Bauw et al., 2022; Kroese et al., 2016; Panzone et al., 2021).

We argue that the intrusiveness of this class of interventions is contingent upon the presence of social pressure. On this note, privacy is a key factor which facilitates discretion in decision-making, enabling individuals to make choices without immediate social repercussions. The connection between privacy and decision-making has been previously explored (Huh et al., 2014). In settings that offer anonymity or a degree of discreteness, individuals may have more agency in their choices. In such environments, the use of social norms to subtly guide decisions, while still allowing for individual discretion, can be seen as an autonomy-preserving intervention. However, in embedded choice settings characterized by a highly social environment, the presence of strong social norms should be considered as a potential threat to autonomy, as individuals may feel compelled to conform to the prevailing social expectations in public settings. Relevant examples identified in this review include prompts at checkout counters encouraging patrons to choose fountain water over soda to support a local soup kitchen (Policastro et al., 2017), instructions given to parents in community settings to make healthy choices for their children (Loeb et al., 2017), and requests for patrons to downsize to smaller meals to combat food waste (Qi et al., 2022).

The impact of social messages varies between a communal cafeteria setting with frequent social interactions and more detached decision contexts (e.g., online grocery stores). Since the social dynamics of decision environments are often not described in the nudging literature, we cannot conclusively address the utilization of social norms in highly social settings. However, we highlight the potential risk to individual agency in such scenarios where social pressure is empirically confirmed.

**Emotional appeals.**

In the realm of food nudges, choice architects can aim to elicit a salient emotional response to make nudged options more appealing and/or make non-nudged options less appealing. Concerns to autonomy arise in the event that the effectiveness of a nudge hinges on the motivation to elicit negative emotions, such as fear, anger, sadness, shame, guilt, envy, disgust, or contempt (Plutchik, 2001). A recent review of studies examining the relationship between affective influence and agency observed that negative stimuli were associated with a lower sense of agency, as indicated through both

self-reporting and implicit measures (Kaiser et al., 2021). Loss aversion, and the resulting negativity bias, in which humans tend to pay heightened attention to, learn from, and consider negative information relative to positive information during decision-making (Rozin & Royzman, 2001; Vaish et al., 2008), may also be a pertinent consideration to agency. As such, careful consideration must be taken in the use of information that could be construed as negative to ensure that such interventions promote autonomy rather than hinder it.

This discussion is particularly relevant in the context of interventions meant to "warn" consumers against adverse health and/or environmental impacts of certain food choices. In the case of front-of-package nutrition labels, several studies have demonstrated that these tools enhance consumer understanding of the nutrition composition of packaged foods and beverages (Temple, 2020). Several studies focused specifically on warning labels, which label foods "high in" or in "excess of" sugar, salt, and/or saturated fats, have found that consumers indicate high acceptance of these labels and consider them useful to inform purchases (Bopape et al., 2021; de Morais Sato et al., 2019; Vargas-Meza et al., 2019). However, choice architects should be wary of other "warning"-type interventions that may cross the line into emotional manipulation. For instance, Aldrovandi and colleagues (2015) examine the effect of presenting rank information (e.g., "you are in the most unhealthy 10% of eaters") on students' willingness to pay for healthy foods, an intervention which runs a higher risk of effectiveness based on triggering shame. This intervention also overlaps with social norm messaging. Similarly, Caso and colleagues (2023) test the influence of fear-based messages that communicate the irreversible consequences of a high intake of red and processed meat in terms of disease and death on self-reported future meat consumption.

On the other hand, several studies were identified in this review which leveraged emotional appeals without linking to negative emotions or posing a risk to autonomy, such as those that sought to highlight healthy and/or sustainable options through the use of hedonic descriptions or sensory appeals, or adding smiley faces (Mecheva et al., 2021) or cartoon characters to healthy options (Ozturk et al., 2020).

**Mechanism 3: Non-transparency**

A prominent criticism of nudges is that they shift behaviors through the manipulation of biases. In this context, transparency has emerged as a key concept to preserve consumer autonomy (Hansen et al., 2021; Michaelsen, 2024; Wachner et al., 2021). The concept has generally been defined as making both the existence of the nudge and its intended objective known (Michaelsen, 2024). We incorporate and broaden the concept of transparency to also evaluate whether, and to what degree, the nudge clarifies alternatives to the nudged choice—a topic scarcely addressed in the literature on the ethics of nudging.

**Non-transparency of intervention**.

To date, the empirical literature on nudging offers limited insights into whether individuals can actually recognize a nudge and its intended purpose. On the one hand, attempts by choice architects to openly disclose nudges often go unnoticed, indicating that people frequently fail to understand the information meant to enhance transparency. Various studies have reported accuracy rates around or below 50% in tests with simple multiple-choice questions designed to check for manipulation awareness (Michaelsen, 2024). On the other hand, there is evidence that individuals can often identify nudges even without explicit notification, implying individuals might recognize nudges even when they are not overtly disclosed (Michaelsen, 2024). In this review, our attention centers on the actions of choice architects that affect the autonomy of individuals, encompassing deliberate efforts to inform about the presence or aim of the nudge. Several studies have aimed to explore the effects of enhancing the transparency of nudges, with the goal of ensuring that their effectiveness is not solely due to exploiting unconscious biases.

For example, consider a nudge intervention to shift the default options at the cash register from unhealthy to healthy snacks in a store. By placing a sign stating "we help you make health(ier) choices" (Cheung et al., 2019; Kroese et al., 2016), the sign informs on the purpose of the nudge in the shop. In some cases, these communications directly highlight the implementation of an intervention. For example, in an aforementioned study in an online supermarket, participants encountered a shopping cart preloaded with selections intended to mirror a "nutritionally balanced grocery shopping cart tailored to their gender and age", effectively making them aware of the intervention's purpose and existence (Coffino et al., 2021).

Messages conveying transparency can either directly highlight the purpose or presence of a nudge, or they might necessitate more advanced inferential reasoning through indirect cues, such as health-related posters in the decision-making environment that lack a clear spatial or thematic connection to the specific nudges implemented (Antunes et al., 2024). The latter method signifies a compromise on autonomy protection, despite its potential to help consumers recognize the intentional design of the choice architecture. Another aspect worth noting in detecting interventions is the frequency of exposure (singularity) to both the choice and the choice architecture. Interventions aimed at frequent patrons are more likely to be noticed as a change, particularly by customers dissatisfied with the nudged choice, who will promptly opt out. The frequency of exposure serves as a safeguard against misleading nudges (Lemken, 2021a). In contrast, irregular visitors may have difficulty discerning the nudge.

Enhancing the transparency of interventions is one approach to enable a deliberative process. However, it's worth noting that a lack of transparency in nudges does not necessarily obstruct the deliberative process. In addition to instances where individuals

frequently identify the nudge, and choice architects are recommended to disclose this, there are also scenarios where such disclosure is not necessary. This is clear for purely descriptive nudges which automatically point to the presence of the intervention, for example, simple labels indicating "organic" or "local" meal quality (Migliavada et al., 2022). Another example is the use of floor arrows to direct customers towards healthier food choices in retail and/or food serving settings (Allan & Powell, 2020; Bauer et al., 2021; Chapman et al., 2019). The awareness of the nudge requires some level of processing the intervention; otherwise, the intervention cannot be effective or suspected of working in the dark. In such cases, additional transparency messages seem unnecessary. This becomes even more evident for self-nudges (van Rookhuijzen et al., 2023) or the provision of commitment tools (Jia et al., 2022; Panzone et al., 2024; Samek, 2019), where cognitive reflection on the choice is inevitable, and consumers actively modify the choice architecture according to their preferences. Further transparency is not deemed necessary.

**Non-transparency of alternatives.**

In decision-making processes, ensuring transparency regarding alternatives is paramount. A significant concern arises when alternatives become invisible. This poses a threat to consumer autonomy by reducing the choice set that is actually considered and limiting the ability to make informed choices. A nudge designed to change the visibility of alternatives acts upon transparency of options, though without necessarily making options invisible. In most cases, the nudge intends to increase the visibility of nudged options but accidentally influences the prominence of alternatives. The extent of this influence varies widely, ranging from subtle interventions like positioning meat alternatives alongside meat products in supermarkets, to harmonize the chance of finding such products (Vandenbroele et al., 2021), to more intrusive ones where consumer awareness of alternatives is severely limited, suggesting that freedom to choose only exists in the abstract. A deliberative decision-making process necessitates, at the very least, a reasonable opportunity to notice the presence of alternatives. This requirement becomes particularly concerning when choice architects actively conceal alternatives to impede deliberation, such as hiding sugary beverages at the bottom of coolers behind a frosted film on the glass front (Mikkelsen et al., 2021). In this case, the use of frosted film presents an intentional barrier to the deliberation process. A modified version of this study, which merely repositions sugary drinks to the bottom of coolers, might be viewed more favorably because it merely re-organizes products based on available space. The latter constitutes a forced choice architectural decision that must prioritize products.

Achieving complete parity in product presentation is often impractical or impossible. Numerous studies (e.g., Meeusen et al., 2023; Young et al., 2020) explore repositioning nudges that simply change the positioning of nudged and non-nudged options to alter

visibility, without making options invisible. It is crucial to understand that the status quo should not serve as the benchmark for evaluating visibility in a particular context; rather, the focus should be on how difficult it becomes to notice an option. Additionally, there may also exist methods to purposefully decrease the visibility of alternatives without unduly limiting consumers' ability to consider them. For instance, implementing a nudge on an online ordering platform could involve adding a partially opaque white layer over the images and product information of unhealthy products (Michels et al., 2023).

Several researchers have noticed the autonomy issue that arises when alternatives become challenging to consider due to their lack of visibility. To address this, researchers have devised a workaround by still reducing the visibility of alternatives while actively referencing them to increase the likelihood that consumers are aware of the possibility to opt out (Campbell-Arvai et al., 2014; Erhard et al., 2023; Gravert & Kurz, 2021). For instance, this approach might involve presenting a default plant-based meal with an option to opt out to a meat meal with a simple click (Erhard et al., 2023). This setup aims to enable a reflective choice process, allowing consumers to evaluate the nudged option first while being explicitly informed of alternative choices, typically with minimal effort required in switching. Therefore, such prompts can serve as a choice architectural tool to enhance autonomy and possibly preserve effectiveness. It's worth noting a nuance in this approach. Choice architects can choose to explicitly name alternatives or simply prompt their existence. For example, Gravert and Kurz (2021) redesigned an "a la carte" menu to offer a choice between a vegetarian and fish dish versus a meat and fish dish, informing patrons that they could request meat without providing a further description of the dish. While providing more information is generally beneficial from an autonomy perspective, the cognitive deliberation process may have its limits in real-world settings.

Another interesting nudge approach that may maintain autonomy yet initially hides alternatives requires that options be made unavailable or not visible during the initial phase of making a future or delayed selection. All choices are then revealed upon a second evaluation at the time of the final decision (Schlegel et al., 2021). While this commitment nudge aims to engage consumers in a more thorough decision-making process, empirical evidence may find most consumers do not reassess their options, leading them to perceive a more restricted choice set mistakenly.

## 6.4  Discussion

In this paper, we delve into a crucial topic: autonomy preservation in nudging strategies. Namely, drawing upon insights from existing literature, we have constructed a typology for evaluating and categorizing the diverse mechanisms that underlie the intrusiveness of nudges in the context of food choices. In devising these three mechanisms—effort to opt out, affective influence, and non-transparency—and relative sub-dimensions, we lay the foundation for a more sophisticated comprehension of how nudges can affect an

individual's ability to make independent and deliberate choices. Here, we discuss how each mechanism has previously been touched upon by other researchers and how to move forward with the typology, including summarizing possible criteria from the results that can be used by choice architects to evaluate nudge intrusiveness along the identified mechanisms (see Table 6-2).

**Table 6-2.** Proposed Measurement Criteria for Each Intrusiveness Mechanisms

| Mechanism | Sub-dimension | Intrusiveness criteria |
|---|---|---|
| | | Potential evaluative criteria of nudge intrusiveness |
| Effort to opt out | Economic resources | • Search time<br>• Transaction time (e.g., form filling, making a call, walking or traveling a distance)<br>• Use of nudge 'stacking'<br>• Monetary and material costs of opting out (e.g. missing out on material rewards or gifts) |
| | Physical resources | • A demand on fitness (standing up, walking, reaching) |
| Affective influence | Social norm | • Non-privacy, degree of discreteness |
| | Emotional appeals | • Negative emotional cues that drive decision making (fear, anger, sadness, shame, guilt, envy, disgust, contempt) |
| Non-Transparency | Non-Transparency of intervention | • Lack of direct or indirect disclosure of the presence and/or purpose of the nudge (e.g. indirect hints via posters on topic of intervention)<br>• Singularity of decision |
| | Non-Transparency of alternatives | • Non-visibility of alternative options or prompts<br>• Non-existence of prompts to alternatives |

**Effort to opt out**: The first criterion that choice architects and other relevant stakeholders should consider in evaluating the intrusiveness of a nudge is whether, and to what extent, a degree of effort is required to opt out. In terms of *economic resources*, this could refer to elements of time, such as search time needed to identify an alternative option, or transaction time needed to execute the decision against a nudged option, such as by filling out a form or making a call. Depending on the size, the use of monetary aspects, such as foregone material gifts or rewards for those who opt out, and the extent to which these might be valued by those to be nudged, should also be considered as a potentially autonomy-threatening dimension. In terms of *physical resources* required to opt out, this involves a demand on fitness of some sort, such as standing up, walking, or reaching.

In contrast to the studies reviewed, where opting out required significant effort, it's often observed in practice that the collective effort to opt out of individual nudges—termed "nudge stacking"—is more prevalent. Nudge stacking has been identified as objectionable to the paternalism libertarian framework in that multiple nudges can sum up to a "shove" (Coons & Weber, 2013). In addition to the time and effort to opt out, nudge stacking also relates to non-transparency insofar as layered nudges make it more difficult for even watchful decision-makers to identify the mechanism behind nudges and therefore easier for choice architects to hide nudges (Ivankovic & Engelen, 2019). The prevalence of nudge stacking in the marketplace is one reason why market nudges have been identified as particularly autonomy-threatening (Ivankovic & Engelen, 2019). This has particular relevance in online environments. Consider frequently employed "dark pattern" nudges in which multiple buttons that should be clicked in order to proceed as desired are in bigger font, centered, and/or boldly colored to draw attention, while alternatives are tucked away in small corners of the screen (Reisch, 2020).

**Affective influence**: Another crucial aspect for evaluating the intrusiveness of nudges is their affective influence, encompassing *social norms* and *emotional appeals*. *Social norms* may leverage social pressures and normative expectations. Negative social norm messages meant to discourage behaviors can have a somewhat stronger impact on affect compared to positive messages designed to encourage behavior. This is primarily attributed to the well-documented "negativity bias," where humans tend to pay heightened attention to, learn from, and consider negative information during decision-making (Rozin & Royzman, 2001; Vaish et al., 2008). Nonetheless, such negative normative cues need not necessarily pose a threat to autonomy. Substantial social pressure limiting deliberation can primarily be anticipated in settings where decisions are made publicly and are subject to controversy.

*Emotional appeals* tap into negative emotional cues such as fear, anger, sadness, shame, guilt, envy, disgust, and contempt, driving decision-making processes. Relatedly, emotional responses to negative stimuli tend to be stronger than those to positive stimuli (Vaish et al., 2008). This heightened emotional reactivity, particularly under stress, can potentially impede an individual's ability to process information rationally. It's important to emphasize that, in response to text-based warning messages, which can sometimes be found on ultra-processed foods, any potential impact on agency remains relatively manageable, as most individuals can still engage in a deliberation process when reflecting on a written message. However, the emotional processing of graphics (consider cigarette packaging in many countries) can be involuntary, so that agency is reduced for better or worse. Not yet considered are stimuli that trigger positive emotions. Positive emotional stimuli have been found to be associated with an increased sense of agency (Kaiser et al., 2021) and improved decision-making processes (Tran et al., 2012). Skillful use of these stimuli presents a promising opportunity to implement effective nudging interventions that preserve autonomy.

**Non-transparency:** A significant criticism of nudges involves their potential to manipulate biases and influence behavior without individuals' awareness. Transparency has thus become crucial for preserving consumer autonomy. For *non-transparency of intervention,* we consider the lack of direct or indirect disclosure regarding the presence and purpose of the nudge. This includes instances where nudges are subtly hinted at, such as through posters on the topic of intervention. The singularity of decision refers to the frequency of exposure to both the choice and the choice architecture. Interventions targeting frequent patrons are more likely to be noticed as changes, providing a safeguard against misleading nudges, whereas irregular visitors may struggle to discern the nudge (Lemken, 2021a). Finally*, non-transparency of alternatives* entails assessing the visibility of alternative options or prompts, as well as the absence of prompts directing individuals to consider alternative choices.

Providing a transparency statement transforms an intervention into a "double nudge," potentially amplifying its impact on behavior and individual agency. This is crucial for nudges that sidestep traditional decision-making processes (Michaelsen, 2024; Wachner et al., 2021). Yet, many nudges in this review, such as messaging nudges and self-nudging strategies, clearly do not bypass decision-making processes. For other nudges, adopting a precautionary approach, the inclusion of a disclosure statement seems helpful, with initial studies showing that it does not compromise effectiveness while boosting agency (Bruns et al., 2018; Cheung et al., 2019; Dranseika & Piasecki, 2020), identifying a potential sweet spot for autonomy enhancement. However, the applicability of this approach across different settings and how well such nudges target specific audiences still warrants investigation.

Decision-making is often characterized by bounded rationality, suggesting that decisions, especially in the food domain (Wansink & Sobal, 2007), are not always based on rational thinking, even without the influence of nudges. Nudges can encourage more thoughtful consideration of options without requiring explicit transparency. Nonetheless, incorporating a transparency message for decisions that occur less frequently is recommended to safeguard autonomy. In certain scenarios, where more intricate reflection is achievable, ethical nudging becomes particularly pertinent, aligning with behavioral public policy's goal of enhancing citizen autonomy (Banerjee, Grüne-Yanoff, et al., 2023). For example, the "nudge+" initiative aims to bolster citizen empowerment by promoting critical analysis and transparent assessment of nudges in advance (Banerjee, Galizzi, et al., 2023b; Banerjee, Grüne-Yanoff, et al., 2023). This approach facilitates individuals in maintaining decision-making autonomy, marking a progression towards more ethical nudging practices where feasible.

The risk of overlooking alternatives was acknowledged before. Lades and Delaney (2022) explain how default settings, which dictate the outcome if individuals take no action, could cause busy and rationally limited individuals to perceive that they lack choice.

Consequently, the freedom of choice for these individuals is diminished when they are unaware of the available options (Lades & Delaney, 2022). In general, this design feature was widely overlooked in ethical nudge assessments despite the substantial autonomy risks of the invisibility of alternatives, while a number of empirical studies in the review have reported on efforts to make individuals aware of alternatives to the nudged option. For autonomy-enhancing nudges, we recommend to not purposefully lower the visibility of alternatives or apply explicit prompts to alternatives in case the intervention may have reduced the visibility of non-nudged options (see Table 6-2).

*Limitations:* This review focuses exclusively on food choice nudges, which may limit the generalizability of the findings to other domains such as health, finance, or environmental behaviors. Additionally, nudges and their impact on behavior can change over time as individuals become more aware of them. This study does not account for the dynamic nature of nudges and how repeated exposure might alter their effectiveness and intrusiveness, nor does it consider other dimensions that are important to an ethical evaluation of nudging such as fairness, consent, and the potential for manipulation. The emphasis on autonomy may overlook other critical factors that influence the acceptance and effectiveness of nudges, such as cultural values, social norms, and individual differences in decision-making processes. A more holistic ethical analysis is necessary to fully understand the implications of nudge strategies. Finally, this study is limited in its ability to assess autonomy threats of nudging in the case of nudges that are used as part of broader policy mixes and integrated with other policy tools (Holz et al., 2023; Merkelbach et al., 2021).

*Policy implications:* The developed typology of nudge intrusiveness provides a framework for choice architects and policymakers to design and evaluate nudges that respect individual autonomy. This framework can guide the creation of interventions that are less intrusive while still promoting desired behaviors, potentially increasing public acceptance and the ethical validity of nudging practices. By highlighting the mechanisms through which nudges can undermine autonomy—such as effort to opt out, affective influence, and non-transparency—this study informs policymakers about key ethical considerations necessary when implementing nudge strategies. It underscores the importance of maintaining transparency and providing easy opt-out options to uphold consumer autonomy, ensuring that nudge strategies can be both effective and ethically sound.

*Future directions:* There remain open ethical questions for nudging. For instance, the deliberative nature of increasing transparency (of an intervention or alternatives) often translates to increased cognitive effort. In principle, furnishing consumers with more information neither constrains freedom of choice nor diminishes personal agency. For instance, the inclusion of nutritional labels, nudge disclosures, or details on alternatives serve an informative purpose. As such, we argue that cognitive effort aimed at prompting

deliberation enhances autonomy by enabling informed decision-making. However, there is a level of information which risks overwhelming the deliberation process, but additional cognitive effort does not automatically translate into an autonomy risk. This boundary condition and the cognitive effort required to resist nudging attempts might be considered a threat under other ethical frameworks. In line with this, we question the overuse of disclosures to alert decision-makers to the presence and purpose of nudges to be burdensome or even autonomy-threatening (think nudge stacking). This is an area for future research on the kind of context that demands and allows for disclosures. Relatedly, there is a link between individuals' awareness of their own limited cognitive capabilities and willingness to outsource regulatory mechanisms to governments (Grelle & Hofmann, 2024; Kukowski et al., 2023). This is an interesting area to explore with regard to cognitive effort and nudge acceptance.

Future studies could also explore complementing the use of this typology by assessing decision-maker's opinions on nudge elements. Rather than solely inquiring about their sense of freedom to choose, as in the traditional perceived intrusiveness approach, more focused questions based on the typology presented here can be devised. For instance, gauging perceived social pressure from peers may shed light on the autonomy in decision-making regarding affective influence. While this approach remains subjective and potentially contentious, employing more targeted questions minimizes the likelihood of conflating ethical concerns unrelated to autonomy, such as opinions on the nudge's objectives and similar matters. Additionally, this approach ensures that patrons are confronted with a cognitive concept commonly understood, while the freedom to choose and consumer autonomy remains a topic not widely comprehended even among researchers.

*In conclusion:* Offering a more nuanced understanding of the factors influencing nudge intrusiveness, our paper adds a valuable perspective to the ongoing discourse surrounding the legitimacy and feasibility of employing nudge strategies. As behavioral interventions continue to exert a significant influence on public behavior, our typology serves as a valuable resource for encouraging critical thinking and responsible decision-making among choice architects. Ultimately, the insights presented herein can serve as a compass for a more ethical use of nudges, ensuring that these interventions align with societal values and uphold individual autonomy. Autonomy-preserving nudges will find it easier to gather widespread support in public policy and with private actors, although they should not be misunderstood as a necessarily sufficient solution to an underlying problem. Depending on the success of lowly intrusive policy measures, a restriction of autonomy can be demanded to improve the functioning of markets or mitigate environmental issues. While nudges may alter decision-making environments, they should be assessed against alternatives like subsidies or taxes, which also influence free choice (Lades & Delaney, 2022; Mukerji & Mannino, 2023). Nevertheless, redesigning

nudges to lowly intrusive policy instruments could be the smallest common denominator to initiate behavioral change.

# 7   General Discussion

The transition towards plant-based diets represents a critical pathway for addressing the complex challenges of sustainable development, public health, and animal welfare. This shift necessitates a holistic approach that integrates advancements in food technology, effective consumer engagement strategies, and supportive public policies. The growing interest in plant-based meat alternatives (PBMAs), in particular those that closely resemble meat, underscores the potential for these products to facilitate dietary change without fundamentally disrupting sociocultural norms around diets and meals, at least in the short run (de Boer & Aiking, 2019; Douglas, 1975). These products can be especially convenient for those who lack the culinary skills to prepare plant-based meals or knowledge of recipes that do not center around meat (Siegrist et al., 2024). However, to sustain and accelerate this momentum, it is imperative to address barriers to acceptance by improving how consumers perceive the personal and societal benefits, normalcy, and affordability of PBMAs.

This research underscores the role of nudges in encouraging plant-based food choices, demonstrating that strategically positioning plant-based options as the easier, normal, and better choice can significantly influence consumer perception and behavior (Ammann et al., 2023; Attwood, Voorheis, et al., 2020; Meier et al., 2022). This can be achieved through structural changes in food environments, such as setting plant-based defaults (Meier et al., 2022; Reisch & Sunstein, 2021), as well as through framed communication strategies in product labeling and advertising (e.g., Gavrieli et al., 2022; Krpan & Houtsma, 2020; Papies et al., 2023; Ye & Mattila, 2021). In this dissertation, default frames that positioned plant-based alternatives as the superior choice over meat, coupled with physical pre-selection, had an impact on consumer choice. It is speculated that the frame signals the reason for the change in the status quo, helping consumers understand why the default has shifted away from meat. This synergy between interventions aligns with previous research and may enhance consumer autonomy by encouraging more reflective decision-making patterns than structural defaults alone (Lemken, 2021a).

While PBMAs offer many benefits over conventional meat products, choosing which benefit to champion in public campaigns and advertizing remains a question. One strategy is to consider how PBMAs are positioned in the context of meals (de Boer & Aiking, 2019; Possidónio et al., 2021) and situations (Elzerman et al., 2013, 2021; Michel et al., 2021; Motoki et al., 2022) which trigger differing eating goals. For example, taste-oriented frames may be more effective in hamburger joints, where enjoyment and indulgence are the primary goals, while sustainability- or health-focused frames might

resonate better in health-conscious or environmentally aware contexts.  This research finds that such an approach can reduce potential conflicts between eating goals, such as taste and sustainability/health  (Raghunathan et al., 2006; Schuldt & Hannahan, 2013), thereby resonating more effectively with consumers.

Beyond nudging, this research highlights the power of competitive pricing in driving consumer behavior. By making PBMAs more financially attractive than traditional meat products, consumers can be incentivized to make more sustainable choices. Importantly, these findings emphasize that affordability, beyond just achieving price parity, is crucial in catalyzing the shift towards plant-based diets. Currently, PBMAs have a 20% price premium over beef and a 77% price premium over meat products in general (Good Food Institute, 2024). However, it is anticipated that as economies of scale are reached, production costs will decrease, equalizing the cost of PBMAs with that of meat (Chafin & Larson, 2022). While this transition may take some time, the lower production and processing costs of plant proteins could eventually result in prices that are not just equal to but lower than those of meat (Rubio et al., 2020). Improving the relative cost of PBMAs could be further promoted by governments that enact policies that price meat to reflect the external costs of production.

In exploring these strategies, it is also crucial to address the ethical considerations associated with nudging. While nudging can be an effective way to influence consumer behavior, it raises questions about consumer autonomy, particularly in the personal realm of food choice. Food nudges can have far-reaching implications for human health and environmental sustainability, but food is also a significant emotional, cultural, and moral aspect of our lives. Therefore, nudging food choices can be particularly sensitive and potentially perceived as more intrusive than nudges in other behavioral domains (Sunstein et al., 2019). Moreover, food choice nudges address daily routine decisions that are often made intuitively and instinctively (i.e., according to "System 1" thinking), making them capable of significantly impacting individuals' daily lives and habits (Wansink & Sobal, 2007). In this context, it is vital to understand how nudges impact our autonomy to avoid undue infringement on basic human needs.

## 7.1  Theoretical Implications

By integrating psychological insights, consumer behavior, and policy preferences, this work explores how subtle behavior-change mechanisms operate within different decision-making contexts. Moreover, this dissertation contributes to the growing body of research on promoting plant-based eating by advancing our understanding of where behavioral nudges are most effective and where their influence may be limited.

One of the central contributions of this research is the demonstration that default nudges leverage cognitive biases, such as the endowment effect, through reference dependence during memory retrieval and preference formation, to make plant-based options more

attractive (Dinner et al., 2011; Johnson et al., 2007). This aligns with existing theories on the mechanisms driving default effects (Dinner et al., 2011; Jachimowicz et al., 2019) and extends them by showing that the sense of "instant" ownership created by endowment plays a significant role in online food settings. However, contrary to theoretical expectations, the study found that endorsement from the food provider—typically a reinforcing factor in nudging (Jachimowicz et al., 2019; Sunstein, 2017)—negatively impacted consumer choices. This is likely because defaults risk being perceived as coercive and can trigger reactance (Brehm, 1966), especially when consumers are skeptical of private business motives (Brown & Krishna, 2004).

This research also contributes to the goal-congruency literature by providing new insights into how framing can enhance the effectiveness of nudges, particularly in the context of promoting PBMAs. It challenges the conventional wisdom that emphasizing virtue attributes—a common industry practice evidenced e.g., by the prevalence of health claims on most meat analogs (Lacy-Nichols et al., 2021)—is always the most effective way to market PBMAs. While framing PBMAs as healthy or sustainable can often increase their appeal (as seen in the success of the framed defaults in Article 1), this strategy is not universally effective. Once more, combining such frames can be ineffective (Reinholdsson et al., 2023) or backfire (Belei et al., 2012). Our findings show that the success of framing depends on how well it aligns with consumers' eating goals and the specific context of the decision. For example, when consumers are in a hedonic mindset, emphasizing sustainability can reduce expectations around taste, reinforcing the perceived trade-off between healthiness and sensory pleasure (Raghunathan et al., 2006). This underscores the importance of goal-congruent framing, where the message resonates with the consumer's immediate motivations, rather than relying on a one-size-fits-all approach.

While nudging can effectively shape everyday food choices, this research corroborates the literature on the theoretical limits of small behavioral interventions in contexts where individuals hold stable, rationalized beliefs (Sunstein, 2017; Venema et al., 2019), such as policy decisions. In the case of public support for a meat tax, subtle nudges like framing and reflective prompts had minimal impact. This underscores a key theoretical implication: nudges are most effective in automatic decision contexts, and their influence diminishes when faced with deeply entrenched incongruent preferences (Sunstein, 2017). Importantly, the welfare-preserving nature of nudges allows individuals to opt out when they have strong preferences, preserving autonomy while still encouraging behavior change. This aligns with the fundamental purpose of nudges: to gently steer decisions while leaving room for people to act on their existing preferences (Thaler & Sunstein, 2008).

## 7.2  Marketing Implications

Marketers can redefine the default choice on menus and in online ordering platforms to feature plant-based options more prominently and frame them as the better choice, while still offering meat choices. This subtle shift can significantly influence consumer decisions without triggering reactance, as it maintains the availability of meat options. As more consumers shop for groceries online, this will become an increasingly relevant space for behavioral intervention (Ahuja et al., 2021). For-profit marketplace nudges have been criticized for threatening autonomy because they are not constrained by government regulations and tend to be "stacked"—applied in abundance—making them particularly difficult to avoid (Ivankovic & Engelen, 2019). Taking heed of this, the opt-out process should not be too cumbersome and should be readily evident to preserve consumer autonomy and avoid a sense of forced choice. Additionally, messaging on why the default was implemented can enhance transparency and involve consumers in the sustainable choice (Lemken, 2021a).

Effective marketing requires understanding and leveraging the context in which consumers make food choices. Blanket campaigns that advertise PBMAs solely based on their sustainability, health, or taste qualities may not be effective, nor will the concept of "hedonic utilitarianism"—promoting both health and taste aspects of PBMAs simultaneously (Gelles, 2021)—likely achieve the desired impact. These strategies are liable to elicit conflicting goals amongst consumers who hold the implicit belief that healthy and sustainable food cannot also be tasty (Raghunathan et al., 2006; Schuldt & Hannahan, 2013). Therefore, marketers should consider the consumer's current mindset (e.g., health-conscious versus pleasure-seeking) when promoting PBMAs to enhance their appeal. For example, in fast-food settings, emphasizing taste and indulgence can be more appealing, while in health-food stores, highlighting nutritional benefits can better align with consumer expectations. This means labeling products with sensory descriptors like "delicious" or "crunchy" in contexts where indulgence is key, and health descriptors like "protein-rich" or "low in saturated fat" in settings where health is the focus. Future research should investigate how these frames interact with emerging novel protein alternatives, such as cultured meat, hybrid animal and plant-based foods, and 3-D printed proteins, as preconceptions about nutrition and naturalness will differ.

## 7.3  Policy Implications

For policy measures to be successfully implemented, they must be socially acceptable. Soft interventions, such as education, product labeling, and nudging, tend to be more socially acceptable but often have limits to their impact on changing dietary behaviors (Ammann et al., 2023; Hagmann et al., 2018; Vellinga et al., 2022). However, the smart design of these interventions and collective action, when coordinated effectively, can cumulatively and significantly increase their effectiveness. Policymakers should invest in

research and experimentation to develop more effective soft interventions, such as those created by behavioral Nudge Units in countries like the U.K., Netherlands, and Germany. Incorporating aspects of planetary health into national dietary guidelines could also raise consumer awareness and help make plant-based diets the norm (Klapp et al., 2022). Educational campaigns should focus on dispelling myths about PBMAs (e.g., that they cannot be tasty) and providing practical guidance on incorporating not just processed PBMAs, but also whole-food protein alternatives into everyday meals. Campaigns like Veganuary and Meatless Monday can work to normalize sustainable diets, making them more appealing and accessible to a broader audience.

As plant-based diets become normalized, it will become increasingly politically feasible to enact more robust policies to support the protein transition. Economies of scale are expected to reduce the production costs of PBMAs, eventually leading to the same or lower prices as meat products (Chafin & Larson, 2022). Policymakers can further support this transition by reducing existing subsidies for meat production and, where possible, implementing politically acceptable taxation strategies on high-emitting meat production methods or consumer products. Revenues from a meat tax can be used to subsidize plant-based foods, as revenue recycling generally improves meat tax acceptance and will provide further financial incentives to opt for plant-based options (Fesenfeld et al., 2020; Maestre-Andrés et al., 2021). In the long term, this approach should make PBMAs more affordable and attractive to consumers, encouraging a shift towards sustainable diets.

Lastly, ethical concerns about autonomy and consumer choice must be addressed when implementing food policy interventions. The developed framework around nudge intrusiveness systematically and critically analyzes how nudges may hinder individual autonomy. This enables choice architects, policymakers, and other relevant stakeholders to better identify nudge interventions that balance respect for individual autonomy with effectiveness. Alternatively, it helps them recognize the limits of nudging principles and argue for more intrusive policy measures where necessary.

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# 8  Appendices

## Appendix A: Article 1

**Figure A1** Meat Default Stimuli



**Figure A2** Plant-Based Default Stimuli

**Figure A3** Plant-Based Default + Sustainability Frame Stimuli
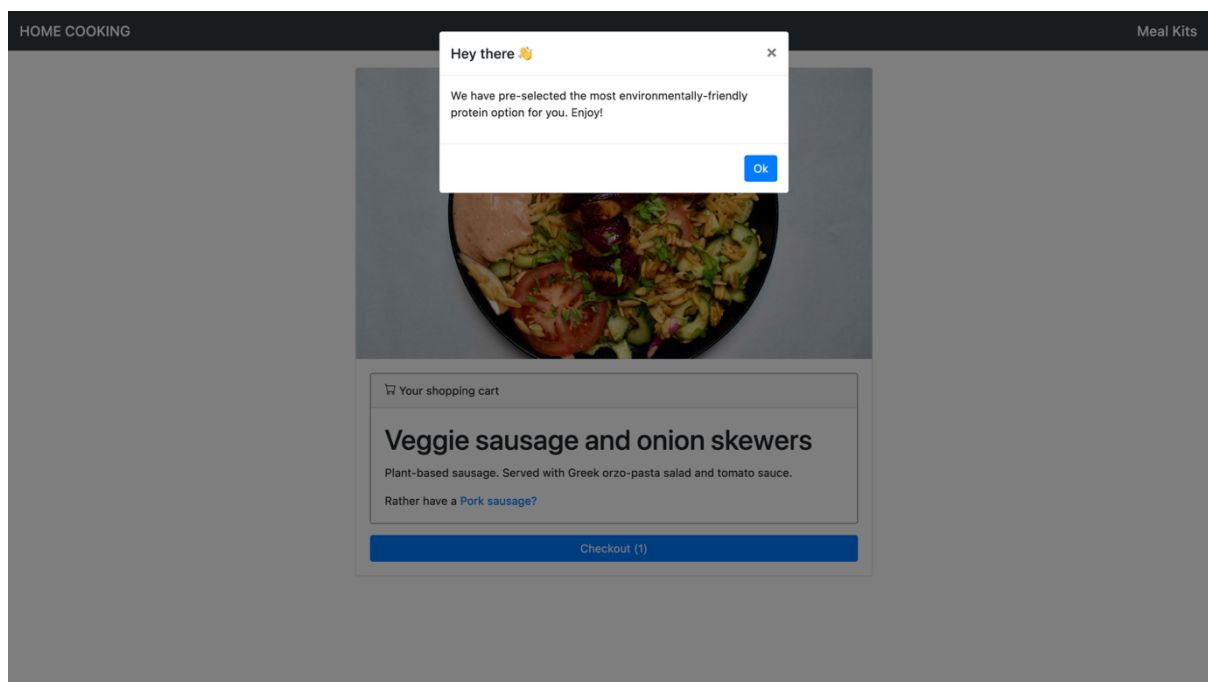


**Figure A4** Plant-Based Default + Taste Frame Stimuli
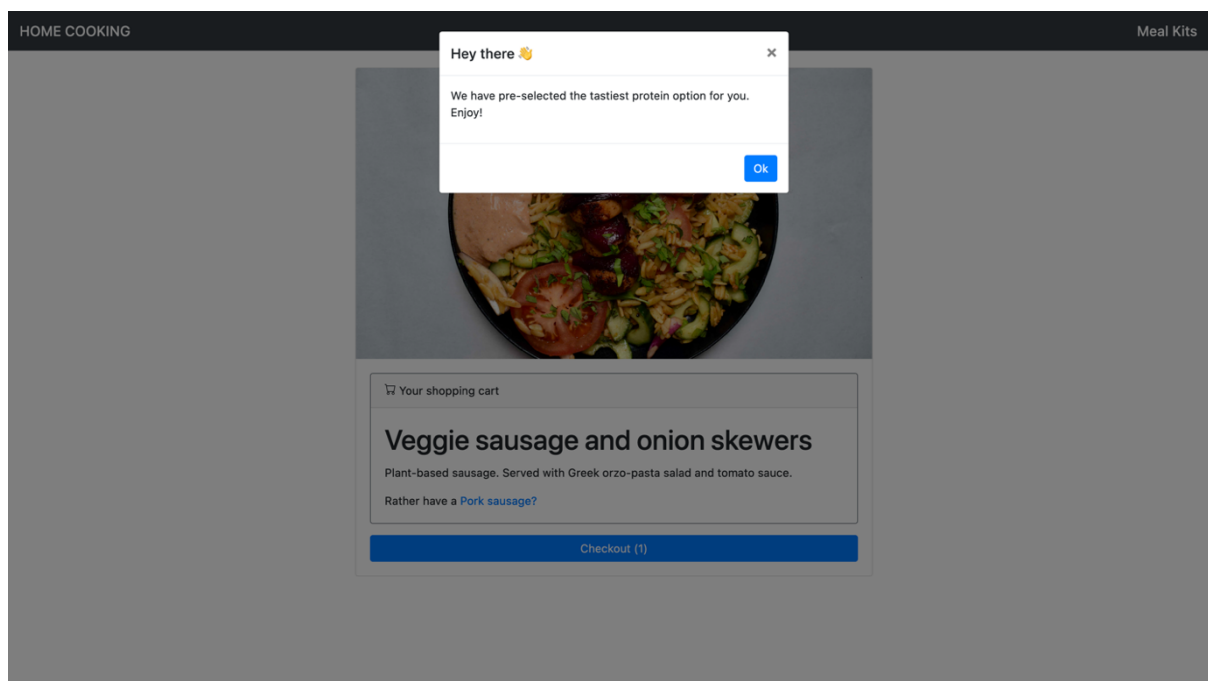


*Note.* Figures A1-A4 were originally in another language and have been translated.

**Appendix B: Article 2**

**B1 Goal Activation Prompts**

a.  Hedonic goal activation

Please write at least two sentences indicating why it is personally important for you to

enjoy life and take pleasure in what you eat.

b.  Health goal activation

Please write at least two sentences indicating why it is personally important for you to

be healthy and maintain a balanced healthy diet.

c.  Sustainability goal activation

Please write at least two sentences indicating why it is personally important for you to

be sustainable and make environmentally conscious food choices.

d.  Control goal activation

Please write at least two sentences indicating how you primarily commute throughout

your town. You could describe your route to work or a location you regularly visit.

**B2 Stimuli**

**Figure B2.1** Veggie Nuggets with Hedonic Frame



**Figure B2.2** Veggie Nuggets with Health Frame



**Figure B2.3** Veggie Nuggets with Sustainability Frame

**Table B1** Mediation Analysis Results Without Covariates

| | Indirect effect via expected taste | | | | Indirect effect via expected health | | | | Indirect effect via expected sustainability | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | EST | SE | CI lower | CI upper | EST | SE | CI lower | CI upper | EST | SE | CI lower | CI upper |
| **Hedonic goal** | | | | | | | | | | | | |
| Health Frame | **-0.950** | **0.366** | **-1.669** | **-0.244** | -0.037 | 0.050 | -0.152 | 0.048 | -0.031 | 0.035 | -0.116 | 0.025 |
| Sust. Frame | **-0.945** | **0.415** | **-1.759** | **-0.126** | -0.015 | 0.052 | -0.130 | 0.084 | -0.005 | 0.038 | -0.085 | 0.074 |
| **Health Goal** | | | | | | | | | | | | |
| Health Frame | 0.032 | 0.409 | -0.767 | 0.836 | -0.023 | 0.050 | -0.121 | 0.079 | 0.025 | 0.032 | -0.025 | 0.104 |
| Sust. Frame | -0.139 | 0.400 | -0.907 | 0.662 | -0.006 | 0.052 | -0.114 | 0.096 | -0.004 | 0.034 | -0.072 | 0.071 |
| **Sust. Goal** | | | | | | | | | | | | |
| Health Frame | 0.521 | 0.423 | -0.315 | 1.351 | 0.073 | 0.064 | -0.036 | 0.218 | 0.016 | 0.039 | -0.059 | 0.105 |
| Sust. Frame | 0.448 | 0.421 | -0.378 | 1.263 | 0.044 | 0.061 | -0.070 | 0.180 | 0.044 | 0.043 | -0.027 | 0.144 |
| **Neutral Goal** | | | | | | | | | | | | |
| Health Frame | -0.438 | 0.406 | -1.248 | 0.350 | 0.037 | 0.053 | -0.060 | 0.155 | -0.010 | 0.034 | -0.086 | 0.056 |
| Sust. Frame | 0.472 | 0.371 | -0.267 | 1.190 | -0.001 | 0.047 | -0.101 | 0.094 | 0.018 | 0.034 | -0.042 | 0.096 |

*Notes:* EST = Mediation effect, SE = Bootstrapped standard error, the CIs are the bootstrapped 95% confidence intervals. For the independent variable, hedonic frame was coded as the reference level. Significance is indicated by CIs that do not cover zero; these values are bolded. Model does not include covariates.

**Appendix C: Article 3**

**C1 Reflection Prompt**

Last year, tax/levy was proposed by the Dutch parliament. This would affect the price of meat for everyone. Currently, some political parties are against this proposal (e.g. Boer Burger Beweging) while others are in favor (e.g. Groen Links). Think about the pros and cons of this policy proposal and tell us your honest opinion in a few lines.

**Table C1** Tax rate by type of meat (€/kg meat)

|  | 10% of hidden costs | 40% of hidden costs | 70% of hidden costs | 100% of hidden costs |
|---|---|---|---|---|
| Beef | € 0.52 | € 2.08 | € 3.64 | € 5.20 |
| Pork | € 0.41 | € 1.64 | € 2.87 | € 4.10 |
| Chicken | € 0.18 | € 0.72 | € 1.26 | € 1.80 |

*Note.* Calculations taken from CE Delft, 2020. Calculations reflect the environmental costs of greenhouse gas emissions causing climate change, other emissions causing environmental pollution, land use-related impacts on biodiversity, and livestock diseases.

**C2 Introductory Survey Text to Attributes and Levels**

**Cost:** The product price could include the hidden costs of meat production to different degrees (such as its environmental harms). The lowest tax/levy rate accounts for 10% of the hidden costs of meat, while the highest tax/levy rate accounts for 100%. Depending on the rate, chicken, pork, and beef could increase in price by varying amounts.

**Revenue uses:** The tax/levy revenues could be used to subsidize the cost of fruits, vegetables, and legumes, to compensate low-income families, or left unallocated for any specific goal.

**Policy reach:** The tax/levy could be implemented EU wide or only in the Netherlands.

**Motivation:** The tax/levy could benefit your personal and public health, animals, or the environment.

**Figure C1** Example Choice Task from Survey

| | Policy Scenario 1 | Policy Scenario 2 |
|---|---|---|
| **Cost** | 10% of hidden costs  | 100% of hidden costs  |
| **Policy reach** | Policy is implemented EU wide | Policy is implemented EU wide |
| **Revenue uses** | Revenues are used to subsidize fruits, vegetables, and legumes | Revenues are not allocated to a specific goal |
| **Motivation** | To improve personal and public health | To improve animal welfare |

Which one of the two policy scenarios are you more likely to support?

◯ Policy scenario 1

◯ Policy scenario 2

On a scale of 0-10, how likely are you to support policy scenario 1, if it was implemented by the government?

Not at all likely — Extremely likely
0 1 2 3 4 5 6 7 8 9 10
◯ ◯ ◯ ◯ ◯ ◯ ◯ ◯ ◯ ◯ ◯

On a scale of 0-10, how likely are you to support policy scenario 2, if it was implemented by the government?

Not at all likely — Extremely likely
0 1 2 3 4 5 6 7 8 9 10
◯ ◯ ◯ ◯ ◯ ◯ ◯ ◯ ◯ ◯ ◯

**Table C2** Socio-Demographic Information for the Dutch Sample (N = 2,032)

| | **Nudge** Levy + No reflection | **Think** Tax + Reflection | **Nudge+** Levy + Reflection | **Control** Tax + No reflection | Total | *p* |
|---|---|---|---|---|---|---|
| Age, mean (SD) | 51.37 (17.86) | 51.17 (17.49) | 50.28 (17.54) | 51.44 (17.46) | 51.07 (17.58) | 0.95 |
| Gender, n (%) | | | | | | 0.47 |
| Female | 52.75 | 47.98 | 50.60 | 49.24 | 50.22 | |
| Otherwise | 47.25 | 52.02 | 49.40 | 50.76 | 49.78 | |
| Education, n (%) | | | | | | 0.09 |
| Lower professional | 14.90 | 17.00 | 15.48 | 17.18 | 16.14 | |
| Intermediate high or secondary | 49.80 | 40.49 | 47.22 | 42.18 | 44.93 | |
| Bachelor's Degree | 22.94 | 29.35 | 27.18 | 26.72 | 26.53 | |
| Postgraduate Degree | 12.35 | 13.16 | 10.12 | 13.93 | 12.4 | |
| Urbanicity | | | | | | 0.90 |
| Rural | 3.33 | 4.66 | 2.78 | 3.82 | 3.64 | |
| Village | 19.80 | 17.41 | 18.25 | 18.89 | 18.6 | |
| Small Town | 18.82 | 18.62 | 18.65 | 16.41 | 18.11 | |
| City | 32.94 | 32.39 | 33.13 | 35.69 | 33.56 | |
| Big City | 25.10 | 26.92 | 27.18 | 25.19 | 26.08 | |
| Income | | | | | | 0.79 |
| Less than 19.999 Euro | 12.17 | 10.07 | 8.33 | 10.00 | 10.13 | |
| 20,000 - 25,999 Euro per year | 14.84 | 13.67 | 12.14 | 14.32 | 13.74 | |
| 26,000 - 42,999 Euro per year | 27.25 | 30.70 | 30.95 | 31.82 | 30.21 | |
| 43,000 - 61,999 Euro per year | 24.09 | 23.98 | 24.29 | 24.09 | 24.11 | |
| 62,000 Euro per year or more | 21.65 | 21.58 | 24.29 | 19.77 | 21.8 | |

*Notes*. This table presents balance checks of sample characteristics between four treatment groups. Significance values indicate whether means (continuous variables) or proportions (categorical variables) are significantly different based by bartlett and chi-squared test, respectively.

**Appendix D: Article 4**

This appendix has been removed due to publication restrictions.

For further information, please refer to:

Jahn, S., Guhl, D., and Erhard, A. (in press). Substitution patterns and price response for plant-based meat alternatives. *Proceedings of the National Academy of Sciences*.

# Appendix E: Article 5

## E1. Supplementary File S1

| Study ID | Population description | Target behavior and applied setting | Control/reference description | Nudge description | Physical resources | Economic resources | Social norms | Emotional appeals | (Non-)Transparency of intervention | (Non-)Transparency of alternatives |
|---|---|---|---|---|---|---|---|---|---|---|
| Aldrovandi 2015 | Undergraduate students who previously reported consumption of either coffee or chocolate | Willingness to pay for coffee vs. orange juice AND chocolate vs. apple in hypothetical experiment | Participants not provided with any information prior to decision-making | Participants were told where they believed they ranked among the university student population for coffee (or chocolate) consumption, and what their actual rank position was (e.g., "you are in the most unhealthy 10% of eaters") | 0 | 0 | 1 | 2 | 1 | 0 |
| Allan 2020 | Hospital visitors | Healthy snack purchases in hospital shop | Status quo hospital site | Point of purchase prompt displayed as eye-level sign on shelves that read "If you are trying to eat less, then choose a snack from the left", snack items displayed with calorie content information and ordered from lowest to highest calories | 0 | 0 | 0 | 0 | 0 | 0 |
| Andreani 2023 | University students | Purchase intention of healthy and sustainable dishes in online survey | Dish displayed without a logo | Logo displayed with hypothetical canteen dishes either framing the choice as healthy or sustainable | 0 | 0 | 0 | 0 | 0 | 0 |
| Andreani 2023 | University students | Purchase intention of healthy and sustainable dishes in online survey | Dish displayed without a logo | Logo displayed with hypothetical canteen dishes either framing the choice as the "chef choice" | 0 | 0 | 1 | 1 | 2 | 0 |
| Antunes 2024 | Children | Healthy lunch choices in elementary schools | Status quo schools | Nudge included (1) banner of the daily school meal menu and two superheroes, (2) waterproof tablecloths, (3) posters on healthy eating habits, (4) displays with playful names, (5) prominent and transparent containers for fruits, and (6) colored footprints that led students to the drinking fountain | 0 | 0 | 0 | 0 | 2 | 0 |

| Attwood 2020 | University students | Choice of 'target' (base price) vegetarian dish in hypothetical online restaurant menu | Decoy absent from menu | Higher-priced 'decoy' vegetarian option added to existing items on menus | 0 | 1 | 0 | 0 | 2 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|
| Bacon 2018 | Adults | Choice of vegetarian meal in hypothetical restaurant | Menu with both vegetarian and non-vegetarian dishes, all presented in the same manner | Vegetarian dish on menu enclosed in a box and entitled 'Chef's Recommendation' | 0 | 0 | 1 | 1 | 1 | 0 |
| Bacon 2018 | Adults | Choice of vegetarian meal in hypothetical restaurant | Menu with both vegetarian and non-vegetarian dishes, all presented in the same manner | Vegetarian dish on menu with more appealing description (e.g., "fresh seasonal risotto primavera") | 0 | 0 | 0 | 1 | 1 | 0 |
| Bacon 2018 | Adults | Choice of vegetarian meal in hypothetical restaurant | Menu with both vegetarian and non-vegetarian dishes, all presented in the same manner | Vegetarian dishes on menu placed in a separate section at end of menu | 0 | 0 | 0 | 0 | 2 | 0 |
| Banerjee 2023 | Adults | Choice of sustainable meal in hypothetical restaurant | Regular 'a la carte' menu with 36 items and equal number of vegetarian and non-vegetarian options, with no prompting prior to meal selection | Prompt to explicitly reflect on a green pledge before viewing a default set-menu with only 18 low emission items. An opt-out to free array menu was available on request | 0 | 1 | 1 | 0 | 0 | 1 |
| Banerjee 2023 | Adults | Choice of sustainable meal in hypothetical restaurant | Regular 'a la carte' menu with 36 items and equal number of vegetarian and non-vegetarian options, with no prompting prior to meal selection | A la carte menu with 36 items, traffic light labeling, and an explicit information disclosure about the labeling scheme | 0 | 0 | 0 | 0 | 0 | 0 |
| Banerjee 2023 | Adults | Choice of sustainable meal in hypothetical restaurant | Regular 'a la carte' menu with 36 items and equal number of vegetarian and non-vegetarian options, with no | Default set-menu with only 18 low emission items and an explicit information disclosure about the default menu. An opt-out to free array menu was available on request | 0 | 1 | 1 | 0 | 0 | 1 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | prompting prior to meal selection | | | | | | | |
| Banerjee 2023 | Adults | Choice of sustainable meal in hypothetical restaurant | Regular 'a la carte' menu with 36 items and equal number of vegetarian and non-vegetarian options, with no prompting prior to meal selection | Default set-menu with only 18 low emission items with no information disclosure about the default menu. An opt-out to free array menu was available on request | 0 | 1 | 1 | 0 | 2 | 1 |
| Banerjee 2023 | Adults | Choice of sustainable meal in hypothetical restaurant | Regular 'a la carte' menu with 36 items and equal number of vegetarian and non-vegetarian options, with no prompting prior to meal selection | A la carte' menu with 36 items and traffic light labeling indicating environmental friendliness | 0 | 0 | 0 | 0 | 0 | 0 |
| Banerjee 2023 | Adults | Sustainable meal choices in online menu | Regular menu with 36 items, including 18 vegetarian and 18 non-vegetarian items | Default shorter menu with 18 sustainable food items from regular menu, 12 vegetarian and 6 non-vegetarian, opt-out possible for regular menu. No information disclosure about the default menu | 0 | 1 | 1 | 0 | 2 | 1 |
| Banerjee 2023 | Adults | Sustainable meal choices in online menu | Regular menu with 36 items, including 18 vegetarian and 18 non-vegetarian items | Default shorter menu with 18 sustainable food items from regular menu, 12 vegetarian and 6 non-vegetarian, opt-out possible for regular menu, and an information disclosure about it's concept and purpose | 0 | 1 | 1 | 0 | 0 | 1 |
| Banerjee 2023 | Adults | Sustainable meal choices in online menu | Regular menu with 36 items, including 18 vegetarian and 18 non-vegetarian items | Regular menu with 36 items, which were colour coded using a traffic-lighting scheme, and an information disclosure about it's concept and purpose | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|---|---|
| Banerjee 2023 | Adults | Sustainable meal choices in online menu | Regular menu with 36 items, including 18 vegetarian and 18 non-vegetarian items | Prompt displayed a pledge for an environmentally friendly diet, after making a decision, individuals were provided with default shorter menu with 18 sustainable food items from regular menu, 12 vegetarian and 6 non-vegetarian, opt-out possible for regular menu | 0 | 1 | 1 | 0 | 0 | 1 |
| Banerjee 2023 | Adults | Sustainable meal choices in online menu | Regular menu with 36 items, including 18 vegetarian and 18 non-vegetarian items | Default shorter menu with 18 sustainable food items from regular menu, 12 vegetarian and 6 non-vegetarian, opt-out possible for regular menu. After menu choice, prompt displayed a pledge for an environmentally friendly diet, after which they could re-evaluate their order | 0 | 1 | 1 | 0 | 0 | 1 |
| Baskin 2016 | Google employees | Snack consumption in the workplace | Snack station located near (6'5") to beverage station | Snack station located far (17'6") from the beverage station | 2 | 1 | 0 | 0 | 2 | 0 |
| Bauer 2021 | Trainees, interns - customers at cafeteria | Choice of the 'green line' for lunch at corporate cafeteria | No reminders | Reminding messages to activate different goals related to choosing the Green Line: three pro-self frames (i.e., better health, better price, and better work performance) as well as one pro-social frame (better for the climate). | 0 | 0 | 1 | 1 | 0 | 0 |
| Bauer 2021 | Regular employees, trainees, interns, guests | Choice of the 'green line' for lunch at corporate cafeteria | Normal, unrestricted access to the 'all inclusive' payment terminals | Limiting easy access to the 'Green Line' alternative by reducing the number of 'all inclusive' payment terminals. | 0 | 2 | 0 | 0 | 2 | 0 |
| Bauer 2021 | Regular employees, trainees, interns, guests | Choice of the 'green line' for lunch at corporate cafeteria | No stickers | Increasing salience of the 'Green Line' by sticking guiding green footprints on the floor from cafeteria entrance to 'Green Line' terminal. | 0 | 0 | 0 | 0 | 2 | 0 |

| Study | Population | Objective | Control | Intervention | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Bauer 2022 | Adults | Increase purchases of fruit and vegetables in the supermarket | Store without intervention | Bright colored signs with messaging "most people choose fruit and vegetables" placed in shopping carts, signs with recipe ideas also suggested vegetables to buy in the cart and around the store | 0 | 0 | 1 | 0 | 0 | 0 |
| Benito-Ostolaza 2021 | Children | Healthy snack choice in school | No poster display/visual stimuli | Posters with a happy emoji surrounded by fruits (positive treatment), or posters with a sad emoji surrounded by highly processed and sugary foods (negative treatment) | 0 | 0 | 1 | 2 | 0 | 0 |
| Bergeron 2019 | Adults | Choice of lighter dessert in experimental, self-service restaurant | A default order form provided to patrons with two dessert options, with one option described as 'the dessert of the day' patrons could check an additional box to opt for an alternative version of their dessert of choice, which was listed as 'lighter' in fat and sugar | A default form provided to patrons with two dessert options, with one option described as ,'the dessert of the day,' patrons could check an additional box to opt for an alternative version of their dessert of choice, which was listed as 'richer' in fat and sugar | 0 | 1 | 1 | 1 | 2 | 1 |
| Biswas 2017 | Restaurant patrons | Meal choice in restaurant | Normal lighting conditions | Low lighting condition, Bright lighting condition | 0 | 0 | 0 | 0 | 2 | 0 |
| Biswas 2017 | University students | Choice between 100-calorie Oreos and chocolate covered Oreos (Written) | Nomal lighting | bright (vs. dim) ambient light | 0 | 0 | 0 | 0 | 2 | 0 |
| Biswas 2017 | University students | Choice between 100-calorie Oreos and chocolate covered Oreos (Had to be said out loud) | Normal lighting | bright (vs. dim) ambient light | 0 | 0 | 0 | 0 | 2 | 0 |
| Bleasdale 2021 | Patrons of food trucks | Sales of healthy vs. unhealthy items at food trucks | No sample | Provision of samples of healthy food items and point-of-purchase prompting (promotional signage; verbal cues) | 0 | 0 | 0 | 1 | 0 | 0 |
| Blom 2021 | University science festival attendees | Healthy alternatives in a virtual reality supermarket | Status quo grocery setting | Healthy grocery items enclosed in an orange frame | 0 | 0 | 0 | 0 | 2 | 0 |

| Study | Population | Choice context | Control | Intervention | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Boronowsky 2022 | University students | Plant-based meal choice in university catered event | Default meat online RSVP form, opt out to plant-based meal possible with the click of a button | Default plant-based online RSVP form, opt out to meat meal possible with the click of a button | 0 | 1 | 1 | 0 | 2 | 1 |
| Buratto 2024 | Adults | Choice of plant-based meals in restaurant | Status quo menu with V (vegetarian) and PB (plant-based) symbols at baseline period | Menu with V (vegetarian) and PB (plant-based) symbols removed | 0 | 0 | 0 | 0 | 2 | 0 |
| Buratto 2024 | Adults | Choice of plant-based meals in restaurant | Status quo menu with V (vegetarian) and PB (plant-based) symbols at baseline period | Menu with LE (low emissions) symbol added to vegetarian/plant-based dishes | 0 | 0 | 0 | 0 | 0 | 0 |
| Buratto 2024 | Adults | Choice of plant-based meals in restaurant | Status quo menu with V (vegetarian) and PB (plant-based) symbols at baseline period | Menu with LE (low emissions) symbol added to vegetarian/plant-based dishes with a disclosure statement "A selection of dishes we would like you not only to taste for the amazing flavour but also for the environment,' | 0 | 0 | 1 | 1 | 0 | 0 |
| Byrd 2018 | US adult consumers | Meal choice in an online menu | Menu with no nutrition information | Participants were randomly assigned to view menus that displayed either (1) calorie information, or (2) calories and sodium (numeric) info | 0 | 0 | 0 | 0 | 0 | 0 |
| Byrd 2018 | US adult consumers | Meal choice in an online menu | Menu with no nutrition information | Participants were randomly assigned to view menu with calorie information and sodium warning symbol ("High sodium intake can increase blood pressure and risk of heart disease and stroke") | 0 | 0 | 0 | 2 | 0 | 0 |
| Calabro 2023 | Young adults | Choice of water from a vending machine | Vending machine without beverage imagery on black background | Vending machine with various "wrappers", i.e., wrapper with branding e.g., Coca-cola logo or a red or blue background, wrapper with picture of water on back background, wrapper with picture of soft drink on back background, wrapper without imagery on red or blue background | 0 | 0 | 0 | 0 | 2 | 0 |

| Study | Population | Outcome | Control | Intervention | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Campbell-Arvai 2014 | University students | Choice of vegetarian meal in university dining facility | Dining facility menu with both vegetarian and non-vegetarian options listed on the same menu | Vegetarian default menu, with patrons informed verbally and in writing about second menu containing meat options posted 3.5 meters away | 2 | 1 | 1 | 0 | 2 | 1 |
| Campbell-Arvai 2014 | University students | Choice of vegetarian meal in university dining facility | Dining facility menu with both vegetarian and non-vegetarian options listed on the same menu | Vegetarian default menu including meat-free labeling and accompanying information on the environmental benefits of reducing meat consumption, with patrons informed verbally and in writing about second menu containing meat options posted 3.5 meters away | 2 | 1 | 1 | 0 | 0 | 1 |
| Carroll 2018 | Participants recruited from the community | Purchases of fruits and vegetables in lab setting | No presentation of fruits and vegetable bundles | Fruit and vegetable bundles displayed | 0 | 1 | 0 | 0 | 2 | 1 |
| Caso 2023 | Adults who eat meat | Self-reported future meat consumption in an online survey | No information message on the consequences of excessive meat consumption | Provision of a text that either focused on the irreversible consequences of a high intake of red and processed meat in terms of death, capturing the influence of the phenomenon at a global level (social nudge), or with a focus on the individual, the exposure to the increased risk of developing cancer and other chronic diseases linked to the regular and constant consumption of red or processed meat in the daily diet (individual nudge). | 0 | 0 | 1 | 2 | 0 | 0 |
| Chapman 2019 | Rural residents | Healthier food choices in grocery and convenience stores | Status quo baseline | Floor arrows guided customers to the produce sections | 0 | 0 | 0 | 0 | 1 | 1 |
| Chapman 2019 | Rural residents | Healthier food choices in grocery and convenience stores | Status quo baseline | Sign in produce section displayed a 'limited amount' message | 0 | 1 | 0 | 0 | 1 | 1 |
| Chapman 2019 | Rural residents | Healthier food choices in grocery and convenience stores | Status quo baseline | Granola bars moved into the candy bar aisle | 0 | 0 | 0 | 0 | 2 | 1 |

| Study | Population | Outcome | Control/Baseline | Intervention | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Chapman 2019 | Rural residents | Healthier food choices in grocery and convenience stores | Status quo baseline | All three nudges implemented at once, i.e., Floor arrows guided customers to the produce sections, sign in produce section displayed a 'limited amount' message, and granola bars moved into the candy bar aisle | 0 | 1 | 0 | 0 | 2 | 1 |
| Cheung 2019 | Take-away food vendor patrons | Sales of fresh fruit, bread roles, and yogurt at take-away food vendor | Fresh fruits were placed out-of-reach at the back of the vendor, two types of bread rolls were placed in separate containers together with croissants, the labels for the three yogurt options (i.e., bowl, cup, and shake) were placed flat on the counter | (1) Fresh fruits were relocated from the back to the front counter, (2) both types of bread rolls were placed together in one container, and croissants in another, (3) labels for the three yogurt options were redesigned with pictures (e.g., of fruits, muesli, containers) added to accompany the text, e.g. 'Bestselling choice!' and placed on the wall in clear view | 0 | 1 | 1 | 0 | 2 | 1 |
| Cheung 2019 | Take-away food vendor patrons | Sales of fresh fruit, bread roles, and yogurt at take-away food vendor | Fresh fruits were placed out-of-reach at the back of the vendor, two types of bread rolls were placed in separate containers together with croissants, the labels for the three yogurt options (i.e., bowl, cup, and shake) were placed flat on the counter | In addition to the three nudges implemented in the first phase of the experiment, a disclosure message was displayed accompanying each individual nudge, i.e., "We help you make healthy choices" | 0 | 1 | 1 | 0 | 0 | 1 |
| Cioffi 2015 | University students | Choice of healthy to-go meals and snack at university dining unit | Status quo dining unit pre-intervention | FDA nutrition facts panel added to pre-packaged meals and snacks | 0 | 0 | 0 | 0 | 0 | 0 |

| Study | Population | Outcome | Control | Intervention | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Coffino 2020 | Food pantry patrons | Healthier grocery purchases in an online grocery store | Provision of nutrition information before purchasing groceries online | Provision of pre-filled online grocery shopping cart containing a variety of groceries selected to meet nutritional requirements based on participants' sex and age (i.e., staying within caloric range etc.) and told that they are free to delete, add, exchange, or keep all items in their cart prior to finalizing their purchase | 0 | 2 | 1 | 0 | 2 | 0 |
| Coffino 2021 | Food pantry patrons | Diet quality (Healthy Eating Index [HEI 2015] scores), energy, and energy density of each online cart (i.e., grocery purchases) | No nudge | Participants in the default condition were instructed that the prefilled grocery cart represented a nutritionally balanced grocery shopping cart on the basis of their gender and age and that they could keep, delete, or exchange any or all of the items in their cart | 0 | 2 | 1 | 0 | 0 | 0 |
| Coombs 2021 | Clients of urban food pantries | Self-reported dietary quality from food pantry | No labelling condition | Intervention used highly visible shelf labels to promote foods consistent with the USDA 2015-2020 Dietary Guidelines for Americans; shelf labels included a colorful thumbs up image and said ,'Healthy Choice,' English or Spanish | 0 | 0 | 1 | 0 | 0 | 0 |
| Coucke 2022 | Adults | Sales of plant-based meat in supermarket | Status quo supermarket | Meat substitutes added to the butchery section and placed next to their equivalent meat products | 0 | 0 | 0 | 0 | 2 | 0 |
| Dalrymple 2020 | Children | Lower-energy dense choices from children's menu in theme-park restaurant | Status quo free array children's menu | Default children's menu with lower-energy-dense items displayed centered on the menu in 20-point font, alternatives were displayed on the bottom of the menu in left-justified 10-point font. | 0 | 0 | 1 | 0 | 2 | 1 |
| Davidson 2021 | Adults and children (randomized at village level) | Diversity of food consumed in experimental buffet and household | No special plate provided | Plate printed with nutrition recommendations with food images and messages e.g., ,'Half plate of rice and at least four other varieties of food,' | 0 | 0 | 1 | 0 | 0 | 0 |

| Study | Population | Outcome | Control | Intervention | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 'Eat a little more food during pregnancy' | | | | | | |
| DeBauw 2022 | Adults | Nutritional quality (NQI) and environmental impact (EII) of the selected food baskets in grocery purchase in mock-up E-grocery store | No eco- or nutri-scores displayed | Eco- and nutri-scores displayed with individual products, grocery baskets, or both | 0 | 0 | 0 | 0 | 0 | 0 |
| DeBauw 2022 | Adults | Nutritional quality (NQI) and environmental impact (EII) of the selected food baskets in grocery purchase in mock-up E-grocery store | No eco- or nutri-scores displayed | Eco- and nutri-scores displayed with both individual products and baskets as well as the average basket scores in the local province | 0 | 0 | 1 | 0 | 0 | 0 |
| DeBauw 2022 | Adults | Nutritional quality (NQI) and environmental impact (EII) of the selected food baskets in grocery purchase in mock-up E-grocery store | No eco- or nutri-scores displayed | Eco- and nutri-scores displayed with both individual products and baskets as well as the average basket scores in the local province and a prompt to "improve your scores" | 0 | 0 | 1 | 1 | 0 | 0 |
| Deek 2022 | Female university students | Healthy food and drink choices from hypothetical online fast-food menu | Participants primed with image displaying a simple graphic (knife and fork) that did not include food or drink items | Participants primed with healthy cue displaying a healthy meal (salad, water and yogurt) or with unhealthy cue displaying an unhealthy meal (burger, milkshake and brownies) | 0 | 0 | 0 | 1 | 1 | 0 |
| Diaz-Beltran 2023 | US adults | Meal choice in a fast-food drive through simuation | Menu with traditional combos with high-calories sides and beverages by default; patrons could opt to switch high-calorie for low-calorie sides, but this information was not stated on the menu | Optimal combos with low-calorie optimal sides and beverages by default; patrons could opt to switch low-calorie for high-calorie sides, but this information was not stated on the menu | 0 | 2 | 1 | 0 | 2 | 2 |

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| Study | Population | Context | Control condition | Intervention condition | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Diaz-Beltran 2023 | Adults in the U.S. | Combo meal selection in hypothetical fast-food drive through | Traditional combo menu with high-calorie sides and beverages by default while low-calorie sides were included in separate section, sides and beverages could be customized via an open-ended question after selection was made | Optimal default menu with low-calorie sides and beverages by default while high-calorie items were included in separate section. Sides and beverages could be customized via an open-ended question after selection was made | 0 | 2 | 1 | 0 | 2 | 0 |
| dosSantos 2018 | Adolescents and adults | | Participants were asked to choose between three similar meals, one meat, one fish and one the VeggiEat dish | The target dish was labelled the 'Dish of the day'. All dishes were provided free of charge, displayed side by side in the same order and served in same portions | 0 | 0 | 0 | 1 | 2 | 0 |
| dosSantos 2020 | Adolescents | Selection of vegetable-based meals in restaurant | Dishes were not communicated as "dish of the day"; menus offered three meals: one meat-based, one fish-based, and one vegetable-based | The vegetable-based dish, highlighted as the 'dish of the day', was communicated to patrons through menu labeling and verbal communication by food service staff. Menus offered three meals: one meat-based, one fish-based, and one vegetable-based | 0 | 0 | 0 | 1 | 2 | 0 |
| Downs 2015 | Pedestrians recruited from busy public locations | Choice of lower calorie snack items in mobile research lab | Seven snacks offered - each depicted with a photograph - but no nutritional information | Seven snacks offered - each depicted with a photograph - with numeric calorie information; three forms were tested: one with calorie labels for each snack, one with calories plus a reference guideline for recommended daily intake of 2,000 calories per day, and the last with calories plus a recommended daily snack intake | 0 | 0 | 0 | 0 | 0 | 0 |

| Study | Population | Behavior | Control | Intervention | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Downs 2015 | Pedestrians recruited from busy public locations | Choice of lower calorie snack items in mobile research lab | Seven snacks offered - each depicted with a photograph - but no nutritional information | Seven snacks offered - each depicted with a photograph - with contextualized numeric nutrition information. Three forms were tested: the snack's calculated percentage of daily calories recommended, the snack's calculated percentage of snack calories recommended, and the number of minutes running on a treadmill required to burn the item as calories | 0 | 0 | 0 | 0 | 0 | 0 |
| Erhard 2023 | Adults | Plant-based meat choice in hypothetical online menu | Default meat menu with preselected meat meal requiring click of a button to opt-out to plant-based meat alternative | Default plant-based meat alternative with preselected plant-based meal requiring click of a button to opt-out to meat | 0 | 1 | 1 | 0 | 2 | 1 |
| Erhard 2023 | Adults | Plant-based meat choice in hypothetical online menu | Default meat menu with preselected meat meal requiring click of a button to opt-out to plant-based meat alternative | Default plant-based meat alternative with preselected plant-based meal requiring click of a button to opt-out to meat and taste frame message displayed "We have selected the most tasty sausage for you" | 0 | 1 | 1 | 1 | 0 | 1 |
| Erhard 2023 | Adults | Plant-based meat choice in hypothetical online menu | Default meat menu with preselected meat meal requiring click of a button to opt-out to plant-based meat alternative | Default plant-based meat alternative with preselected plant-based meal requiring click of a button to opt-out to meat and sustainability frame message displayed "We have selected the most sustainable sausage for you" | 0 | 1 | 1 | 0 | 0 | 1 |
| Fennessy 2023 | Female prisoners | Choice of healthy meals (lunch, dinner, and dessert) from paper-based menu in female prison | Baseline period with status quo menu (no smiley emoticons) | Smiley face emoticon placed next to healthy foods in menu and 'Healthy Choice' label | 0 | 0 | 1 | 0 | 0 | 0 |
| Fennis 2020 | University students | Consumption of grapes in laboratory setting | Grapes were presented as easy to grow and widely available in supermarkets | Label displayed on grape packaging 'limited availability' and participants were told the grapes came from a specific region in Chile, were difficult to grow, and limited in supply | 0 | 1 | 0 | 0 | 2 | 1 |

| | | | throughout the year | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Fennis 2020 | University students | Hypothetical intention to buy cranberries in survey | Online ad for cranberries with the description "Always there for you," and indicated that the cranberries were of a common species that grows in large areas, can be harvested anytime, and widely available | Online ad for cranberries with the description 'Limited availability' and indicated as a rare species that only grows in a specific area, which can be harvested only during a limited time and is only available in specialty stores during a limited times | 0 | 1 | 0 | 0 | 2 | 1 |
| Ferrante 2022 | Children | Choice of healthier side in a university-based restaurant | Children's meal with default side of all fries, free of charge | Children's meals with default side, of small fries and large carrots, or small carrots and large fries, free of charge; option to opt-out for either only fries or only carrots was available upon request and written in small font at the bottom of the menu | 0 | 1 | 1 | 0 | 2 | 1 |
| Flores 2019 | Cafeteria patrons | Lower-calorie dish choice and calories consumed in cafeteria and online menu | (Healthy or indulgent) desserts placed at the beginning of the cafeteria buffet/online menu | (Healthy or indulgent) desserts placed at the end of the cafeteria buffet/online menu | 0 | 1 | 0 | 0 | 2 | 1 |
| Garaus 2023 | Adults | Dessert choice in an online menu | No claim on menu for 'healthy' dessert | Menu with a 'health claim' that modified the language of the healthy dessert to include words like 'low sugar' and 'light' | 0 | 0 | 0 | 0 | 0 | 0 |
| Garaus 2023 | Adults | Dessert choice in an online menu | No claim on menu for 'healthy' dessert | Menu with a 'sensory claim' that modified the language of the healthy dessert to include words like to include words like 'sweet' and 'crunchy' | 0 | 0 | 0 | 1 | 2 | 0 |
| Gavrieli 2022 | Employees | Amount of plant-based food taken per plate at self- | Plant-based dishes with no appealing names | Plant-based dishes presented with appealing names on | 0 | 0 | 0 | 1 | 2 | 0 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | service, buffets in workplace office cafeterias | on menu, e.g., "Collard Greens Vegetable Soup" | menu, e.g., "Sweet Velvety Soup with Collard Greens" | | | | | | |
| Gill 2022 | University students | Choice of healthy foods in hypothetical imagined fast-food restaurant | Portion sizes on menu included S, M, and L for healthy food (carrot sticks) | Portion sizes on menu included S, M, L, and XL for healthy food (carrot sticks) | 0 | 0 | 0 | 0 | 2 | 0 |
| Gillebaart 2023 | Adults | Choice of healthy snack in experimental supermarket | Shopping basket inlay with neutral pictures | Shopping basket inlay with pictures of healthy items | 0 | 0 | 0 | 0 | 0 | 0 |
| Gillebaart 2023 | Academic professionals invited to evaluate a novel vegetable display | Participant evaluation of vegetable display in an academic environment | No nudge present | Monitor placed over vegetables with an animated character who gives a thumbs up when patrons choose a vegetable | 0 | 0 | 1 | 1 | 0 | 0 |
| Gillebaart 2023 | Supermarket patrons | Vegetrable purchases in supermarket setting | Normal vegetable displays (I.e., no nudge) | Monitor placed over vegetables with an animated character who gives a thumbs up when you choose a vegetable | 0 | 0 | 1 | 1 | 0 | 0 |
| Gottselig 2023 | Adults | Willingness to pay for sustainable food products in conjoint experiment | No nudge prior to conjoint experiment | Respondents exposed to pictures randomly drawn from a set of nature pictures | 0 | 0 | 0 | 0 | 2 | 0 |
| Gottselig 2023 | Adults | Willingness to pay for sustainable food products in conjoint experiment | No nudge prior to conjoint experiment | Social norm nudge presented to participants prior to conjoint experiment that communicates the percentage of consumers making more sustainable food choices | 0 | 0 | 1 | 0 | 0 | 0 |
| Gravert 2021 | Employees | Vegetarian lunch meal selection from vegetarian, fish, and meat options in a restaurant | Lunch menu listed meat and fish options, with statement of a vegetarian option available on request | Lunch menu listed vegetarian and fish options, with statement of a meat option available on request | 0 | 1 | 1 | 0 | 2 | 1 |
| Gynell 2022 | University students | Healthy snack choice in paper-based and online menus | Healthy items placed at the bottom of the menu | Healthy items placed on the top of the menu | 0 | 0 | 0 | 0 | 2 | 1 |
| Gynell 2022 | University students | Healthy snack choice in paper-based and online menus | Healthy items placed at the | Healthy items placed in the middle of the menu | 0 | 0 | 0 | 0 | 2 | 1 |

| Study | Population | Choice | Intervention | Comparator | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | bottom of the menu | | | | | | | |
| Hansen 2021 | Stakeholders within public health and consumer regulation, and master and PhD students | Choice of vegetarian lunch at conference buffet | A standard lunch registration sent online prior to the conference presenting a non-vegetarian buffet as the default, but allowing the active choice of a vegetarian option (I.e., At the conference a non-vegetarian buffet will be served for lunch. Please state here if you would like to have a vegetarian dish prepared for you) | A lunch registration sent online presenting a vegetarian buffet as the default, allowing the active choice of a non-vegetarian option (I.e., At the conference a vegetarian buffet will be served for lunch. Please state here if you would like to have a non-vegetarian dish prepared for you) | 0 | 1 | 1 | 0 | 2 | 0 |
| Hawkins 2021 | Students | Snack choice in lab setting while completing an online survey | Participants shown three sets of instagram images: one of low-energy dense (LED) food images, one of high energy dense (HED) images, and one of control images (interior design). All images presented with similar number of 'likes' | Participants shown three sets of instagram images: one of low-energy dense food images, one of high energy dense images, and one of control images (interior design). LED or HED images presented with high social endorsement (I.e., much higher numbers of 'likes') | 0 | 0 | 1 | 0 | 2 | 0 |
| Hielkema 2022 | Adults | Choice of vegetarian dish in hypothetical menu | Menu including vegetarian dishes with an explicate vegetarian label, i.e., vegetarian, vegan, plant-based or meat-free (e.g., Vegetarian curry stew with coconut and sweet potatoes) | Menu including vegetarian dishes with a neutral label (e.g., "curry stew with coconut and sweet potatoes"), asterisk indicated dish was also suitable for vegetarians | 0 | 0 | 0 | 0 | 2 | 0 |

| Study | Population | Behavior | Control | Intervention | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Hielkema 2022 | Adults | Choice of vegetarian burger in hypothetical restaurant | Default beef burger menu option with instructions to ask the waiter for vegetarian burger | Default vegetarian burger menu option with instructions to ask the waiter for vegetarian burger | 0 | 1 | 1 | 0 | 2 | 0 |
| Hielkema 2022 | Adults | Choice of vegetarian burger in hypothetical restaurant | Vegetarian burger labeled on menu with conventional title | Vegetarian burger indulgently labeled as ,'Flame-grilled Black Bean Burger' on menu | 0 | 0 | 0 | 1 | 2 | 0 |
| Hoenink 2021 | Supermarket shoppers | Beverage purchases in supermarket | No traffic-light labelling used to indicate relative sugar content of beverages | On-shelf traffic-light sugar labels implemented (I.e., green for the lowest sugar content, yellow for medium sugar content, and red for high sugar content). In addition, the shelf included a small poster explaining the meaning of the on-shelf sugar labels | 0 | 0 | 0 | 0 | 0 | 0 |
| Hubbard 2015 | Students with disabilities at residential school | Increase choice and consumption of fruits, vegetables and whole grains, and reduce choice and consumption of refined grains in school lunchroom | Baseline period with status quo lunchroom, including sides bundled with entrees, fruit kept behind the counter, and desserts placed at eye level of children | Peanut butter and jelly sandwiches were moved to the back counter and made available only by request; fruit was moved to the beginning of the serving line; apples, bananas and oranges were separated into attractive and easy-to-reach baskets; an easy-to-eat fruit option (e.g. apple sauce) was available by request daily near the fresh fruit; the healthiest entree was placed earlier in line, followed by sides; sides were unbundled from the entrees; desserts were kept behind the counter, rather than serving them at eye level | 2 | 1 | 1 | 0 | 2 | 2 |
| Jesse 2021 | Participants in an online survey | Choice of healthy/sustainable recipe in an online survey | No nudged recipe | Upon selection of 'vegetarian' preference for a recipe, one option is highlighted by using a different color background to emphasize it | 0 | 0 | 0 | 0 | 2 | 0 |

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| Jesse 2021 | Participants in an online survey | Choice of healthy/sustainable recipe in an online survey | No nudged sandwich recipe | Hybrid nudge adopted that combines a pre-selection of the nudged sandwich (default) on online menu and a social norm message (i.e., '90% of people liked this'). Participants could opt to a different sandwich with the click of a button | 0 | 1 | 1 | 0 | 2 | 0 |
| Jesse 2021 | Participants in an online survey | Choice of healthy/sustainable recipe in an online survey | No nudged pasta recipe | Nudged pasta recipe option is pre-selected for participants, who can opt out of it by clicking a buton | 0 | 1 | 1 | 0 | 2 | 0 |
| Jesse 2021 | Participants in an online survey | Choice of healthy/sustainable recipe in an online survey | No nudged 'fish' recipe | Nudged 'fish' recipe option with social norm message (i.e., '90% of people liked this') | 0 | 0 | 1 | 0 | 2 | 0 |
| Jesse 2021 | Participants in an online survey | Choice of healthy/sustainable recipe in an online survey | No nudged 'dessert' option | Text warning label to advise against the selection of an option that read "Please note that this dish contains alcohol/has a high amount of kilocalories per serving" | 0 | 0 | 0 | 0 | 0 | 0 |
| Jia 2022 | Hospital employees | Improved food choices in hospital cafeteria | A standard letter delivered to participants each month with general health tips (e.g., eating fruits and vegetables, exercising regularly) over 12 months | Two emails per week and one letter per month delivered to participants over 12 months, a weekly e-mail provided each participant with a log of their cafeteria food purchases from the prior week, including traffic light labels for all items and total calories purchased, using each participant's daily calorie goal (i.e., for weight loss or maintenance) as a benchmark | 0 | 0 | 1 | 1 | 0 | 0 |
| Kattelmann 2014 | University students | Improvements in weight, BMI, waist circumference, and intake of F&V, sugary drinks, whole grains, and dietary fat | Control group with no nudge intervention delivered | 21 mini-educational lessons and emails delivered to participants online over 10 weeks; the messages addressed eating behavior, physical activity, stress management, and healthy weight management; simultaneously, participants used an app to view graphs of their goal(s), progress toward | 0 | 0 | 1 | 0 | 0 | 0 |

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| | | | | a goal, and recommendations for each target behavior | | | | | | |
| Kee 2022 | Customers at the State Fair | Choice of smaller portion size from lunch menu at State Fair restaurant | Status quo menu without labels, all foods were available in two sizes | Menu with green 'Low Calorie' label added next to the regular size portions, all foods were available in two sizes | 0 | 0 | 0 | 0 | 0 | 0 |
| Keegan 2019 | University students | Selection of salad option from an online fast food menu with three other unhealthy options | Salad option positioned either in the middle or end of the other options, which are all equally spaced out in the online menu | Salad option is spaced further from the unhealthy options in the online menu | 0 | 0 | 0 | 0 | 2 | 1 |
| Kingham 2023 | Undergraduate women | Choice of high nutritional value meals online fast-food menu | Menu presented a mix of high and low nutritional value items in each column or adjacent to one another | Menu presented high and low nutritional value items separately such that the space between the two columns was increased | 0 | 0 | 0 | 0 | 2 | 1 |
| Knowles 2019 | University students | Selection of 'fruit' vs. chocolate' snack in lab setting | In the lab, two snack bowls were set up ,one with fruit and one with chocolate, both placed either 20 cm away or both placed 70 cm from participant | In the lab, two snack bowls were set up: one with fruit (20cm proximal) and one with chocolate (70cm distal), or alternatively, the fruit (70cm distal) and chocolate (20cm proximal) | 2 | 0 | 0 | 0 | 2 | 0 |
| Kongsbak 2016 | Male university students | Vegetable consumption in self-serve lab buffet | Fruits and vegetables placed in the middle of the buffet and served as a mixed salad | Fruit and vegetables placed at the beginning of the buffet and individual salad ingredients separated into individual bowls | 0 | 0 | 0 | 0 | 2 | 1 |
| Kroese 2016 | Customers at snack shop | Healthy choices at train station snack shop | No changes made to positioning of snacks in snack shop (i.e., unhealthy snacks | Healthy snacks placed at the cash register | 0 | 0 | 0 | 0 | 2 | 1 |

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|---|---|---|---|---|---|---|---|---|---|---|
| | | | at the cash register, as usual) | | | | | | | |
| Kroese 2016 | Customers at snack shop | Healthy choices at train station snack shop | No changes made to positioning of snacks in snack shop (i.e., unhealthy snacks at the cash register, as usual) | Healthy snacks placed at the cash register and a sign posited saying "we help you make healthier choices" | 0 | 0 | 1 | 0 | 0 | 1 |
| Krpan 2020 | Adults | Choice of vegetarian meal in hypothetical restaurant menu | Menu with vegetarian options grouped under the label "Vegetarian Main Courses" | Menu with vegetarian options grouped under the label 'Environmentally Friendly Main Courses for a Happy Planet' and other dishes listed under "Main Courses" | 0 | 0 | 1 | 1 | 0 | 0 |
| Krpan 2020 | Adults | Choice of vegetarian meal in hypothetical restaurant menu | Menu with vegetarian options grouped under the label "Vegetarian Main Courses" | Menu with vegetarian options groups under the label 'Refreshing Main Courses for Relaxing Conversations' other dishes listed under "Main Courses" | 0 | 0 | 0 | 1 | 2 | 0 |
| Krpan 2020 | Adults | Choice of vegetarian meal in hypothetical restaurant menu | Menu with vegetarian options grouped under the label "Vegetarian Main Courses" | Menu with vegetarian and non-vegetarian dishes mixed in the same section labeled as "Main Courses", and asterisks indicated which dishes were suitable for vegetarians | 0 | 0 | 0 | 0 | 0 | 0 |
| Kurz 2018 | University students | Choice of vegetarian dish in university restaurant | University restaurant without nudge intervention offering three warm dish options (1 vegetarian, 1 meat, 1 fish) | University restaurant offering three warm dish options (1 vegetarian, 1 meat, 1 fish) where the the vegetarian option was repositioned from the middle to the top of the printed menu, and the dish was moved from behind the counter to a spot visible to customers at the point of decision-making | 0 | 0 | 0 | 0 | 2 | 1 |
| Lai 2020 | Children | Choice of white (vs. chocolate) milk in school lunchroom | Status quo lunchroom without prompt | Verbal prompt to children in the lunch line: 'try the white milk' | 0 | 0 | 1 | 0 | 0 | 0 |
| Lai 2020 | Children | Choice of white (vs. chocolate) milk in school lunchroom | Status quo lunchroom without prompt | Verbal prompt to children in the lunch line "try the white milk, it tastes good' | 0 | 0 | 1 | 1 | 0 | 0 |

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| Lai 2020 | Children | Choice of white (vs. chocolate) milk in school lunchroom | Status quo lunchroom without prompt | Glow-in-the-dark bracelet (worth $0.20) was attached to white (but not chocolate) milk cartons | 0 | 2 | 0 | 0 | 0 | 0 |
| Langen 2022 | Employees and students | Sustainable meal choice in workplace and school cafeterias | Baseline period without nudge intervention | Sustainable meals repositioned on the counter and on the menu to increase visibility | 0 | 0 | 0 | 0 | 2 | 1 |
| Langen 2022 | Employees and students | Sustainable meal choice in workplace and school cafeterias | Baseline period without nudge intervention | Menu displayed descriptions food names for sustainable meals, e.g., "Westphalia meets Orient: spicy Munsterland tuber with chickpeas and arugula" | 0 | 0 | 0 | 1 | 2 | 0 |
| Langen 2022 | Employees and students | Sustainable meal selection in workplace and school cafeterias | No nudge intervention | Signage at the food counter displayed sustainability traffic light label, i.e., combined calculation for environment, health and fairness dimensions | 0 | 0 | 0 | 0 | 0 | 0 |
| Langen 2022 | Employees and students | Sustainable meal selection in workplace and school cafeterias | No nudge internvetion | Signage at the food counter displayed sustainability traffic light label, i.e., combined calculation for environment, health and fairness dimensions with an explanation of the label | 0 | 0 | 0 | 0 | 0 | 0 |
| Libotte 2014 | University students | Composition of a meal and total meal energy selected from fake food lunch buffet in lab setting | Students given standard plate size | Students given large plate size | 0 | 0 | 0 | 0 | 2 | 0 |
| Lin 2022 | Survey respondents | Willingness to pay for sustainably produced coffee in online discrete choice experiment | Coffee packaging presented with either no label, or up to three labels indicating pro-environmental choices: USDA organic, fair trade, and carbon trust labels | In addition to the pro-environmental labels, an additional claim is placed on one of the coffee options that states, 'this product is for green shoppers' in green color. | 0 | 0 | 1 | 0 | 0 | 0 |
| Liu 2022 | University students | Reduction in food waste from online pizza menu | Menu displaying 3 size options, i.e., 1, 2 or 3-slices, any other number of slices could be written in the text box "other" | Menu with only 1 size option, i.e., 1-slice, any other number of slices could be written in the text box "other" | 0 | 1 | 0 | 0 | 2 | 0 |

| Study | Population | Outcome | Comparator | Intervention | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Loeb 2017 | Parent-child dyads | Choice of healthier breakfast menu for child at community center | Unhealthy default breakfast menu with unhealthy items and neutral video shown to parents prior to breakfast selection | Video shown to parents with messaging, e.g., "Making health easy for your child means making the best choices for him or her", followed by presentation with a default menu that offers a healthy breakfast combo. Unhealthy options were listed in smaller font at the bottom and available upon request | 0 | 1 | 2 | 1 | 0 | 1 |
| Loeb 2017 | Parent-child dyads | Choice of healthier breakfast menu for child at community center | Unhealthy default breakfast menu with unhealthy items and neutral video shown to parents prior to breakfast selection | Video shown to parents with neutral content about food safety, followed by presentation with a default menu that offers a healthy breakfast combo, unhealthy options were listed in smaller font at the bottom and available upon request | 0 | 1 | 1 | 0 | 2 | 1 |
| Loeb 2017 | Parent-child dyads | Choice of healthier breakfast menu for child at community center | Unhealthy default breakfast menu with unhealthy items and neutral video shown to parents prior to breakfast selection | Video shown to parents with messaging, e.g., "Making health easy for your child means making the best choices for him or her", followed by presentation with a default menu that offers an unhealthy breakfast combo, healthy options were listed in smaller font at the bottom and available upon request | 0 | 1 | 2 | 0 | 0 | 1 |
| Luomala 2023 | Shoppers at grocery store | Sales of organic products vs. calorie-dense products in grocery store | No nudge | Visual priming stimuli (floor stickers and shopping basket adds) and olfactory stimuli (basil scent diffusers, carrot sample tastings) | 0 | 0 | 0 | 1 | 2 | 0 |
| Manippa 2023 | Adults | Healthy choice on hypothetical online menu | Menu with unhealthy items positioned on the left and healthy items on the right | Menu with healthy items positioned on the left and unhealthy items on the right | 0 | 0 | 0 | 0 | 2 | 1 |
| Manippa 2023 | Adults | Healthy choice on hypothetical online menu | Menu with unhealthy items positioned on the left and healthy items on the right | Menu with healthy items positioned on the left and unhealthy items on the right | 0 | 0 | 0 | 0 | 2 | 1 |

| Study | Population | Outcome | Comparison | Intervention | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Marcano-Olivier 2019 | School children | Fruit and vegetable consumption in school cafeteria | Status quo cafeteria | Five nudges implemented simultaneously: (1) brightly colored posters encouraging fruit consumption displayed; (2) attractive names added to fruit and vegetables (e.g., dinosaur tree broccoli); (3) attractive labels added to fruits and vegetables, (4) whole fruit servings replaced by sliced fruit placed into colorful bowls, (5) vegetables placed at the beginning of the line and fruit placed before dessert | 0 | 0 | 0 | 1 | 0 | 1 |
| McGrath 2023 | Adults | Purchase of fruits and vegetables in grocery store | Trolley without divider placard | Trolley with placard covering the bottom of the shopping trolley indicating the recommended proportion fruits and vegetables, half of the placard read 'Fruits and Vegetables only' with images of produce, while the other half read 'Everything else' | 0 | 0 | 0 | 0 | 0 | 0 |
| McGrath 2023 | Shoppers in supermarket | Fruit and vegetable purchase in supermarket | Shopping trolleys with no messaging | Placards giving the message that the majority of shoppers purchased fruit and vegetables at each shop were placed in shopping trolleys. | 0 | 0 | 1 | 0 | 0 | 0 |
| Mecheva 2021 | Children | Healthy snack choice in school field experiment | Healthy (banana) and unhealthy (Chocolate cake) displayed side by side | Healthy (banana) and unhealthy (Chocolate cake) displayed side by side and a happy, green smiley face placed next to healthy snack and red sad face next to unhealthy one | 0 | 0 | 1 | 1 | 0 | 0 |
| Mecheva 2021 | Children | Healthy snack choice in school field experiment | Healthy (banana) and unhealthy (Chocolate cake) displayed side by side | Healthy (banana) and unhealthy (Chocolate cake) displayed side by side and children first see a classmate (a peer of similar age and same gender, and who is a 'confederate' leaving the room with a banana | 0 | 0 | 1 | 0 | 2 | 0 |

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| Mecheva 2021 | Children | Healthy snack choice in school field experiment | Healthy (banana) and unhealthy (Chocolate cake) displayed side by side | Healthy (banana) and unhealthy (Chocolate cake) displayed side by side and children first see a classmate (a 'confederate' peer) leaving the room with a chocolate cake | 0 | 0 | 1 | 0 | 2 | 0 |
| Meeusen 2023 | Hospital employees | Healthy (vs. unhealthy) meal purchases in hospital cafeteria | No changes to workplace cafeteria | Healthy choices placed at the front of the cafeteria, and unhealthy choices at the back | 1 | 0 | 0 | 0 | 2 | 1 |
| Meeusen 2023 | Hospital employees | Healthy (vs. unhealthy) meal purchases in hospital cafeteria | No changes to workplace cafeteria | Signs emphasizing the health benefits of the products offered, as well as encouraging statements, were developed and placed next to healthy products | 0 | 0 | 0 | 0 | 0 | 0 |
| Menapace 2017 | Adults | Choice of locally grown fruit toppings on ice cream in ice-cream parlor | Status quo menu without labeling | Menu with locally grown fruit options labeled as "Trentino fruits from an area particularly suited for high-quality production", i.e., a terroir label | 0 | 0 | 0 | 0 | 0 | 0 |
| Menapace 2017 | Adults | Choice of locally grown fruit toppings on ice cream in ice-cream parlor | Status quo menu without labeling | Menu with locally grown fruit options labeled as "Only 0.03 kg of CO2 emitted by transporting 1 kg of fresh fruit" | 0 | 0 | 0 | 0 | 0 | 0 |
| Michels 2023 | Adults | Choice of healthy foods in mock-up online supermarket | Status quo online ordering platform | Online ordering platform with opaque white layer added over picture and product information of unhealthy products | 0 | 0 | 0 | 0 | 2 | 1 |
| Michels 2023 | Adults | Choice of healthy foods in mock-up online supermarket | Status quo online ordering platform | Online ordering platform with opaque white layer added over picture and product information of unhealthy products and a disclosure statement about the purpose of the nudge and the adverse health consequences of unhealthy diets | 0 | 0 | 0 | 2 | 0 | 1 |
| Michels 2023 | Adults | Choice of healthy foods in mock-up online supermarket | Status quo online ordering platform | Online ordering platform without opaque white layer added over picture and product information of unhealthy products, a statement about the adverse | 0 | 0 | 0 | 2 | 0 | 1 |

| Study | Population | Outcome | Control | Intervention | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | health consequences of unhealthy diets | | | | | | |
| Michels 2023 | Adults | Choice of healthy foods in mock-up online supermarket | Status quo online ordering platform without opaque white layer added over picture and product information of unhealthy products | Participants decided whether they would like the nudge or not, after viewing the online ordering platform with opaque white layer added over picture and product information of unhealthy products and a disclosure statement about the purpose of the nudge and the adverse health consequences of unhealthy diets | 0 | 0 | 0 | 2 | 0 | 1 |
| Michels 2023 | Adults | Choice of healthy foods in mock-up online supermarket | Status quo online ordering platform without opaque white layer added over picture and product information of unhealthy products | Participants decided whether they would like the nudge or not, after viewing the online ordering platform with opaque white layer added over picture and product information of unhealthy products | 0 | 0 | 0 | 2 | 0 | 1 |
| Migliavada 2022 | University students | Choice of vegetable dishes for lunch in university canteen | Status quo canteen without organic/local labeling | The three available vegetable dishes were labeled as "local" | 0 | 0 | 0 | 0 | 1 | 0 |
| Migliavada 2022 | University students | Choice of vegetable dishes for lunch in university canteen | Status quo canteen without organic/local labeling | The three available vegetable dishes were labeled as "organic" | 0 | 0 | 0 | 0 | 1 | 0 |
| Migliavada 2022 | University students | Choice of vegetable dishes for lunch in university canteen | Status quo canteen without organic/local labeling | The three available vegetable dishes were labeled as "organic & local" | 0 | 0 | 0 | 0 | 1 | 0 |
| Mikkelsen 2021 | Vocational school students | Healthy beverage purchases in vocational school canteen | Status quo beverage cooler | Sugar sweetened beverages were placed at the bottom of beverage cooler, where they were less visible | 2 | 0 | 0 | 0 | 2 | 1 |
| Mikkelsen 2021 | Vocational school students | Healthy beverage purchases in vocational school canteen | Status quo beverage cooler | Sugar sweetened beverages were placed at the bottom of beverage cooler, where they were less visible and a frosted film covered the glass front | 2 | 0 | 0 | 0 | 2 | 2 |

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| Missbach 2016 | University students | Choice of low-calorie cereal bar from serving tray | Low-calorie cereal bar positioned on the left of two other higher-calorie bars | Low-calorie cereal bar positioned in the middle of two other higher-calorie bars | 0 | 0 | 0 | 0 | 2 | 0 |
| Mohr 2019 | University students | Fewer calories ordered in hypothetical online fast food menu | Online ordering system prompts individuals to indicate their calorie goals for the meal before displaying status quo menu | Online ordering system prompts individuals to indicate their calorie goals for the meal before displaying menu with a virtual order assistant, featuring a human-like face with dynamic expressions, reflecting the calorie content of the shopping basket along with messages e.g., "Great choice!" and "Are you sure?" | 0 | 0 | 1 | 2 | 1 | 0 |
| Mohr 2019 | University students | Fewer calories ordered in hypothetical online fast food menu | Status quo menu | Online ordering system prompts individuals to indicate their calorie goals for the meal before displaying menu with shopping basket calorie content and associated color-coding system (yellow, green, red) | 0 | 0 | 0 | 0 | 0 | 0 |
| Mohr 2019 | University students | Fewer calories ordered in hypothetical online fast food menu | Status quo menu | Online ordering system prompts individuals to indicate their calorie goals for the meal before displaying menu with healthy options highlighted in green background | 0 | 0 | 0 | 0 | 0 | 0 |
| Montagni 2020 | Employees | Healthy dish choice in workplace cafeterias | Status quo cafeteria | Healthy meal items in cafeteria labeled with a "Green Apple Label", and multiple educational elements around nutrition were delivered on-site and remote, i.e., webinars , "Lunch & Learns", TV slides, posters, tabling events, cooking demos, etc. | 0 | 0 | 0 | 0 | 0 | 0 |
| Morren 2021 | University students | Sustainable food choice in grocery stores reported via shopping receipts images | No information nudge received | In an online survey, personalized information nudges based on reported dietary choices were delivered about the health or environmental impacts of | 0 | 0 | 0 | 0 | 0 | 0 |

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| | | | | meat ingredients with suggested replacement ingredients | | | | | | |
| Mors 2018 | Adults | Lunch choice in test room buffet | No intervention (i.e., odor priming) prior to lunch choice | Priming with either bread or cucumber odor prior to lunch selection | 0 | 0 | 0 | 0 | 2 | 0 |
| Ntoumanis 2022 | Survey participants | Willingness to pay for sugar-free vs. sugar-containing food products in an online survey experiment | Participants listened to a control narrative irrelevant to food choices prior to decision-making | Participants listened to a narrative by a dietary specialist emphasizing the health risks of sugar consumption prior to decision-making | 0 | 0 | 0 | 2 | 0 | 0 |
| Oh 2022 | Ice cream store patrons | Number and nutrition content of ice cream scoops purchased in store | Ice cream flavors partitioned into 'virtues' and 'vices' based on nutritional value and displayed in-store with 'virtue' flavors alternating with 'vice' flavors in both rows of the counter, ice cream was served by employees | Ice cream flavors partitioned into 'virtues' and 'vices' based on nutritional value and displayed in-store either with (1) 'virtue' flavors on the left/right or (2) 'virtue' flavors in the front/back row of the counter, ice cream was served by employees | 0 | 0 | 0 | 0 | 1 | 0 |
| Oh 2022 | Ice cream store patrons | Number and nutrition content of ice cream scoops purchased in store | Ice cream flavors partitioned into 'virtues' and 'vices' based on nutritional value and displayed in-store with 'virtue' flavors alternating with 'vice' flavors in both rows of the counter, ice cream was served by employees | Ice cream flavors partitioned into 'virtues' and 'vices' based on nutritional value and displayed in-store either with (1) 'virtue' flavors on the left/right or (2) 'virtue' flavors in the front/back row of the counter and traffic light labels were added to the flavors (i.e., red for vice and green for virtue), ice cream was served by employees | 0 | 0 | 0 | 0 | 1 | 0 |
| Olstad 2014 | Patrons at a community pool | Sales of healthy foods at an outdoor community pool concession stand | Status quo menu with item names, descriptors, prices and colorful photos | Appealing names added to healthy items on menu, unhealthy item names unchanged | 0 | 0 | 0 | 1 | 2 | 0 |

| Olstad 2014 | Patrons at a community pool | Sales of healthy foods at an outdoor community pool concession stand | Status quo menu with item names, descriptors, prices and colorful photos | Appealing names added to healthy items on menu, unhealthy item names unchanged and a taste testing intervention, where small samples of healthy items were distributed to pool patrons | 0 | 0 | 0 | 1 | 2 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|
| Otto 2020 | Adults | Reduce calories ordered in chain cinnamon roll shop | No advertisement shown | Participants shown mock advertisement with the message "People at this store in this part of the city will order items with 250 calories on average." | 0 | 0 | 1 | 0 | 0 | 0 |
| Otto 2020 | Adults | Reduce calories ordered in chain cinnamon roll shop | No advertisement shown | Participants shown mock advertisement with the message ,"People at other stores in other states across the country will order items with 250 calories on average." | 0 | 0 | 1 | 0 | 0 | 0 |
| Otto 2020 | University students | Reduced calories ordered in hypothetical ice cream shop | Participants asked to imagine walking into an ice cream shop without messaging | Participants asked to imagine walking into an ice cream shop and a shop worker saying ,"On the [university name] campus, customers order on average 120 calories in ice cream toppings" | 0 | 0 | 1 | 0 | 0 | 0 |
| Otto 2020 | University students | Reduced calories ordered in hypothetical ice cream shop | Participants asked to imagine walking into an ice cream shop without messaging | Participants asked to imagine walking into an ice cream shop and a shop worker saying "Worldwide, customers order on average 120 calories in ice cream toppings" | 0 | 0 | 1 | 0 | 0 | 0 |
| Ozturk 2020 | School children | Healthy lunch entree selection in school cafeteria | Baseline status quo and control schools with free array menu | Menus designed by graphical artists to increase salience of healthy options using cartoons (e.g., dinosaurs and detectives) and food nicknames; morning slide shows also advertised healthy lunch options with corresponding cartoon themes | 0 | 0 | 0 | 1 | 0 | 0 |

| Study | Population | Outcome | Control condition | Intervention condition | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Panzone 2021 | University students | Choice of products with low carbon footprint in experimental online supermarket | Participants prompted to spend $25 in online supermarket, with standard shop layout | Participants prompted to spend $25 in online supermarket; participants were informed that products had been rearranged into three aisles on the basis of their carbon footprint | 0 | 0 | 0 | 0 | 0 | 1 |
| Panzone 2021 | University students | Choice of products with low carbon footprint in experimental online supermarket | Participants prompted to spend $25 in online supermarket, with standard shop layout | Participants prompted to spend $25 in online supermarket; participants were informed that products had been rearranged into three aisles on the basis of their carbon footprint; additionally, a banner was displayed above the shopping area that communicated a clear goal, 'Keep Carbon Low,' and rationale,'Caring for the environment is an important moral value. So, choose products with a lower carbon footprint.' | 0 | 0 | 1 | 0 | 0 | 1 |
| Panzone 2023 | Adults | Low carbon footprint of grocery purchases in experimental online supermarket | No commitments solicited before online shopping; carbon footprint and nutritional composition of each product could be viewed by moving a cursor over an icon | Participants were prompted to commit to purchasing a food basket with a low carbon footprint prior to shopping where participants could choose to commit or not; carbon footprint and nutritional composition of each product could be viewed by moving a cursor over an icon | 0 | 0 | 1 | 0 | 0 | 0 |
| Panzone 2023 | Adults | Low carbon footprint of grocery purchases in experimental online supermarket | No commitments solicited before online shopping; carbon footprint and nutritional composition of each product could be viewed by moving a cursor over an icon | Participants were prompted to commit to purchasing a food basket with a low carbon footprint prior to shopping where participants were forced to commit; carbon footprint and nutritional composition of each product could be viewed by moving a cursor over an icon | 0 | 0 | 1 | 0 | 0 | 0 |
| Parkin 2022 | Adults | Vegetarian dish choice from online menu | Status quo menu without V symbol | Menu with V symbol presented to the left of the dish name | 0 | 0 | 0 | 0 | 0 | 0 |

| Study | Population | Outcome | Control | Intervention | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Parkin 2022 | Adults | Vegetarian dish choice from online menu | Status quo menu without V symbol | Menu with V symbol presented to the right of the dish name | 0 | 0 | 0 | 0 | 0 | 0 |
| Peeters 2022 | Adults | Purchase of sustainably sourced meat products in hypothetical online farm-to-consumer membership platform where meat products were labeled according to the level of sustainability | Individuals were given a shopping assignment in farm-to-consumer platform without a self-assessment of biospheric values or opportunity to choose a membership | Participants were prompted to self-assess their own biospheric values and then choose which type of membership (three options varying in sustainability, animal welfare, and public health levels) to the farm-to-consumer platform they would like, after which they were given a shopping assignment in the platform where meat products were labeled according to the level of sustainability (same as the membership scheme) | 0 | 0 | 1 | 0 | 0 | 0 |
| Policastro 2017 | University students | Healthier beverage choice in college food retail setting | No messaging intervention | In a dining hall, posters displayed messages on calorie savings in numerical values when switching from soda to water | 0 | 0 | 0 | 0 | 0 | 0 |
| Policastro 2017 | University students | Healthier beverage choice in college food retail setting | No messaging intervention | In a dining hall, posters displayed messages on calorie savings and/or charity donations, i.e., if customers chose fountain water over soda, the proceeds would go to a local soup kitchen | 0 | 1 | 2 | 0 | 0 | 0 |
| Prusaczyk 2021 | Online survey respondents | Willingness to order beef burger in hypothetical online survey | Besides an image of a burger, participants read a message informing them of the option between beef and beef-mushroom burgers and informed that the beef-mushroom burgers enhance the meaty flavor of the beef | Besides an image of a burger, participants read a message informing them of the option between beef and beef-mushroom burgers and informed that the beef-mushroom burgers enhance the meaty flavor of the beef; participants were informed that everyone would be served a beef-mushroom burger unless they specifically asked for an all-beef burger | 0 | 1 | 1 | 0 | 0 | 1 |

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| Prusaczyk 2021 | Online survey respondents | Willingness to order beef burger in online survey | Besides an image of a burger, participants read a message informing them of the option between beef and beef-mushroom burgers and informed that the beef-mushroom burgers enhance the meaty flavor of the beef | Participants were informed of the GHG emissions associated with beef consumption; then, besides an image of a burger, participants read a message informing them of the option between beef and beef-mushroom burgers and informed that the beef-mushroom burgers enhance the meaty flavor of the beef | 0 | 0 | 0 | 1 | 0 | 1 |
| Qi 2022 | University students, staff, and faculty | Increased vegetable consumption and decreased food waste in sensory lab | Participants received message on a control topic (i.e., screen time among youth or financial literacy) before being served meal with larger proportion of meat (25% vegetables, 50 % meat, 25% rice) on small plate by default; they were then given the opportunity to downsize to a smaller meal at lower cost | Participants received message on a control topic (i.e., screen time among youth or financial literacy) before being served meal with larger proportion of vegetables (50% vegetables, 25 % meat, 25% rice) on small plate by default; they were then given the opportunity to downsize to a smaller meal at lower cost | 0 | 2 | 1 | 0 | 2 | 0 |
| Qi 2022 | University students, staff, and faculty | Increased vegetable consumption and decreased food waste in sensory lab | Participants received message on a control topic (i.e., screen time among youth or financial literacy) before being served meal with larger proportion of meat (25% vegetables, 50 % meat, 25% rice) on small plate by default; they were then given the opportunity to | Participants received message on a control topic (i.e., screen time among youth or financial literacy) before being served meal with larger proportion of vegetables (50% vegetables, 25 % meat, 25% rice), on large plate by default; they were then given the opportunity to downsize to a smaller meal at lower cost | 0 | 2 | 1 | 0 | 2 | 0 |

| | | | downsize to a smaller meal at lower cost | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Qi 2022 | University students, staff, and faculty | Increased vegetable consumption and decreased food waste in sensory lab | Participants received message on a control topic (i.e., screen time among youth or financial literacy) before being served meal with larger proportion of meat (25% vegetables, 50 % meat, 25% rice) on small plate by default; they were then given the opportunity to downsize to a smaller meal at lower cost | Participants received message on food waste before being served meal with larger proportion of vegetables (50% vegetables, 25 % meat, 25% rice) on small plate by default; they were then given the opportunity to downsize to a smaller meal at lower cost | 0 | 2 | 2 | 0 | 0 | 0 |
| Qi 2022 | University students, staff, and faculty | Increased vegetable consumption and decreased food waste in sensory lab | Participants received message on a control topic (i.e., screen time among youth or financial literacy) before being served meal with larger proportion of meat (25% vegetables, 50 % meat, 25% rice) on large plate by default; they were then given the opportunity to downsize to a smaller meal at lower cost | Participants received message on food waste before being served meal with larger proportion of vegetables (50% vegetables, 25 % meat, 25% rice) on large plate by default; they were then given the opportunity to downsize to a smaller meal at lower cost | 0 | 2 | 2 | 0 | 0 | 0 |

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|---|---|---|---|---|---|---|---|---|---|---|
| Qiu 2023 | University students | Liking and wanting of low-calorie food images in psychology lab | Participants asked to imagine eating yellow potato chips/cake for ten seconds three times in a row before rating liking/wanting of the potato chips and eight other food images (yellow, green, or red in color) | Participants asked to imagine eating yellow potato chips for ten seconds 30 times in a row before rating liking/wanting of the potato chips and eight other food images (yellow, green, or red in color) | 0 | 0 | 0 | 0 | 2 | 0 |
| Quinn 2018 | Students in secondary schools | Selection of healthy target items (fruits, vegetables, low-fat milk) in school cafeterias | Status quo school cafeteria | Displaying fruits and vegetables in attractive ways | 0 | 0 | 0 | 0 | 2 | 1 |
| Quinn 2018 | Students in secondary schools | Selection of healthy target items (fruits, vegetables, low-fat milk) in school cafeterias | Status quo school cafeteria | Create posters/signage promoting particular healthy foods (I.e., 'Fall is apple harvest time, get them at their best!') | 0 | 0 | 0 | 0 | 0 | 1 |
| Quinn 2018 | Students in secondary schools | Selection of healthy target items (fruits, vegetables, low-fat milk) in school cafeterias | Status quo school cafeteria | Display milk in front of/on top of chocolate milk | 2 | 0 | 0 | 0 | 2 | 2 |
| Quinn 2018 | Students in secondary schools | Selection of healthy target items (fruits, vegetables, low-fat milk) in school cafeterias | Status quo school cafeteria | Highlight healthy foods through labels, signs, or stickers | 0 | 0 | 0 | 1 | 0 | 1 |
| Quinn 2018 | Students in secondary schools | Selection of healthy target items (fruits, vegetables, low-fat milk) in school cafeterias | Status quo school cafeteria | Give healthy food items creative names | 0 | 0 | 0 | 1 | 2 | 0 |
| Radnitz 2023 | University students | Vegan menu choice in hypothetical and actual university dining hall | Free array menu with four vegan and four omnivore entrees featured prominently | Optimal default menu with four vegan entrees featured prominently as the default items, opt-out for four meat/poultry-based entrees listed in smaller text at bottom of menu and available on request | 0 | 1 | 1 | 0 | 2 | 1 |
| Radnitz 2023 | University students | Vegan menu choice in hypothetical and actual university dining hall | Free array menu with four vegan and four omnivore entrees featured prominently | Sub-optimal default menu with four omnivore entrees featured prominently as the default items with opt-out for four vegan entrees listed in smaller text at bottom of menu and available on request | 0 | 1 | 1 | 0 | 2 | 1 |

| Reinholdsson 2023 | Fast-food restaurant patrons | Choice of vegetarian meal from digital menu display in fast-food restaurant | Digital menu display with a grid of icons, including a 'green' section for vegetarian and vegan options | Message added to the 'green' section that reads 'Many here choose green!" | 0 | 0 | 1 | 0 | 0 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|
| Reinholdsson 2023 | Fast food restaurant patrons | Choice of vegetarian meal from digital menu display in fast-food restaurant | Digital menu display with a grid of icons, including a 'green' section for vegetarian and vegan options | Message added to the 'green' section icon that reads 'The green option tastes good!' | 0 | 0 | 0 | 1 | 0 | 0 |
| Reinholdsson 2023 | Fast food restaurant patrons | Choice of vegetarian meal from digital menu display in fast-food restaurant | Digital menu display with a grid of icons, including a 'green' section for vegetarian and vegan options | Message added to the 'green' section icon that reads 'The green option feels good!' | 0 | 0 | 1 | 1 | 0 | 0 |
| Reinholdsson 2023 | Fast food restaurant patrons | Choice of vegetarian meal from digital menu display in fast-food restaurant | Digital menu display with a grid of icons, including a 'green' section for vegetarian and vegan options | Position nudge implemented in which the 'green' section icon was moved from the 6th position (out of 10) to the 1st position | 0 | 0 | 0 | 0 | 2 | 1 |
| Samek 2019 | School children | Choice of white rather than chocolate milk in cafeteria lunch line | Students given message prior to lunch informing them that white milk is the healthier choice | Students given the same message as the control group but, upon choosing white milk, get a smiley face sticker from the teacher | 0 | 2 | 1 | 0 | 2 | 0 |
| Samek 2019 | School children | Choice of white rather than chocolate milk in cafeteria lunch line | Students given message prior to lunch informing them that white milk is the healthier choice | Students given goal-setting card prior to lunch prompting them to decide if they would like to commit to a goal of choosing healthier white milk that day | 0 | 0 | 1 | 0 | 0 | 0 |
| Saulais 2019 | Patrons of self-service restaurant 'living lab' | Vegetable-rich meal selection in self-service restaurant lab | Two dish options presented side by side on the menu | Vegetarian dish made the 'dish of the day' on the menu, displayed in a separate text box to increase salience of the option | 0 | 0 | 0 | 1 | 2 | 0 |

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|---|---|---|---|---|---|---|---|---|---|---|
| Schlegel 2021 | University athletes | Choice of lower-energy dense snack (vs. higher-energy dense snack) after sports match in experiment | Pre-match questionnaire without priming question; after the match, athletes were then offered a single snack of their choice, from three lower-energy dense (apple, banana, orange) and three higher energy dense (chocolate bar, granola bar and biscuit) | Pre-match questionnaire with priming question, i.e., asked to choose one of three low-energy-dense options for consumption after the match; after the match, athletes were then offered a single snack of their choice, from three lower-energy dense (apple, banana, orange) and three higher energy dense (chocolate bar, granola bar and biscuit) | 0 | 1 | 0 | 0 | 2 | 1 |
| Schneider 2022 | Children | Choice of new, healthy dish from children's restaurant menu | Regular children's menu with new, healthy dish included | Promotion of new, healthy dish on the menu with a fun, descriptive name, the use of comic characters to highlight the meal on the menu, and positioning the dish first on the menu as the 'recommended dish' by the restaurant | 0 | 0 | 1 | 1 | 2 | 0 |
| Schomaker 2022 | Adults | Choice of healthy food items in online choice task | Participants prompted to make choices between healthy and unhealthy items in choice task | Participants prompted to make choices between healthy and unhealthy items in choice task, but prior to doing so, arrows are displayed that point in the direction of the healthy item. | 0 | 0 | 0 | 0 | 2 | 0 |
| Segovia 2023 | Regular meat-eaters | Choice of plant-based meat alternatives in online supermarket | No messaging displayed next to meat and plant-based meat alternatives | Health message displayed next to meat and plant-based meat alternatives, i.e., "To reduce your risk of diabetes by 40%, eat one less serving of meat every day" | 0 | 0 | 0 | 1 | 0 | 0 |
| Segovia 2023 | Regular meat-eaters | Choice of plant-based meat alternatives in online supermarket | No messaging displayed next to meat and plant-based meat alternatives | Environmental message displayed next to meat and plant-based meat alternatives, i.e., ,"To reduce your environmental impact by 40%, eat one less serving of meat every day" | 0 | 0 | 1 | 1 | 0 | 0 |

| Segovia 2023 | Regular meat-eaters | Choice of plant-based meat alternatives in online supermarket | No messaging displayed next to meat and plant-based meat alternatives | Health and environmental message displayed next to meat and plant-based meat alternatives, i.e., "To reduce your risk of diabetes by 40%, eat one less serving of meat every day" and "To reduce your environmental impact by 40%, eat one less serving of meat every day" | 0 | 0 | 1 | 1 | 0 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|
| Seward 2016 | University students | Healthy food selection in university cafeteria | Status quo cafeteria sites | Traffic-light labeling added to dishes in cafeteria (I.e., red, yellow, green), healthier food and beverage items were made more accessible or convenient to reach, and serving lines were changes so that vegetables were at the beginning | 1 | 0 | 0 | 0 | 0 | 1 |
| Shin 2022 | University students, staff, and faculty | Choice of low sugar content beverages in convenience store | Status quo refrigerator where beverage position was not changed | Sugar sweetened beverages moved from eye zone to non-eye zone in refrigerator | 2 | 0 | 0 | 0 | 2 | 0 |
| Slapo 2019 | University students | Selection of environmentally friendly dishes in cafeteria | No labels added to dishes | Either (1) traffic-light labels (red, yellow, and green) were added to all dishes, (2) single green label was placed only on environmentally friendly dishes, or (3) single red label on least environmentally friendly dishes; additionally, posters were placed in the cafeteria to explain the labeling system and the climate impact of the different food categories | 0 | 0 | 0 | 0 | 0 | 0 |
| Slapo 2019 | University students | Selection of healthy and sustainable target dishes from online preordering system of university canteen | Dishes presented on preordering system in free away without logos | A 'Healthy and Sustainable' logo was displayed next to names of target dishes | 0 | 0 | 0 | 0 | 0 | 0 |
| Soregaroli 2021 | Restaurant patrons | Selection of wine with a low carbon footprint in a full service restaurant | Five wines labelled with a card that reports wine type and price (equal for each wine) | Five wines labelled with a card that reports wine type, price (equal for each wine), and CO2 emissions associated with each wine | 0 | 0 | 0 | 0 | 0 | 0 |

| Study | Population | Outcome | Comparator | Intervention | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Stein 2019 | Food pantry patrons | Choice of target healthy items (e.g., kale, brown rice, whole-wheat pasta) from food pantry | No intervention | Recipes prepared and labeled using the healthy target items and offered to patrons for a tasting in the waiting room by a research assistant | 0 | 0 | 0 | 1 | 2 | 0 |
| Stein 2019 | Food pantry patrons | Selection of target healthy items (e.g., kale, brown rice, whole-wheat pasta) from food pantry | No intervention | Recipes prepared and labeled using the healthy target items and offered to patrons for a tasting in the waiting room by a research assistant; additionally, bundles of recipe ingredients were placed on a table in the food pantry and offered the ingredients and recipe to make the meal that was being tasted | 0 | 1 | 0 | 1 | 2 | 1 |
| Suleman 2022 | Grocery store shoppers | Purchases of fruits and vegetables in grocery store | Baseline status quo | Grocery cart dividers installed in shopping carts to indicate how much of the cart should be filled with fruits and vegetables | 0 | 0 | 0 | 0 | 2 | 0 |
| Suleman 2022 | Grocery store shoppers | Purchases of fruits and vegetables in grocery store | Baseline status quo | In addition to grocery cart dividers, plaques were installed inside all grocery carts with a message about how many fruits and vegetables were typically purchased in the store: 'In this store the average shopper buys at least 4 fruits or vegetables' | 0 | 0 | 1 | 0 | 2 | 0 |
| Tal 2015 | Grocery store shoppers | Purchases of fruits and vegetables in grocery store | No sample provided | Samples of either cookies or apples offered to shoppers as they entered the store | 0 | 0 | 0 | 1 | 2 | 0 |
| Tal 2015 | University students | Selection of healthier option in online experiment | No sample provided | Participants provided with either apple or cookie sample | 0 | 0 | 0 | 1 | 2 | 0 |
| Tal 2015 | University students | Selection of low-calorie foods in virtual grocery market | No sample provided | Sample of chocolate milk provided accompanied by one of two messages: 1) "healthy, wholesome chocolate milk" or 2) 'rich, indulgent chocolate milk' | 0 | 0 | 0 | 1 | 0 | 0 |
| Thomas 2021 | Nationally representative panel | Purchase of healthier packaged foods in grocery stores | Baseline period with no health star rating displayed | Health star rating displayed together with product nutrition fact label | 0 | 0 | 0 | 0 | 0 | 0 |

| Study | Population | Outcome | Control | Intervention | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Thomas 2021 | University students/adults | Choice of healthier packaged foods in lab setting | No health star rating displayed together with product nutrition fact label | Health star rating displayed together with product nutrition fact label | 0 | 0 | 0 | 0 | 0 | 0 |
| Thorndike 2014 | Patrons of hospital cafeteria | Increased purchases of 'green' and decreased 'red' products in hospital cafeteria | No labeling condition or choice architecture changes | Traffic-light labels applied to all items and the new labeling system was promoted to hospital employees and visitors, and permanent signage and menu board changes accompanied the labels | 0 | 0 | 0 | 0 | 0 | 0 |
| Thorndike 2014 | Patrons of hospital cafeteria | Purchases of 'red' and 'green' products in hospital cafeteria | No labelling condition or choice architecture changes | Traffic-light labels applied to all items and the new labeling system was promoted to hospital employees and visitors, and permanent signage and menu board changes accompanied the labels; additionally, items were rearranged to make green items more apparent (e.g., placing baskets of bottled water throughout the cafeteria; and providing prepackaged salads next to the pizza counter) | 0 | 1 | 0 | 0 | 0 | 1 |
| Thorndike 2017 | Grocery store shoppers using WIC benefits | Purchase of fruits and vegetables in WIC-eligible grocery store | Baseline status quo | Replacing usual displays in the front of the store (e.g., bakery display, chip display) with attractive display of fresh fruits and vegetables | 0 | 0 | 0 | 0 | 2 | 1 |
| Tonkin 2019 | University students | Healthy food choices in experimental setting | Menu with a fork image on the front and a fork image on the inside where food options were listed | Two menu variations tested: 1) Fruit and vegetable basket depicted on cover of menu, fork image on the inside with food options, and 2) Fork image on the cover of the menu, fruit and vegetable basket depicted on the inside with food options | 0 | 0 | 0 | 0 | 2 | 0 |
| Valencic 2024 | Adults | Choice of high-fiber foods in experimental online grocery store | Higher-fibre foods positioned at the bottom of the webpage within each food category, and | Higher-fibre foods positioned at the top of the webpage within each food category, and Fruits and Vegetables category listed first on the | 0 | 0 | 0 | 0 | 2 | 1 |

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|---|---|---|---|---|---|---|---|---|---|---|
| | | | Fruits and Vegetables category listed last on the webpage of the online grocery store | webpage of the online grocery store | | | | | | |
| van Rookhuijzen 2021 | Sports canteen patrons | Choice of healthy products in sports canteen | Status quo baseline canteen | Healthier products placed at eye-level or more in sight or reach | 1 | 0 | 0 | 0 | 2 | 1 |
| Vandenbroele 2018 | Grocery store shoppers | Portion size of sausage purchased in grocery store | 150g sausage portion offered by default | Additional portion options - 125g and 100g packages of sausages - offered side by side | 0 | 0 | 0 | 0 | 2 | 0 |
| Vandenbroele 2021 | Grocery store shoppers | Purchase of meat substitutes in grocery store | Meat product offered in the butchery, and meat substitute was available on a separate, vegetarian shelf in the vegetables and fruits department | Meat substitute remained on the vegetarian shelf but also appeared in the butchery, pairwise with the meat product and also in proximity to other sandwich offerings that contain meat | 0 | 0 | 0 | 0 | 2 | 0 |
| vanderMolen 2021 | Grocery store shoppers | Healthy food purchases in virtual supermarket | Status quo supermarket | Orange colored arrows pointed from unhealthy low-fiber products to healthier high-fiber variants; orange colored frames around sections of the frozen vegetables; division, and smaller, individual orange colored frames around healthy low-fat dairy products | 0 | 0 | 0 | 0 | 2 | 0 |
| VanGestel 2018 | Kiosk customers | Healthy food choice in a kiosk | Status quo food positioning, with unhealthy food products positioned at the checkout counter | Healthy foods repositioned at the checkout counter display, while unhealthy alternatives remained available in the store | 1 | 0 | 0 | 0 | 2 | 1 |
| vanKleef 2014 | Children | Bread choice (wheat vs. white) during school breakfast session | Two baskets of bread rolls placed in the front of the classroom: one with regular-shaped white bread, and regular-shaped whole wheat bread | Two baskets of bread rolls placed in the front of the classroom according to one of the following conditions: 1) fun-shaped white bread, regular wheat bread; 2) fun-shaped wheat bread, regular white bread; 3) fun-shaped white and wheat bread | 0 | 0 | 0 | 1 | 2 | 0 |

| vanKleef 2015 | Restaurant patrons | Choice of side dish in self-service restaurant | No verbal prompts | Addition of verbal prompt by employees, i.e., "Would you like to add orange juice for 50 cents?"; this was also done on separate weeks for other side dishes, including fruit salad and pancakes | 0 | 1 | 0 | 0 | 2 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|
| vanKleef 2018 | University students | Choice of whole wheat bread for a sandwich served in a university canteen | Free sandwich with white bun offered by default, with listed option to opt for a whole wheat bun instead | Free sandwich with whole wheat bun offered by default, with sign that listed option to opt for a white bun instead. The white bun alternative was clearly visible. The default free sandwich was framed as the "sandwich of the day" | 0 | 1 | 1 | 1 | 2 | 1 |
| vanRookhuijzen 2021 | Sports canteen patrons | Choice of healthy products in sports canteen | Status quo baseline canteen | A picture of the grilled sandwich that was placed on the counter with the message that it was available while supplies last | 0 | 1 | 0 | 0 | 2 | 1 |
| vanRookhuijzen 2021 | Sports canteen patrons | Choice of healthy products in sports canteen | Status quo baseline canteen | A picture of the grilled sandwich was placed on the counter | 0 | 0 | 0 | 0 | 2 | 1 |
| vanRookhuijzen 2021 | Sports canteen patrons | Choice of healthy products in sports canteen | Status quo baseline canteen | Patrons who request a sports drink are automatically provided the zero-sugar version, with the regular version available upon request | 0 | 1 | 1 | 0 | 2 | 0 |
| VanRookhuijzen 2021 | Adults | Hypothetical healthy food choice in questionnaire | Participants were prompted to choose one option they would like to consume from choice sets consisting of four options (2 healthy, 2 unhealthy) | Participants were prompted to choose one option they would like to consume from choice sets consisting of four options (2 healthy, 2 unhealthy) with one of the healthier products pre-selected | 0 | 1 | 1 | 0 | 2 | 0 |
| vanRookhuijzen 2023 | Adults working from home with the intention to increase fruit consumption | Increased fruit consumption at home | Participants were not asked to self-nudge | Participants received an explanation on what nudges are and asked to choose one of six nudges to implement themselves (there were two accessibility, two salience, and two reminder nudges to choose from) | 0 | 0 | 0 | 0 | 0 | 0 |

| Study | Population | Outcome | Control | Intervention | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Vellinga 2022 | Adults | Decreased meat purchases in virtual supermarket | No intervention prior to entering virtual supermarket | Participants exposed to an information nudge to create awareness regarding the environmental impact of meat production prior to entering virtual supermarket | 0 | 0 | 0 | 0 | 0 | 0 |
| Venema 2020 | Individuals recruited from university campus | Reduced sugar added to tea in lab setting | Standard size teaspoon for adding sugar in tea offered (5 ml) | A small spoon (2.5 ml) for adding sugar in tea offered | 2 | 0 | 0 | 0 | 2 | 0 |
| Venema 2023 | Hospital staff and visitors | Vegetarian sandwich choice in hospital canteen | Status quo hospital canteen | Combination of nudges adopted simultaneously. First, the vegetarian sandwich display was placed at eye-level with 'chef's recommendation' signage and a brief description of the cafe's sustainability goals. 'Chef's recommendation' stickers were placed on vegetarian sandwich bags. Finally, the vegetarian sandwiches were placed at the beginning of the canteen line | 0 | 0 | 1 | 1 | 0 | 1 |
| Walmsley 2018 | University students | Purchases of fruits and vegetables in campus grocery store | Fruits and vegetables located at the back of the store | Fruits and vegetables moved to the aisle closes to the entrance with an entrance-facing display | 0 | 0 | 0 | 0 | 2 | 1 |
| Wongprawmas 2023 | University students | Selection of healthy and sustainable target dishes from online preordering system of university canteen | Dishes presented on preordering system in free away without logos | A 'Healthy and Sustainable' logo was displayed next to names of target dishes | 0 | 0 | 0 | 0 | 0 | 0 |
| Wongprawmas 2023 | University students | Selection of healthy and sustainable target dishes from online preordering system of university canteen | Dishes presented on preordering system in free array without any logo | 'Healthy and Sustainable' dishes placed at the beginning of each dish category | 0 | 0 | 0 | 0 | 0 | 0 |
| Wongprawmas 2023 | University students | Selection of healthy and sustainable target dishes from online preordering system of university canteen | Dishes presented on preordering system in free array without any nudging | 'Healthy and Sustainable' dishes placed at the beginning of each dish category in addition to the 'Healthy and Sustainable' logo | 0 | 0 | 0 | 0 | 0 | 0 |

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|---|---|---|---|---|---|---|---|---|---|---|
| Yi 2022 | University students | Choice of added kale/spinach in smoothies on university campus venues | Status quo baseline period | Next to the cash register, a green poster prompted customers to add kale or spinach to their smoothie, another poster read "Are you getting your servings of veggies in? Try adding kale or spinach. Only $1.00" | 0 | 1 | 1 | 0 | 2 | 0 |
| Yi 2022 | University students | Choice of fruit on university campus venues | Status quo baseline period | Next to fruit stand, a bright, yellow poster read "Try a FRESH whole fruit today! Only $1.00 (Grapefruit $1.25)" | 0 | 1 | 1 | 0 | 2 | 0 |
| Yi 2022 | University students | Choice of large (vegetable) portion in self-serve barbecue station on campus venue | Status quo baseline period | Next to barbecue station, poster reminded customers of the greater value for money in choosing a larger bowl and displayed the price for medium and large bowls | 0 | 1 | 0 | 0 | 2 | 0 |
| Yi 2022 | University students | Healthy choice (i.e., sandwiches with spinach) in deli sandwich station | Status quo baseline period were iceberg lettuce was placed in larger containers and closer to customers, without signage | In a custom-made deli station, baby spinach was placed closer to customers while the iceberg lettuce was placed farther away and a sign read ,"Did you know you can add spinach for no extra charge? Try it today!" | 0 | 1 | 1 | 0 | 2 | 0 |
| Yi 2022 | University students | Increased consumption of salad at self-service salad bar | Medium plates stacked in the front row facing customers in line for the salad bar, whereas large plates were stacked in the middle row and small bowls in the back row | Large plates stacked in the front row facing customers in line for the salad bar, whereas medium plates were stacked in the middle row and small bowls in the back row | 2 | 0 | 0 | 0 | 2 | 0 |
| Young 2020 | Shoppers in supermarket | Healthier cereal choice in supermarkets | Status quo supermarkets and pre-intervention period | Healthier breakfast cereals placed at eye-level on shelves | 1 | 0 | 0 | 0 | 2 | 1 |
| Zhang 2022 | Young adults | Choice of vegetable dishes in hypothetical virtual reality (VR) restaurant | VR vegetable and meat dishes dishes displayed in red containers | VR vegetable dishes displayed in blue containers, while meat dishes are displayed in red containers | 0 | 0 | 0 | 0 | 2 | 0 |

| Study | Population | Context | Comparator | Intervention | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Zhang 2022 | Young adults | Choice of vegetable dishes in hypothetical VR restaurant | VR vegetable and meat dishes dishes displayed in red containers | VR vegetable dishes displayed in red containers, while meat dishes are displayed in blue containers | 0 | 0 | 0 | 0 | 2 | 0 |
| Zhang 2022 | Young adults | Choice of vegetable dishes in hypothetical VR restaurant | VR vegetable and meat dishes dishes displayed in red containers | VR vegetable and meat dishes displayed in blue containers | 0 | 0 | 0 | 0 | 2 | 0 |
| Zhang 2024 | Adults | Vegetable consumption in lab setting | Status quo ordinary plate and bowl | Tableware painted with patterns of grains, meats, and vegetables and a marker line indicating the proportion of the bowl that fits 50 g of rice, and recommended portions of vegetables and meats on the plate | 0 | 0 | 1 | 0 | 0 | 0 |
| Zhou 2019 | Adults ages 65 and older | Selection of novel plant-based dishes in various restaurant settings (senior centers, restaurant, private club) | Presentation of three dishes with equal opportunity: fish dish, meat dish, and veggie dish | Veggie dish labelled as the 'dish of the day' | 0 | 0 | 0 | 1 | 2 | 0 |
| Zhuo 2023 | Adults | Sustainable choice within product categories in simulated online supermarket | In supermarket website, products in each product category were randomly ordered | In supermarket website, products in each product category were listed in the order of most sustainable to least sustainable, but no information about this ordering was given | 0 | 0 | 0 | 0 | 2 | 0 |
| Zhuo 2023 | Adults | Sustainable choice within product categories in simulated online supermarket | In supermarket, products in each product category were listed in the order of most sustainable to least sustainable, but no information about this ordering was given | In supermarket, products in each product category were listed in the order of most sustainable to least sustainable, and a statement was shown in a box at the top of each product category page to reveal this ordering, i.e., "The products on this page have been ordered from the most environmentally sustainable to the least environmentally sustainable. This is to make it easier for you to choose a more sustainable product if you wish." | 0 | 0 | 0 | 0 | 0 | 1 |

## E2. Supplementary File (S2) Frequencies of Nudge Intrusiveness by Nudge Type and Intrusiveness Dimension

*Nudge type*: Campaigns, Commitments, Default, Improved design strategies, Information mechanisms, Other, Transaction shortcuts, Warnings and reminders
*Intrusiveness dimensions*: physical resources, economic resources, social norms, emotional appeals, non-transparency of nudge, non-transparency of alternatives
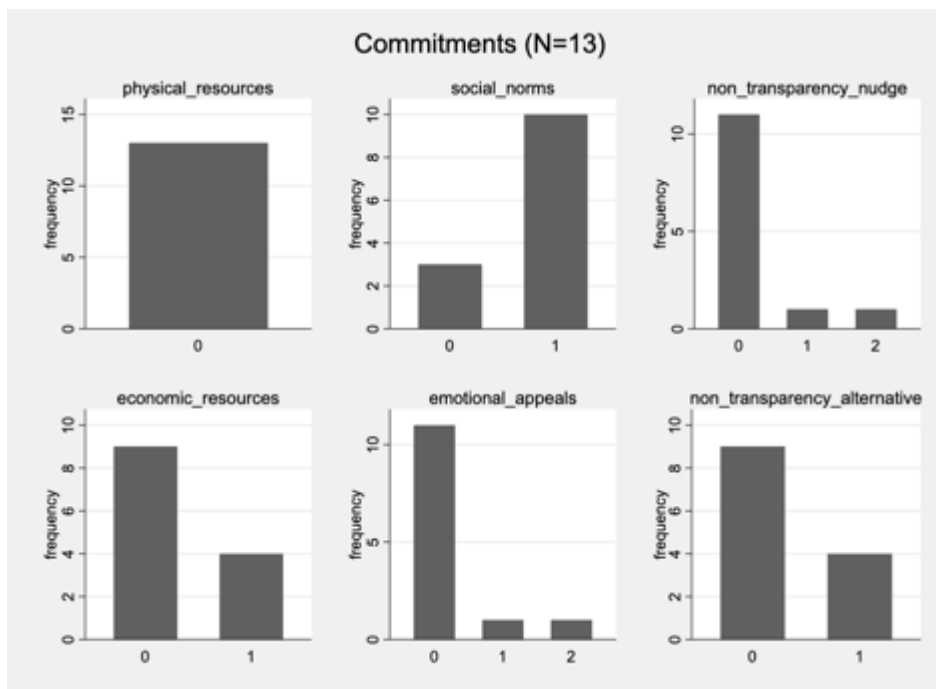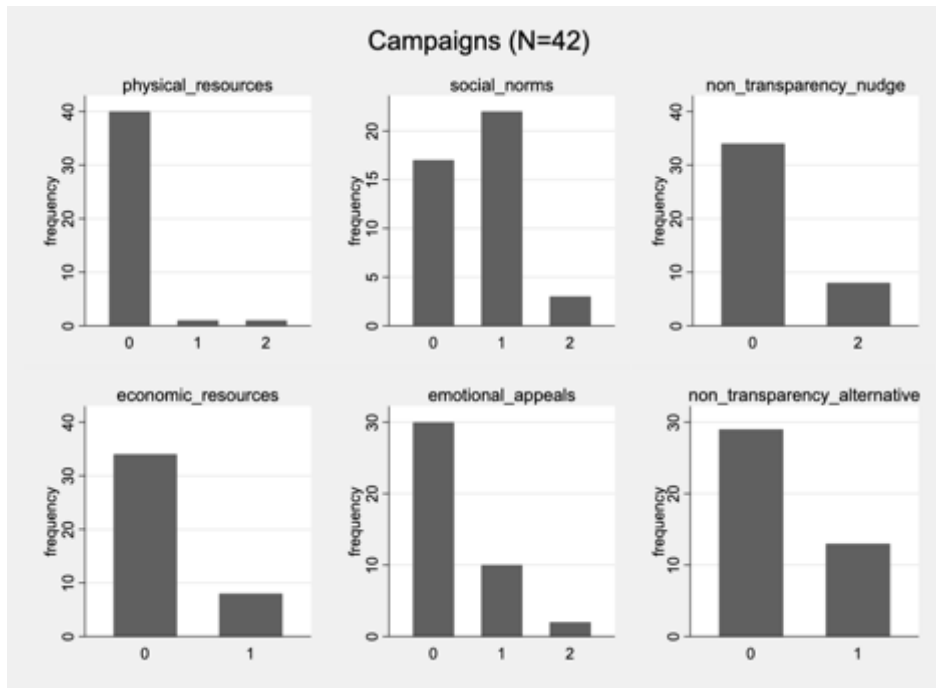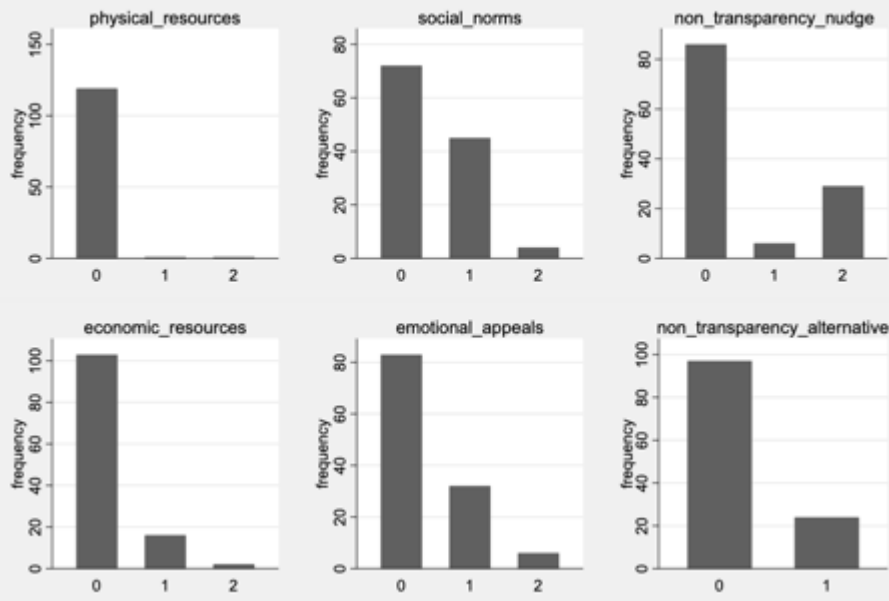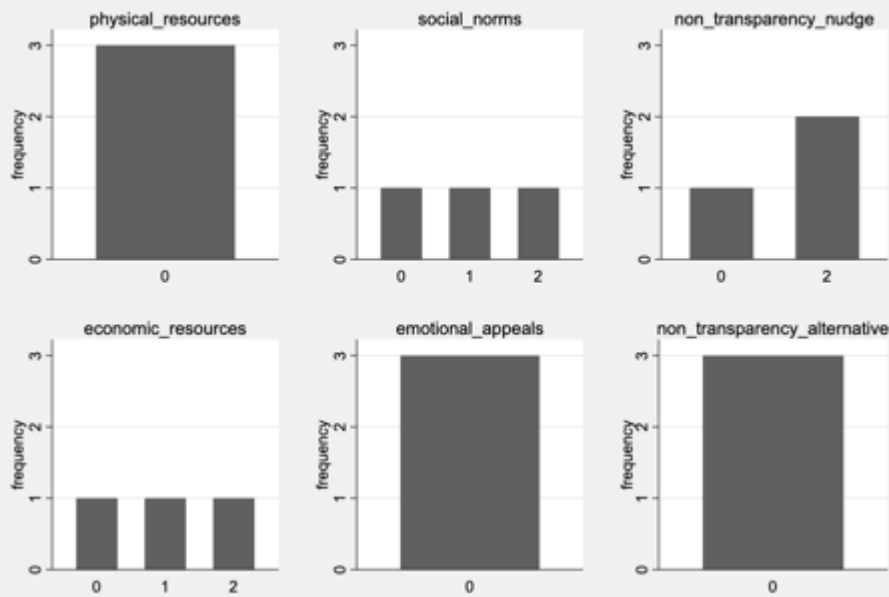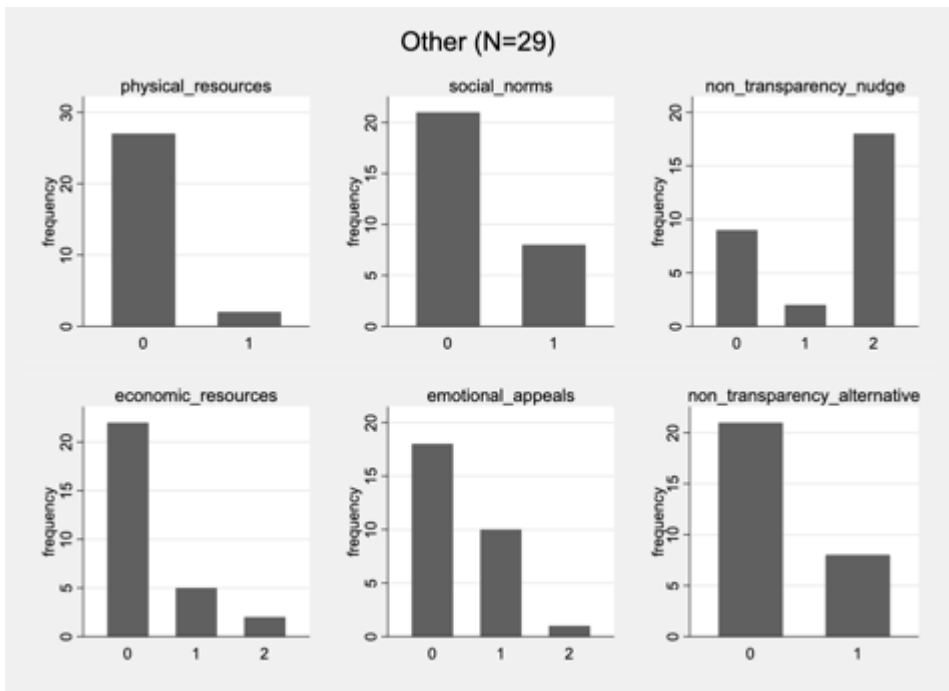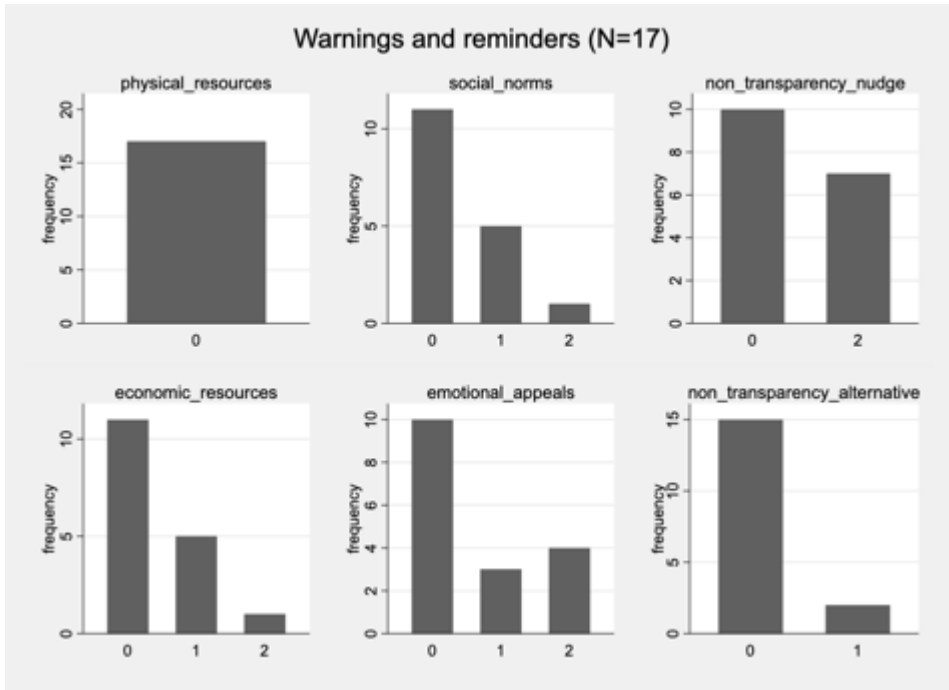
Defaults (N=47)
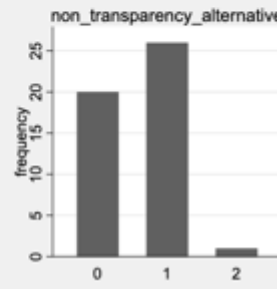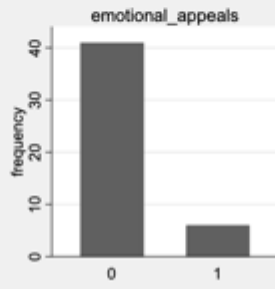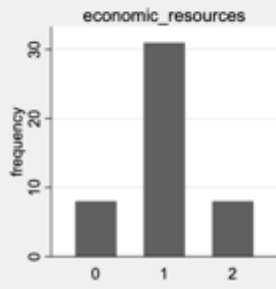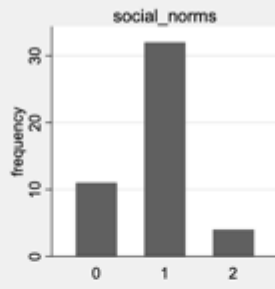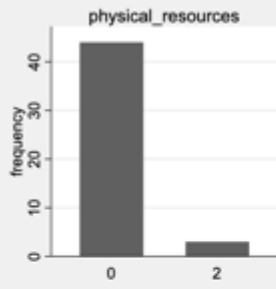
Improved Design Strategies (N=85)

184
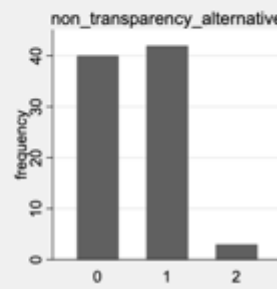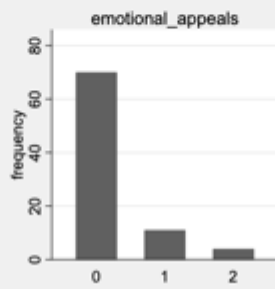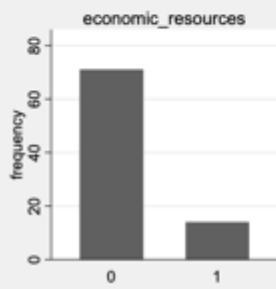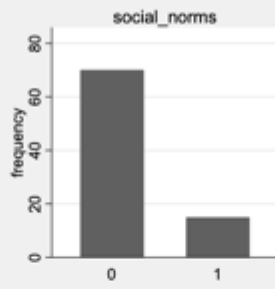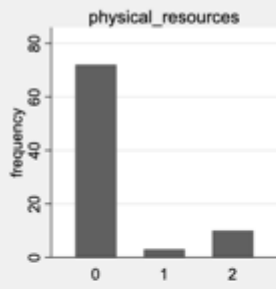
Information mechanisms (N=121)



Transactional shortcuts (N=3)

X-axis: 0=Nudge is not applicable to this intrusiveness mechanism, 1= Nudge prays upon this intrusiveness mechanism but the degree is not considered intrusive, 2=Nudge might be intrusive, Note, a nudge could be categorized as more than one nudge type

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## Statement of Contribution to Each Paper of this Cumulative Dissertation

My contribution to the five papers of this cumulative dissertation is as follows:

- Article 1: *"How do defaults and framing influence food choice? An intervention aimed at promoting plant-based choice in online menus"* co-authored by Yasemin Boztug and Dominic Lemken: I contributed to the conceptualization of the study. I collected the data, conducted the formal analyses, created the visualization, wrote the original draft and edited the manuscript.

- Article 2: *"Tasty or sustainable? Goal conflict in plant-based food choice"* co-authored by Steffen Jahn and Yasemin Boztug: I contributed to the conceptualization of the study, data collection, formal analysis and visualization. I wrote the original draft and edited the manuscript.

- Article 3: *"Driving public support for a meat tax: Fiscal policies and behavioral interventions"* co-authored by Sanchayan Banerjee and Meike Morren: I contributed to the conceptualization of the study, data collection, formal analysis and visualization. I wrote the original draft and edited the manuscript.

- Article 4: *"Substitution patterns and price response for plant-based meat alternatives"* co-authored by Steffen Jahn and Daniel Guhl: I contributed to the conceptualization of the study, data collection, writing the original draft, and editing the manuscript.

- Article 5: *"A choice architect's guide to the (autonomous) galaxy: a systematic scoping review of nudge intrusiveness in food choices"* co-authored by Dominic Lemken and Simone Wahnschafft: I contributed to the conceptualization of the study, data collection, visualization, writing the original draft, and editing the manuscript.