The Journal of Population and Sustainability

ISSN 2398-5496

Article title: Nudging interventions on sustainable food consumption: a systematic review

Author(s): Becky Blackford

Vol. 5, No. 2, 2021, pp.17-62.

doi: 10.3197/jps.2021.5.2.17

PEER REVIEWED ARTICLE

Nudging interventions on sustainable food consumption: a systematic review

Becky Blackford[1]

Bournemouth University

Abstract

As population growth continues, sustainable food behaviour is essential to help reduce the anthropogenic modification of natural systems, driven by food production and consumption, resulting in environmental and health burdens and impacts. Nudging, a behavioural concept, has potential implications for tackling these issues, encouraging change in individuals' intentions and decision-making via indirect proposition and reinforcement; however, lack of empirical evidence for effectiveness and the controversial framework for ethical analysis create challenges. This systematic review evaluated the effectiveness of nudging interventions on sustainable food choices, searching five databases to identify the effectiveness of such interventions. Of the 742 identified articles, 14 articles met the eligibility criteria and were included in this review. Overall, the potential of certain nudging interventions for encouraging sustainable food choices were found in strategies that targeted 'system 1' thinking (automatic, intuitive and non-conscious, relying on heuristics, mental shortcuts and biases), producing outcomes which were more statistically significant compared to interventions requiring consumer deliberation. Gender, sensory influences, and attractiveness of target dishes were highlighted as pivotal factors in sustainable food choice, hence research that considers these factors in conjunction with nudging interventions is required.

1 blackfordbecky@gmail.com

Keywords: nudging interventions; sustainable food choice; food security

Introduction

Population growth, increased per capita global affluence, urbanisation, increased food productivity and food diversity, decreased seasonal dependence, and food prices have caused major shifts in global dietary and consumption patterns (Lassalette et al., 2014; Tillman and Clark, 2014; Davis et al., 2016). Westernisation of food consumption has occurred in population growth regions over the last 50 years, increased demand for meat and dairy, empty calories and total calories has altered the global nature and nutrient transition scale of food consumption (Kearney, 2010; Tillman and Clark, 2014). The Food and Agriculture Organisation of the United Nations (FAO) suggest that food production will have to increase by 70% to feed an additional 2.3 billion people by 2050, with the majority of this population growth occurring in developing countries (FAO et al., 2020).

The 2019/20 annual global production of cereal grains (2.7 billion tonnes) alone is capable of providing adequate nutritional energy to 10-12 billion people (Cohen, 2017; FAO et al., 2020). However, issues surrounding the allocation and utilisation of cereal grains has led to 43% being used for human food consumption, 36% for animal feed and 21% for other industrial uses such as biofuels. This utilisation can price the most vulnerable people out of the world grain market, limiting food choices, purchases, and human wellbeing (Cohen, 2017). The FAO estimate that 8.9% (690 million) of the global population are undernourished and 9.7% (750 million) are exposed to severe levels of food insecurity (FAO et al., 2020).

Global food production is a significant driver in the anthropogenic modification of natural systems, causing burdens and impacts on both the environment and human health. Externalities including environmental impact (e.g., climate change, biodiversity loss, and natural resource depletion), and negative impacts on human health and culture (e.g., obesity, cancer, diabetes, loss of cultural heritage, impacts on rural businesses, access to green spaces) are generally not included in the price of commodities (Lassalette et al., 2014; Beattie and McGuire, 2016; Benton, 2016; Notarnicola et al., 2017; Schanes et al., 2018; Sustainable Food Trust, 2019; Taghikhah et al., 2019; Viegas and Lins, 2019). Encouraging consumers to adopt more sustainable food behaviour, such as locally sourced foods or diets containing less meat, is essential to reduce the impact of food production and

consumption, especially in developed countries (Kerr and Foster, 2011; Schoesler et al., 2014; Hartmann and Siegrist, 2017; Ferrari, et al., 2019; Hedin et al., 2019; FAO, 2019; de Grave et al., 2020).

Sustainable consumption (SC) was first highlighted in the 1992 United Nations Conference on Environment and Development, chapter 4 - Agenda 21 (UNCED, 1992), and defined in the 1994 Oslo Symposium on Sustainable Consumption as:

> the use of services and related products which respond to basic needs and bring a better quality of life while minimising the use of natural resources and toxic materials as well as emissions of waste and pollutants over the life cycle of the service or product so as not to jeopardise the needs of future generations. (United Nations, 2020, p.8)

The 2018 Third International Conference of the Sustainable Consumption Research and Action Initative (SCORAI) in Copenhagen highlighted the role of behavioural economics and related strategies on consumption routines to assist SC (SCORAI, 2018). Hence it is vital to understand human behaviour as complex and influenced by cognitive bias and heuristics (Fischer et al., 2012; Lehner et al., 2016).

Kahneman (2011) proposed that human thinking is driven by two systems:

- system 1- automatic, intuitive and non-conscious, relying on heuristics, mental shortcuts and biases

- system 2-intervening, deliberate and conscious, relying on the availability of information and cognitive capacity to process information to make rational choices

Both are susceptible to 'nudges' that encourage behavioural change within civil society (Allcott and Mullainathan, 2010; Kahneman, 2011; Fischer et al., 2012; Marteau, 2017). Richard Thaler and Cass Sunstein first popularised the term 'nudge' in the book *Nudge: Improving Decisions About Health, Wealth, and Happiness* (2008), in reference to any characteristic of the decision environment "that alters people's behaviour in a predictable way without forbidding any options or significantly changing their economic incentives" (Thaler and Sunstein,

2008, p.6). Sunstein (2013) further suggested that nudges can be promising tools for promoting a broad range of pro-environmental and sustainable consumption behaviours (Sunstein, 2013).

Nudging interventions can play an important role in sustainable food consumption (SFC), helping change consumers food habits in a non-obtrusive, cost-effective manner by modifying the choice architecture in which consumers operate - thus steering their behaviour in preferred directions (Torma et al., 2018; Kácha and Ruggeri, 2019; Vandenbroele, et al., 2019). Hence nudges are the opposite of coercive policy tools which tackle behaviour change through fines or bans (Ferrari, et al., 2019). Blumenthal-Barby and Burroughs (2012) describe the ethical issues surrounding the MINDSPACE framework and identify six principles that can be used to nudge people: defaults (D); ego and commitment (EC); incentives (I); messenger and norms (MN); priming (P); and salience and affect (SA) (BIT, 2010; Blumenthal-Barby and Burroughs, 2012). Descriptive norms, such as incentivising tools for online shopping, can help encourage pro-environmental behaviour and the purchasing of green products (Demarque et al., 2015) whilst social norm interventions, such as those around the use of reusable cups, can help customers avoid wasteful disposable items (Loschelder, et al., 2019). D and P nudges, such as visibility, positioning, display area size and quantity, can shift consumers' purchase behaviour towards more sustainable choices (Coucke, et al., 2019), whereas environmentally friendly food packaging can produce overall positive impacts on consumers' sustainability choices (Ketelsen, et al., 2020).

Nudging is still in its infancy. The UK established the Behavioural Insight Team in 2009 to help develop the concept of nudge units, initiatives and networks, whilst The World Bank, OCED and the EU have supported research to further examine the potential of nudging (Hansen, 2016). Policymakers utilise nudges to help design, implement and evaluate the appropriate policy instruments to assist in devising effective policies to enhance sustainable behaviour and counteract the negative impact of other actors who encourage 'undesirable' behaviours (Lehner et al., 2016; Marteau, 2017). However, nudging has been challenged and criticised on a number of grounds, including the lack of empirical evidence proving its effectiveness, the difficulty in putting theory into practice, and for ethical reasons – i.e. paternalism and reduced human autonomy (Hansen, 2016; Kasperbauer, 2017).

Existing systematic reviews (SR) undertaken on nudging interventions on food choices have mainly focused on human health and diet (Bucher et al., 2016; Wilson et al., 2016; Broers et al., 2017; Bianchi et al., 2018; Taufika et al., 2019; Vecchio and Cavallo, 2019), and the environmental impacts on the supply chain (Ferrari et al., 2019). For example, Ferrari et al. (2019) showed that 'green nudging', especially D, NM, P and SA, has the most significant effect on leveraging more sustainable practices and behaviours of both farmers and consumers, having the potential to be used as tools for environmental policy formulation (Ferrari et al., 2019). Bucher et al. (2016), Broers et al. (2017) and Bianchi et al. (2018) illustrated how altering placement of food items can produce a moderate significant effect on promoting healthier eating behaviours through healthier food choices. Bucher et al. (2016) further suggested that the strength of the nudge depends on the type of positional manipulation, the magnitude of the change and how far away foods are placed (Bucher, et al., 2016; Broers et al., 2017; Bianchi et al., 2018). Bianchi et al., (2018) additionally demonstrated that SA, I and P could increase consumers plant-based choices by 60-65% (Bianchi et al., 2018). Wilson et al. (2016) illustrated that the combination of P and SA enable consistent positive influences on healthier food and beverage choices, making healthier options easier to choose both mentally and physically (Wilson et al., 2016). Furthermore, Taufika et al. (2019) illustrated that the combination of SA and MN could be associated with the reduction of meat consumption (Taufika et al., 2019). Vecchio and Cavallo (2019) suggested that, overall, nudge strategies successfully increased healthy nutritional choices by 15.3% (Vecchio and Cavallo, 2019).

Although these results show that nudges are generally effective in promoting healthier food choices and sustainable practices and behaviours, none of the studies examined the effectiveness of nudging interventions on SFC. There is a knowledge gap on the effectiveness of nudging interventions on sustainable food choices. The goal of this systematic review is to synthesise the empirical findings of existing published academic literature that has investigated the effect of various nudging interventions on these choices and therefore upon SFC in real-life contexts. This paper will:

- examine the evidence around the effectiveness of interventions for SFC

- show the factors that influence the effectiveness of interventions
- help identify research gaps in current understanding of the field (Peričić-Poklepović & Tanveer, 2019; CEE, 2020)

Methodology

A search was conducted to identify published literature that utilised interventional and experimental studies to examine nudging interventions to encourage SFC. The studies were identified using the search strategy and analysed against inclusion criteria, those studies that met these criteria were further synthesised by analysing abstracts and full texts. Type of nudges applicable were D, EC, I, MN, P and SA.

Search strategy

This systematic review was conducted in September 2020. The search terms used to identify literature from data sources were:

"nudge*" OR "nudging" OR "nudging theory" AND "sustainable* consumption" AND "food" OR "diet" AND "consumer".

Using these search terms, published literature were retrieved from online databases, Web of Science, Scopus, ScienceDirect, EBSCO (Bournemouth University Library) and Google Scholar[2]. The title and abstracts of the retrieved articles were screened for relevance. The potentially relevant articles were examined for their eligibility to be included in the review, whilst the references of the eligible literature were screened to identify any additional eligible literature.

Language and date restrictions

Publication dates were restricted to between 2010-2020 in order that only material released after the publication of Thaler and Sunstein's (2008) techniques was considered. Only literature published in English were included.

2 "effectiveness" AND "interventions" included for ScienceDirect and Google Scholar due to large size of articles found. ScienceDirect did not accept wildcards (*).

Selection criteria

The inclusion criteria for selecting eligible literature were:

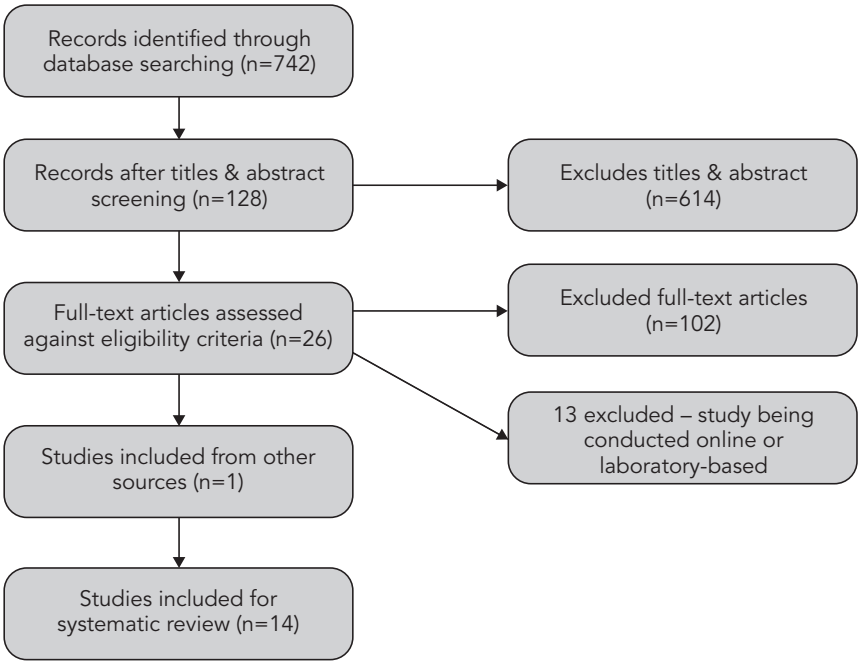
- Full test peer-reviewed studies in English language
- Primary studies between 2010–2020
- Studies should examine the effectiveness or impact of nudges on sustainable food choices
- Randomised control trial studies or have a 'control' to ensure empirical evidence
- The study should measure sustainable food choices as one of its outcomes via dietary choices i.e., less meat more vegetables

'Grey' literature such as reports and letters were excluded as they were not peer-reviewed.

Selection process

A total of 742 eligible studies were retrieved from the data sources using the aforementioned search strategy, 6 from Web of Science, 338 from ScienceDirect, 9 from EBSCO (Bournemouth University Library), 379 from Google Scholar and 8 from Scopus. After reviewing titles and abstracts, 614 were excluded (Fig 1). The remaining 128 studies were assessed against the inclusion criteria, resulting in exclusion of 102 studies, leaving 26 for further review. 12 articles were further excluded owing to collection of empirical evidence being conducted in a laboratory setting or online surveys, holding the potential for behavioural bias, resulting in 14 articles that were based in a naturally occurring setting i.e., supermarket/canteen. Searching reference lists of the remaining 13 articles, 1 further article was obtained, creating a total of 14 articles for the SR (Fig 1).

Figure 1: ROSES Flow Diagram – illustrating search progression and elimination of literature for SR (Haddaway et al., 2017)



Data extraction and synthesis

From the 14 eligible articles basic descriptive data were recorded to ensure quality assessment, including study design, year of data collection, country of residence, target subjects, sample size and intervention setting. More detailed data extraction included: intervention strategy; outcome measured; data analysis method; main findings; and effectiveness of intervention when evaluated against sustainable food choices i.e., less meat more vegetables.

The simple mnemonic MINDSPACE framework was utilised to identify the nine robust nudges that can influence behaviour: messenger; incentive; norms; defaults; salience; priming; affect; commitments; and ego – MINDSPACE (BIT, 2010). For this SR, they have been grouped into six categories – D, EC, I, MN, P and SA (Table 1) (Blumenthal-Barby and Burroughs, 2012).

Table 1: Description of six categories of nudges

Nudge	Description
Messenger & Norms	To affect decision behaviour, people are heavily influenced by who communicates.
Incentive	To motivate change in behaviour by predictable mental shortcuts, such as strongly avoiding losses or rewards.
Default	To cultivate behaviour that encourages "go with the flow" of pre-set options.
Salience & Affect	To influence behaviour and decision making by bringing attention to what is novel and seems personally relevant, triggering emotional associations which can shape actions.
Priming	Utilising subconscious cues to influence behavioural strategically.
Ego & Commitment	Achieving long-term behavioural change by utilising public promises, reciprocate acts, self-esteem and self-image.

There are many frameworks that help identify key concepts and nudges to influence behaviour towards healthier choices. The TIPPME framework (Typology of Interventions in Proximal Physical Micro-Environments) aims to reliably classify, describe and enable more systematic design, reporting and analysis of interventions in order to help change behaviour across populations utilising nudges D, P, SA to change selection, purchase and consumption of foods (Hollands et al., 2017). Applying EC, MN, SA nudges, the SHIFT framework aims to encourage consumers into pro-environmental behaviours when the message or context influences psycological factors, such as social influence, habit formation, individual self-feeling, cognition and tangibility (White et al., 2019). Chance et al.'s (2014) The 4P's framework aims to integrate nudges within a dual-system model of consumer choice by targeting possibilities, process, persuasion and person, using nudges D, EC, MN, P, SA. Kraak et al. (2017) extend this framework by suggesting a marketing mix and choice architecture 8P's framework, highlighting the potential to promote and socailly normalise healthy food environments. This works by utilising nudges D, EC, I, MN, P, SA encouraging voluntary changes made to the properties of the environment and food being sold (place, profile,

portion, pricing, promotion) and volunatry changes made to the placement of food sold (healthy default picks, priming/prompting, proximity (Kraak et al., 2017).

Study quality assessment

To assess the quality of data obtained from the eligible studies a rating scheme was utilised, ranging from weak (*) to very strong (****). The principles of the ratings were based on study design, selection bias, sample size, duration of study, and risk of bias from missing information (Table 2). The rating scheme was adapted from a previous study undertaken by Nørnberg et al. (2015) who successfully utilised this method to rate and assess the effectiveness of interventions on vegetable intake in a school setting.

Table 2: Definition and explanation of study quality assessment (Nørnberg, et al., 2015)

Rating	Definition	Study Description	Design & Methods
*	Weak	Three of more of the following details are missing: intervention setting, design, duration, RCT or control, statistical analysis.	Design of intervention or statistical methods are flawed.
**	Moderate	One or two missing details and satisfactory presentation.	Small sample size (<50) and/or short duration (<1 week).
***	Strong	One or two missing details and clearly presented.	Large sample size (>100) and/or longer duration (>1 week)
****	Very Strong	All details evident and clearly presented.	Large sample size (>100) and/or longer duration (>1 week). Includes any or all of the following: population randomly allocated or matched for intervention or control and validated assessment.

Results

Overall effectiveness of nudging interventions on SFC

The 14 articles included in this SR all focused on SFC in the form of food choice behaviour and were conducted in North America and Europe. Interventions were conducted at supermarkets, canteens, cafeterias, restaurants or cafeterias at

universities, workplace, senior activity centres and the Institute Paul Bocuse. The subjects consisted of students, university staff, workplace employees, retirees, and the general population. Five studies used SA as the core nudge, three used a P/SA combination, two used a D/P combination, one used P, one used D, one used D/SA combination and one used I/MN/SA combination. The intervention strategies, intervention duration and sample sizes were largely heterogeneous across all studies (Table 3).

The different strategies and methods applied to implement the varying nudges illustrated differing effectiveness (Table 4). The studies utilising nudges SA (Gravert and Kurz, 2019; Kurz, 2018), P (Garnett et al., 2019), D/P combination (Coucke et al., 2019; Vandenbroele et al., 2018) and D/SA combination (Campbell-Arvai et al., 2014) provided statistically significant impact for increasing sustainable food choices. However, studies that implemented D (Zhou et al., 2019), P/SA combination (McBey et al., 2019) and SA (Piester et al., 2020; Salmivaara and Lankoski, 2019; Slapø and Karevold, 2019) were not statistically significant. One study which utilised P/SA combination (Ohlhausen and Langen, 2020) showed statistical significance with regards to SA but not P, whilst a P/SA combination (Kaljonen et al., 2020) and I/MN/SA combination (Becchetti et al., 2020) illustrated marginal statistical significance, highlighting the potential use of these combinations.

Data quality assessment

Twelve studies were randomised control trials (RCT), duration of interventions varied considerably, ranging from 1 day to 3 years, three studies did not specify the intervention duration. All studies, bar one, had a large sample size (>100) and one lacked sufficient statistical analysis. The quality rating of the included studies was strong to very strong with a mean rating of 3.2 and standard deviation of 1.08 (Table 5).

Sustainable food choices

In total, five of the studies utilised the nudge SA to encourage SFC (Kurz, 2018; Gravert and Kurz, 2019; Salmivaara and Lankoski, 2019; Slapø and Karevold, 2019; Piester et al., 2020). The main strategy utilised consisted of signage, ranging from descriptive menus to visual environmental information. Gravert and Kurz (2019) suggested that introducing two different menus, 1 x meat and fish dishes 1 x vegetarian and fish dishes – meat or vegetarian choices were available upon

Table 3: Intervention description of the included studies (n 14)

Author(s)/ Year(Data)/ Country	Study Design	Study Setting/ Participants	Sample Size	Nudge[#]	Intervention Strategy
Campbell-Arvai et al., 2014 Midwestern USA	Phase 1: cross sectional survey Phase 2: RCT 2x2x2 between subjects factorial design	University canteens (randomly selected) Undergraduate students	320 students	D SA	2- phase intervention Phase 1: rating of vegan/ vegetarian meals from unappealing to appealing Phase 2: providing 4 different menu types (default, default + information, information only & control)
Coucke et al., 2019 European City (unknown)	RCT	Supermarket – butcher counter General population[$]	Not specified	D P	Enhance visibility of poultry via 1. enlarging the display area size 2. increasing quantity of displayed poultry products
Kaljonen et al., 2014–2017 Finland	Cohort study Qualitative	Finnish Environment Institute (SKYE) restaurant Employees	188 – climate label 16 – recipe development	P SA	1. climate label: informing employees of most climate-friendly lunch choices 2. food order: positioning vegetarian food first on buffet line

			No data for number of lunches sold		3. tinkering: developing and increasing diversity, taste and appearance of vegetarian meals
Piester et al., 2019 USA	Cohort study RCT	University café Undergraduate/ graduate students, faculty staff and other	Study 1 – 228 Study 2 – 228	SA	1. sustainability labels: indicating the degree of environmental impact of each food item 2. one item targeted (veggie burger) for sustainability and taste by using sustainability
Slapø & Karevold 2019 Norway	RCT	University cafeteria Undergraduate/graduate students & staff	228 observations	SA	Simple labels: three different labelling systems 1. traffic light labels 2. single-green label 3. single- red label
McBey et al., 2019 Scotland	Cross sectional survey Qualitative	Focus groups at various sites Parents with young children, undergraduate students, working class men, gym users, retirees & cohabiting couples no children	60 participants	P SA	1. simplification and framing of information: environmental labelling of meat products 2. changes to physical environment: positioning in supermarkets

Author(s)/ Year(Data)/ Country	Study Design	Study Setting/ Participants	Sample Size	Nudge[#]	Intervention Strategy
Gravert & Kurz 2016 Sweden	RCT	Restaurant White collar employees	2776 meals eaten	SA	Customers randomly presented with one of two menus 1. meat and fish dishes 2. vegetarian and fish dishes meat or vegetarian dish was available upon request
Kurz 2015–2016 Sweden	RCT	Two university restaurants 1 x control 1 x treated Students and staff	53,537 meals eaten (average)	SA	1. visibility of vegetarian dishes equally visible to the other two meat dishes 2. vegetarian dishes brought to position 1 in menu order
Becchetti et al., 2016 Italy	RCT	12 Coop Italia General population[$]	3,212 items purchased	I MN SA	3 x small posters displayed in shops promoting importance of buying environmentally responsible products, strategically placed to replace the traditional price tag on shelves

					1. LABEL: poster only 2. LABEL5: poster with 5% price increase 3. LABEL10: poster and 10% price increase
Vandenbroele et al., 2018 **Belgium**	RCT	Retail store General population[$]	161 participants	D P	Altering options sizes of sausages at point of purchase 1. large default portion size (150g) 2. medium in-between portion (125g) 3. small portion (100g)
Ohlhausen & Langen 2016 **Germany**	Cohort study RCT with factorial design	Several university canteen & business canteen Students & staff Employees	1340 participants	P SA	Combining and comparing two nudge interventions in two different settings: 1. descriptive name labels (DNLs) for most sustainable dish of a choice set menu 2. decoy effect (DE), supplying unattractive decoy meal choice

Author(s)/ Year(Data)/ Country	Study Design	Study Setting/ Participants	Sample Size	Nudge#	Intervention Strategy
Garnett et al., 2017 United Kingdom	RCT With-in subject crossover experiment	University Cafeterias (A, B, C) Students and staff	94,644 meals	P	1. doubling the proportion of vegetarian meals available from 25% to 50% 2. fortnightly alternations between 1 (control) and 2 (experiment) vegetarian options
Salmivaara & Lankoski 2016 Finland	2x2 between-subject factorial Cluster randomized design	19 workplace restaurants Employees	1,289 participants	SA	Implementing and activating four injunctive norms message signs on roach fish patties 1. control 2. promotes wellbeing of Baltic Sea. 3. promotes increasing supply and consumption of ethical local food 4. combination of 1 & 2

Zhou et al., 2016–2017 **Denmark, France, Italy, United Kingdom**	Quasi-experimental study RCT	Denmark: senior activity centre, and University of Copenhagen France: living lab of the Institute Paul Bocuse Italy: The Club in Pian di Mungnone UK: restaurant at Bournemouth University Urban dwellers over 65 years old	348 participants Denmark – 97 France – 118 Italy – 46 UK – 87	D	Implementing a plant-based 'Dish of the Day': 1. fish cakes 2. meat balls 3. veggie balls (Dish of the Day)

[$] General population assumed (not specified by study)

[#] Nudge: SA – Salience & Affect, P – Priming, MN – Messenger & Norms, I – Incentive and D – Default

Table 4: Nudging intervention findings of the included studies (n 14)

Author(s)/ Year (Data)/ Country	Outcome Measured	Data Analysis Method	Main Findings	Effectiveness
Campbell-Arvai et al., 2014 Midwestern USA	Phase 1: the relative appeal of meat-free default food options for experimental menus Phase 2: food choice – item purchased	Phase 1: 7-point semantic differential scale (-3 to +3) Phase 2: binary logistic regression (BLR)	1. the appeal factor was a significant predictor of food choice 2. default menu increased the probability of meat-free choices 3. presence of information on menu was not a significant factor 4. gender was a significant factor (female)	p<0.001 p<0.001 p=0.534 p=0.02
Coucke et al., 2019 European City (unknown)	Food choice: item purchased	Three-way ANOVA and post hoc contrast tests	1. sales of poultry were significantly higher than sale of other meat(s) 2. significant increase in amount of poultry sold in treatment store 3. revenue from poultry was significantly higher than revenue for other meats 4. significant decrease in amount of poultry sold when nudge removed	p<0.001 p<0.05 (+13%) p=0.001 (-18%) p<0.001
Kaljonen et al., 2014–2017 Finland	Food choice: items purchased	Focus groups – qualitative data	1. climate label produced no significant results	1. 42% looked at label and purchase the labelled lunch 'now and then'; mainly women

		Foodweb tool for estimation of GHG emissions of food items	2. food placement made vegetarian option easier to choose and helped change daily eating habits 3. menu planning and recipe development played a key role in tinkering solutions for problems encountered	2. vegetable intake increased by 10% 3. use of pulses per meal served increased by a third from 2014–2017
Piester et al., 2019 USA	Food choice: item purchased	ANOVA	1. intention-behaviour gap was prominent 2. women purchased more sustainable labelled food items 3. study 2: women more likely to purchase veggie burger when given extra information alongside the labels	45% bought what they intended p=0.11 (38% over the control group) p=0.23 (19%)
Slapø & Karevold 2019 Norway	Food choice: items purchased	Ordinary Least Square regression (OLS)	1. traffic light labels marginally reduced sales of meat dishes in period 1 but not in period 2 2. single green and red labeling had no effect on sales of meat, fish or vegetarian dishes	p=0.10 (7%-9% {period 1}) p=0.38 (period 2) p>0.1

Author(s)/ Year (Data)/ Country	Outcome Measured	Data Analysis Method	Main Findings	Effectiveness
McBey et al., 2019 Scotland	Changes in hypothetical behaviour	NVivo 11 used for analysis of audio recordings	1. how information is framed is crucial due to the disconnection between food choices and environmental impact 2. the physical layout of a supermarket, can promote perceived notions on how alternative products are accepted by consumers i.e. not for them if placed in rarely visited aisles	1. evidence for the efficacy of nudges is limited, especially in-regard to pro-environmental behaviour 2. qualitative research may be partially salient in reducing meat consumption, as what can appear as simple solutions often breakdown as individuals' lived experiences with food choice are better understood
Gravert & Kurz 2016 Sweden	Food choice: item purchased	χ^2	1. meat dishes chosen reduced in intervention period 2. vegetarian dishes increased in the intervention period 3. intervention had no lasting effects but no evidence for compensational behaviour	$p<0.01$ (-38%) $p<0.01$ (+200%) $p<0.01$

Kurz **2015–2016** **Sweden**	Food choice: items purchased	OLS DiD estimation	1. experiment did not allow for disentanglement of which nudge caused what impact 2. at the treated restaurant, vegetarian dishes increased significantly after nudge implementation 3. size of treatment effect increases over time, possibly from exposure to nudge and network effects 4. when nudge interventions removed, vegetarian dishes still proceeded to be purchased at a higher rate	p≤0.01 (~+40%) +6 points p≤0.01 (+0.8-0.9% each week) p≤0.01 (+4 points higher than the baseline period)
Becchetti et al., 2016 **Italy**	Food choice: items purchased	Econometric	1. overall effect of the nudge is positive 2. LABEL5 and LABEL10 provided significant promise, increasing sales and supporting the theory that higher environmental concerns induce the purchase of organic foods, albeit expensive, making some consumers price inelastic	p≤0.01 (+2%) (10%-50% of the market share) p≤0.01 (+5% & +4.3% respectively)

Vandenbroele et al., 2018 **Belgium**	Food choice: units purchased	Two-way ANOVA	1. over half of the units sold were the smaller/ medium portions 2. customers didn't purchase more packages of the smaller/medium portions (backfire effect) 3. compensatory purchases of other meats did not differ among buyers of smaller, medium and large sausage portion size	52% (13% less meat (kg) sold) p=0.001 p=0.62
Ohlhausen & Langen **2016** **Germany**	Food choice: meals purchased	Voting system BLR Mann Whitney U-test	1. preferred DNLs: 'seasonal ingredients'; 'traditional style';'organic (dish)' & 'sustainable agriculture' 2. targeted DNLs dishes were favoured more than competitor dishes 3. no significance for targeting DE on choice 4. combination of DNLs and DE have a significant impact. (DNLs most influential)	64.0%, 63.5%, 35.5% & 22.5% respectively p≤0.001 (+10% equating to 50.8% of purchases) p=0.266 p≤0.001

Garnett et al., 2017 **United Kingdom**	Food choice: meals purchased	Binomial generalized linear mixed models	1. vegetarian meals increased in all cafeterias significantly 2. largest effects found in diners who had lowest previous levels of vegetarian choice selection 3. serving more vegetarian options had little effect on overall sales, no rebound effect	University Cafeterias (A, B, C) 61.8%, 78.8%, 40.8% respectively p≤0.001
Salmivaara & Lankoski **2016** **Finland**	Food choice: units purchased	ANOVA QCA (quality comparative analysis)	1. no significant differences in roach fish patties choice amongst control and treatment groups 2. activating norms with a message that include a combination of two injunctive norms was not significant	p=0.6263 p=0.7320 (wellbeing Baltic Sea) p=0.2638 (local food)
Zhou et al., **2016–2017** **Denmark, France, Italy, United Kingdom**	Food choice: meal purchased	Pearson's chi-square test BLR	1. no statistical significance found for an increase in participants' choice of a plant-based dish when set as a default across countries 2. males are less likely to choose a plant-based dish compared to female 3. security and universalism main factors for choosing default dish	p=0.109-0.865 47.7% of males p=0.011 + p=0.008 respectively

**p value of p<0.05 statistically significant

Table 5: Data quality assessment (mean = 3.2, standard deviation = 1.08)

Author(s)/ Year Country	Sample Size	Duration (pre and post intervention excluded)	Control Group	Random Allocation	Missing Information	Rating
Campbell-Arvai et al., 2014 USA	Large (>100)	2 weeks	Yes	Yes	–	****
Coucke et al., 2019 European City	–	4 weeks	Yes	Yes	Country unknown and sample size not specified	**
Kaljonen et al., 2020 Finland	Large (>100)	3 years	No	No	Unknown sample of size for intervention	**
Piester et al., 2020 USA	Large (>100)	–	Yes	Yes	Unknown duration of intervention	***
Slapø & Karevold 2019 Norway	Large (>100)	6 weeks	Yes	Yes	–	****
McBey et al., 2019 Scotland	Medium (<100)	–	No	No	Unknown duration of study	*
Gravert & Kurz, 2019 Sweden	Large (>100)	3 weeks	Yes	Yes	Some limited statistical analysis	****
Kurz 2018 Sweden	Large (>100)	17 weeks	Yes	Yes	–	****

Becchetti et al., 2020 Italy	Large (>100)	9 weeks	Yes	Yes	–	****
Vandenbroele et al., 2018 Belgium	Large (>100)	–	Yes	Yes	Unknown duration of intervention	***
Ohlhausen & Langen 2020 Germany	Large (>100)	8 weeks	Yes	Yes	–	****
Garnett et al., 2019 United Kingdom	Large (>100)	9 months	Yes	Yes	–	****
Salmivaara & Lankoski 2019 Finland	Large (>100)	1 day	Yes	Yes	Long-term viability of results	**
Zhou et al., 2019 Denmark, Italy, France, United Kingdom	Large (>100)	5 months	Yes	Yes	–	****

request. Meat dish choice decreased by 38% with the vegetarian and fish menu and vegetarian choices increased (3.9%) with the meat and fish menu – no compensatory effect was monitored ($p<0.01$). Kurz (2018) found that by changing the position of vegetarian dishes in a menu order, and allocating equal visibility of vegetarian dishes with meat dishes in the purchasing environment, purchase of vegetarian dishes increased by 40% ($p \leq 0.01$). Weekly sales of vegetarian dishes increased by 0.8%-0.9% after the intervention ceased ($p \leq 0.01$) (Kurz, 2018).

Slapø and Karevold (2019) found that impementing traffic light labelling (red, yellow, green) on dishes to indicate the environmental friendliness of a dish, encouraged a 7%-9% reduction in meat sales ($p=0.10$), although having just singular green or red labels had little to no impact ($p>0.1$). Salmivaara and Lankoski (2019) indicated that activating injunctive norm message signs at point of purchase had no significant effect on sustainable food choice ($p=0.6263$), whilst Piester et al. (2020) found that implementing sustainability labels on menus marginally influenced women's uptake of more sustainable choices ($p=0.11$) but not for men ($p=0.23$). Piester et al. (2020) identified the intention-behaviour gap, highlighting that only 45% of people bought the items they intended to purchase.

Three studies utilised P/SA combination (McBey et al., 2019; Kaljonen et al., 2020; Ohlhausen and Langen, 2020), applying signage with availability and accessibility to help encourage more SFC. Kaljonen et al. (2020) suggested that increasing the availability and accessibility of vegetarian dishes in a buffet line, placing vegetarian dishes at the front, increased sales by 10%. Climate labels attached to the dishes had limited effect, although women were more susceptible (42%). Ohlhausen and Langen (2020) found that DNLs were statistically significant when in combination with a DE (unattractive meal dish) ($p \leq 0.001$), while DNLs were 10% more influential than the DE. McBey et al. (2019) proposed that environmental labelling is crucial for framing the disconnection between food choice and the environmental consequence, and the physical layout of retail stores can be a powerful tool in promoting SFC to consumers.

A D/SA combination (Campbell-Arvai et al., 2014) which implemented 'appealing' vegan/vegetarian dishes on a menu assisted significantly with the prediction of food choices made by consumers ($p<0.001$), and when applied into a default menu (appealing dishes positioned at top) sales increased significantly ($p<0.001$); however

providing information-only menus promoted a decrease in meat-free purchases (p=0.534). Becchetti et al. (2020) utilised a combination of I/MN/SA, implementing three small posters/labels in-store, one promoting environmental responsibility and two labels implementing a 5% and 10% price increase on organic items. Overall, the intervention increased sales by 2% (p≤0.01), with the 5% and 10% labels increasing sales of organic items by 5% and 4.3% respectively, supporting the theory that higher environmental concern can induce the purchase of organic foods, and can induce the purchase of organic food despite its greater cost.

Garnett et al. (2019) utilised P, doubling the quantity of vegetarian dishes (25% to 50%) available in three university cafeterias. The intervention increased vegetarian dish uptake by 60.4% across the three cafeterias, positively impacting consumers whom previously had low levels of vegetarian purchases (p≤0.001) with no rebound effect. Zhou et al. (2019) used 'Dish of the Day' as a D intervention, providing statistically insignificant results (p=109-0.865). However, they highlighted that the default dish was chosen when concerns such as security (e.g., safety, harmony, and stability of society, of relationships, and of self) and universalism (e.g., understanding, appreciation, tolerance, and protection, for the welfare of all people and for nature) were strong (p=0.11 and p=0.008 respectively). D/P combination (Coucke et al., 2019; Vandenbroele et al., 2018) provided statistically significant results. Couke et al. (2019) increased sales of poultry by 13% (p<0.05) and decreased sales of other meats by 18% (p=0.001) via enhanced visibility and quantity of poultry available at a butcher's counter. When the intervention ceased, poultry sales decreased significantly (p 0.001). Vandenbroele et al. (2018) illustrated that altering the portion sizes of sausages (150g, 125g, 100g) increased the purchase of 125g and 100g portions marginally (52%), with no compensatory effect on customers purchasing extra portions of the same size (p=0.001). The intervention decreased overall meat (kg) purchased by 13%, however compensatory purchases of other meats did not differ amoung buyers of all portion sizes (p=0.62).

Discussion

Effectiveness of nudging interventions on SFC

Out of the 14 studies reviewed, ten provided statistically significant results, supporting the positive effectiveness of nudging interventions in encouraging sustainable food choices (Table 6).

Table 6: Effectiveness of nudging interventions on SFC

Reference	Intervention	Food Choice
SA		
Gravert & Kurz, 2019	Two different menu's: 1 x meat & fish; 1 x vegetarian & fish – both indicating that vegetarian or meat options were available upon request	Meat choice decreased 38% with vegetarian & fish menu and vegetarian choices increased by 3.9% with meat & fish menu ($p<0.01$)
Kurz, 2018	Changing menu position of (vegetarian dishes – top) and ensuring equal visibility of vegetarian dishes	Menu positioning and dish visibility increased vegetarian dish choice by 40% and increased weekly sales by 0.8-0.9% ($p\leq0.01$)
Piester et al., 2020	Sustainability labels attached to dishes on menu and additional information	Vegetarian dish selection slightly increased for women only ($p=0.11$), added information made less effect ($p=0.23$), again women only
Salmivaara & Lankoski, 2019	Injunctive norm messages on posters at point of purchase	Neither messages regarding the wellbeing of Baltic Sea or local food created an uptake of the roach fish patties food choice ($p=0.7320$/ $p=0.2638$ respectively)
Slapø & Karevold, 2019	Traffic light labelling and single red and green labelling	Traffic light labelling decreased meat dish choice by 7%-9% in period 1 ($p=0.10$) but not in period 2 ($p=0.38$) and neither the single green nor red label made a significant impact ($p>0.1$)
P/SA combination		
Kaljonen, et al., 2020	Climate labels and food order position in a buffet line	Food positioning increased vegetarian food choice by 10% but climate labels only made people look 'now and then' 42% of the time; mainly women

McBey et al., 2019	Environmental labels and changes to physical environment of supermarket	Environmental labels were shown to be importance for people to connect between food choice and the environment. Changing the layout of a supermarket so that alternative can be placed in aisles that are not rarely visited would help customers feel like these products are for them and not part of 'otherness'
Ohlhausen & Langen, 2020	DNLs and a DE	DNLs increased vegetarian dish uptake by 10% ($p \leq 0.001$), DE did not influence food choice ($p=0.23$), however combined had significance ($p \leq 0.001$)
D/SA combination		
Campbell-Arvai et al., 2014	Rating of unappealing and appealing vegetarian/vegan dishes and implementing four different menu's (default, default & information, information & control)	Using appealing vegetarian/vegan dishes help to predict food choice ($p \leq 0.o01$), default menu (appealing dishes at top) had a significant impact ($p \leq 0.001$), whereas an additional information menu was not significant ($p=0.534$)
I/MN/SA combination		
Becchetti et al., 2020	3 x small posters/labels indicating an environmental responsibility message, two of which have a 5% and 10% price increase	Overall positive impact by 2% ($p \leq 0.01$) and a significant effect with price increases of 5% & 10% labels (5% &4.3% respectively) ($p \leq 0.01$). Suggesting that consumers are price elastic
D		

Zhou et al., 2019	Implementing plant-based 'Dish of the Day' to a menu of three dishes: 1. fish cakes 2. meat balls 3. veggie balls (Dish of the Day)	'Dish of the Day' had an insignificant effect (p=0.109-0.865) The more importance participants gave to sensory factors and universalism the more they chose the veggie balls (p<0.05)
P		
Garnett et al., 2019	Doubling proportion of vegetarian dishes available from 25% to 50%	Vegetarian dish sales increased in the three separate cafeterias by 61.8%, 78.8% &40.8%, the largest effect occurring with participants whom previously had the lowest purchase of vegetarian options (p≤0.001)
D/P combination		
Coucke et al., 2019	Enhancing visibility of poultry products by increasing the display size area and quantity of poultry products	Sales increased by 13% for poultry (p<0.05), decreasing revenue of other meat products by 18% (p=0.001).
Vandenbroele et al., 2018	Differing portion size of sausages: 150g (D) 125g 100g	52% of 125g &100g portions were purchased, reducing meat (kg) purchased by 13%. Customers did not buy extra 125g/100g portion packages to compensate (p=0.001). Compensatory purchases did not differ among buyers of 150g/125g/100g portions (p=0.62)

SA as a nudge

Gravert and Kurz, (2019) suggested that the simple and inexpensive rearrangement of menus in terms of convenience could reduced meat consumption by 38% and increase vegetarian and fish dishes sold by 200% ($p<0.01$). Kurz (2018) further supported this theory by suggesting that increasing visibility and changing menu position could encourage a persistent shift in consumption behaviour ($p\leq0.01$) whereas Löfgren et al. (2012) proposed that experienced participants were harder to nudge than inexperienced participants. The heterogenous effects of the nudge in relation to the type of vegetarian dish served identified that the target dish(es) offered had to be more attractive to meat eaters, hence vegetarian burgers/patties had the most successful impact. With that said, disentanglement of which nudge (visibility/position) caused the vegetarian dish increase was not undertaken.

Conversely, Piester et al. (2020) found the effectiveness of sustainability labels with additional information on a menu was not effective, possibly due to the unknown duration of the intervention and information overload of having messages that combine different types of information (Carfona et al., 2019). Women were more likely to purchase vegetarian dishes with sustainability labels ($p=0.11$), and with additional information this increased ($p=0.23$), this is consistent with past research emphasising gender influence in SFC (Andersen and Hyldif, 2015; Zhou, et al., 2019). Piester et al. (2020) highlighted that only 45% of participants purchased what they intended, hence the intention-behaviour gap of consumers is crucial in understand purchasing habits (ElHaffar et al., 2020; Rausch and Kopplin, 2021).

Slapø and Karevold (2019) provided marginally significant results utilising traffic light labelling, supporting the theory of the 'compromise effect' (choosing the middle option) (Carroll and Vallen, 2014). Initially there was 7-9% reduction in meat consumption ($p=0.10$), this behaviour declined over time and almost reverted back to the control period behaviour after period 1; providing evidence that consumers can develop "label fatigue" ($p=0.38$) (Thorndike et al., 2014). Single red and green labels had no signficant impact ($p>0.1$), possibly due to lack of available environmental information (Ratner et al., 2008), limited previous knowledge regarding the connection between food choices and environmental consequences (Hartmann and Siegrist, 2017; Lea et al., 2006) and perceived needs of consumers in the choice situation (i.e. focused on sensory factors rather than environmental preservation) (Andersen and Hyldif, 2015; Slapø and Karevold, 2019).

Salmivaara and Lankoski (2019) concurred with these results, suggesting that activating injunctive norm messages to promote sustainable food choice is an ineffective measure (p=0.6263), possiblly due to the 1-day intervention duration and exclusion of vegetarian and vegan participants. Nevertheless, this intervention could help identify potential subgroups of consumers who are sensitive to the intervention, i.e. older educated women influenced more by the message of "ecological wellbeing". Multiple norms could have complex casual interactions and joint effects, i.e. messages of ecological wellbeing and local food could be combined to have greater impact than the message used independently; a topic requiring further attention (McDonald et al., 2014).

P/SA combination as a nudge

Ohlhausen and Langen (2020) were able to identify the SA nudge (DNLs) as 10% more effective in increasing vegetarian dish choice ($p \leq 0.001$), especially the use of "sustainability" and "regional" (20% and 15% respectively), proving consistent with past research (Morizet et al., 2012). Whereas, in constrast to previous non-food related literature, the P nudge (DE) lowered choice frequencies of sustainable choices overall (p=0.23) (Simonson, 1989; Doyle et al., 1999; Masicampo and Baumeister, 2008). This study supports Kurz (2018) theory that nudging interventions are not only influenced by the type of nudge or setting but by other variables (i.e. target dish), hence based on systematic assessment of similarities and difference between dishes, careful selection and grouping of target dishes and competitor dishes is required (Ohlhausen and Langen, 2020).

Both Kaljonen et al. (2020) and McBey et al. (2019) undertook qualitative studies that used descriptive labels as the SA nudge. Kaljonen et al. (2020) suggested that climate labels are a restriction to menu and recipe development, whilst McBey et al. (2019) suggested that how descriptive messages are framed is crucial, i.e. comparing meat products with sources of environmental pollution. Kaljonen et al. (2020) further suggested that availability and accessibility, by changing the food order available in a buffet line (P nudge), helps to encourage more vegetarian dish choices (+10%). Coinciding with McBey et al. (2019) who suggested that the physical layout of supermarkets play a pivotal role in highlighting the 'otherness' of alternative food choices (i.e. plant-based), creating a 'not for me' implication. Both studies agreed with past research that more qualitative research is required in understanding SFC (Lehner et al., 2016), the complex and multi-faceted nature

of food choice means that what holds true in controlled conditions may not work in every day life (Kahneman, 2011).

D/SA combination as a nudge

Campbell-Arvai et al.'s (2014) D/SA combination suggested that by placing less environmentally-friendly food choices in slightly less convenient positions on a menu (i.e. bottom) the default menus increased the probablility of consumers choosing a meat-free dish ($p \leq 0.001$). This was consistent with other research (Downs et al., 2009; Just and Wansink, 2009). The attractiveness of menu dishes had a significant influence on food choice enabling prediction of the choice ($p \leq 0.001$), whereas the presence of information on a default menu provided statistically insignificant interactions ($p=0.534$). Additional information is less effective at motivating behaviour change at an individual-scale and with real time choices due to immediate or intuitive factors that dominate decisions, especially when time pressure and distractions conspire to prevent personal deliberation (Shiv and Fedorikhin, 1999; Ariely and Loewenstein, 2006). The study design did not record 'actual' food choice or consumption, hence exaggeration of environmentally-friendly behaviour could have occurred (de Boer et al., 2009; Bray et al., 2011).

I/MN/SA combination as a nudge

As previously discussed, Becchetti et al. (2020) provided marginally significant results when implementing three posters/labels, highlighting the effectiveness of consumers environmental responsibility (+2%; $p \leq 0.01$). These findings exceeded the results of Hainmueller et al.'s (2015) study. Consumers believe that this form of intervention can affect other consumers choices by up to 80%, coinciding with the theory that social norms have strong effects on consumer purchasing habits (Collins et al., 2019; Liu et al., 2019).

D as a nudge

Zhou et al.'s (2019) 'Dish of the Day' (veggie balls) intervention provided statistically insignificant results across four countries ($p=0.109$-0.865). This is in contrast to many studies that have shown that D nudges can promote healthier purchase behaviour (McDaniel et al., 2001; Feldman et al., 2011). The unappealing nature of the veggie balls could have resulted from a lack of detailed information accompanying the dish and the equality it was given amongst the other two

dishes, lowering participants' attention to the default dish. Females from the UK and Denmark were more likely to choose the D target dish, especially when more importance was given to sensory factors and universalism (p=0.042 and p=0.033), supporting the view that peoples' concern about nature could be effective for SFC (Worsley et al., 2016). Zhou et al. (2019) highlighted that default-based interventions can be important tools in motivating pro-environmental behaviour and serve to complement information and educational efforts over the long-term. However, this could be seen as underhanded and choice constraining, limiting freedom and autonomy of decison makers.

P as a nudge

P as a nudge has the potential to encourage SFC, it is a relatively cheap and easily implemented strategy that generally goes unnoticed by consumers. Garnett et al. (2019) highlighted that meal selection is neither fixed nor random but rather partially determined by availability. By increasing the proportion of vegetarian choice uptake significantly increased, reflecting past research (Holloway et al., 2012; Lombardini and Lankoski, 2013; Bianchi et al., 2018). The greatest impact was measured amongst participants who were least likely to chose vegetarian dishes before the intervention ($p \leq 0.001$), corresponding with Scarborough's findings (2014).

D/P combination as a nudge

Both Coucke et al. (2019) and Vandenbroele et al. (2018) provided statistically significant results for encouraging sustainable food choice (p 0.05 and p=0.001 respectively), however the studies lacked information on either sample size or duration. Vandenbroele et al. (2018) suggested that nudging consumers at point of purchase, rather than at moment of consumption, led to a 13% reduction in meat (kg) purchased and helped to change consumers purchase behaviour, concurring with previous research (Arno and Thomas, 2016; Vermeer et al., 2010). Coucke et al. (2019) supported this theory by suggesting that increasing the display size and quantity of more sustainable meat products (poultry), increased sustainable choices (+13%). When the intervention was removed sales of the sustainable meat product decreased, highlighting that visual cues can have an impact on consumers behaviour (Van Kleef et al., 2012; Wilson et al., 2016; Helmefalk and Berndt, 2018). Overall, D/P combination is an effective nudge for promoting and encouraging consumers to change their behaviour to more SFC practices.

Conclusion

Overall, this review has established the potential of certain nudging interventions for encouraging sustainable food choices and SFC. Strategies that required little involvement (system 1) from consumers, produced higher statistically significant outcomes compared to nudging interventions which required more deliberation (system 2). Gender, sensory factors, attractiveness, and type of target dish played a pivotal role in encouraging sustainable food choices. Females were influenced by interventions significantly more than males. Proximity, placement, and information encouraged consumers to adopt more sustainable food choices and the overall presentation, portion size and choice of sustainable alternatives played a key role in encouraging consumers into SFC. Successful nudges included P, D/P combination, SA, D/SA combination and I/MN/SA combination. These five nudges utilised intervention strategies that enhancing availability and accessibility, promoted consumers environmental responsibility, altered portions sizes, offered food alternatives upon request, and targeted appealing dishes in combination with a default menu. Five studies that utilised D, SA combination and P/SA combination all provided insignificant results. Interventions such as 'Dish of the Day', activating injuctive norms and sustainability labels, with additional information, proved ineffective tools for promoting sustainable food choices. The effectiveness of nudging is optimal when utilsied together with information campaigns, economic incentives and education, and hindered by factors including bias, intention-behaviour gap and external influences such as social norms, environmental determinants and financial status (Broers et al., 2017; Taufika et al., 2019).

This SR had several limitations. The search terms "nudges, nudging or nudge theory" may have lead to many undetected studies being left out, as well as "behavioural interventions" not being included in the search strategy may have limited the outcome. The studies were mainly heterogeneous with different interventions measured. Participants were mainly students or staff and the intervention settings were primarily universities, restricting greater external validity. All of the studies were undertaken in developed and highly westernised countries, hence further research should be undertaken in developing countries to allow for better understanding of the effectiveness of nudging interventions. Only English papers were eligible, hence a possibility of missing important relevant studies in other languages. Furthermore, this SR has been conducted by a single reviewer which could potentially cause bias on screening, rating and synthesis of the studies.

All of the studies, bar one, focused on short-term effectiveness of nudging and thus more research should be undertaken to understand if nudging is effective in the long-term. Further research regarding gender, sensory influences, dish attractiveness, multiple norms, intention-behaviour gap and tinkering could be addressed in conjuction with nudging interventions to better understand how more sustainable eating can be achieved in real-life situations, strengthening evidence and knowledege of how nudging might encourage SFC.

Further qualitative research should also be undertaken to enable greater understanding of what occurs in non-controlled environments. Ethical consideration of nudging and transparency is required in any future use of the technique in order to address the issue of freedom or autonomy in decision-making.

The number of people that can be supported within planetary boundaries in part depends on their choices (Cohen, 2017). The massive environmental impact of agriculture and the food industry mean that food choices will become of increasing importance. People are at the centre of sustainable development and with global population projected to increase to 9.7 billion by 2050 (United Nations, 2019), individual and collective human choices coupled with environmentally sustainable practices will be key drivers to enable a sustainable expansion in food production (Cohen, 2017). Nudging may play a role in changing behaviour toward habits of sustainable food consumption.

Acknowledgements

I would like to thank Professor Adrian Newton, his support, guidance, and patience made it possible to complete this review. I would also like to acknowledge the contributions of the two anonymous reviewers and JP&S editor David Samways in developing this paper. My thanks also to family and friends for their support.

References

Allcott, H. and Mullainathan, S., 2010. Behaviour and energy conservation. *Science,* 327(5970), pp.1204–1205.

Alsaffar, A., 2016. Sustainable diets: the interaction between food industry, nutrition, health and the environment. *Food Science And Technology International, 22*, pp.102–111.

Andersen, B. and Hyldif, G., 2015. Consumers' view on determinants to food satisfaction. A qualitative approach. *Appetite,* 95, pp.9–16.

Ariely, D. and Loewenstein, G., 2006. The heat of the moment: the effect of sexual arousal on sexual decision making. *Journal of Behavioral Decision Making,* 19, pp.87–98.

Arno, A. and Thomas, S., 2016. The efficacy of nudge theory strategies in influencing adult dietary behavior: asystematic review and meta-analysis. *BMC Public Health,* 16, pp.676–687.

Beattie, G. and McGuire, L., 2016. Consumption and climate change: Why we say one thing but do another in the face of our greatest threat. *Semiotica,* 213, pp.493–538.

Becchetti, L., Salustri, F. and Scaramozzino, P., 2020. Nudging and corporate environmental responsibility: a natural field experiment. *Food Policy,* 97 https://doi.org/10.1016/j.foodpol.2020.101951

Benton, T., 2016. *What will we eat in 2030? World Economic Forum.* [Online] Available at: https://www.weforum.org/agenda/2016/11/what-will-we-eat-in-2030/ [Accessed 25 August 2020].

Bianchi, F. et al., 2018. Interventions targeting conscious determinants of human behaviour to reduce the demand for meat: a systematic review with qualitative comparative analysis. *International Journal of Behavioral Nutrition and Physical Activity,* 15(102), pp.1–25.

Bianchi, F. et al., 2018. Restructuring physical microenvironments to reduce the demand for meat: a systematic review and qualitative comparative analysis. *Lancet Planet Health,* 2, pp.384–397.

BIT, 2010. *MINDSPACE Influencing behaviour through public policy,* London: Cabinet Office.

Blumenthal-Barby, J. S. and Burroughs, H., 2012. Seeking better health care outcomes: the ethics of using the "nudge". *The American Journal of Bioethics,* 12(2), pp.1–10.

Bolos, L. A., Lagerkvist, C. J. and Nayga Jr, R. M., 2019. Consumer choice and food waste: can nudging help?. *Agricultural and Applied Economics Association,* 34(1), pp.1–8.

Bray, J., Johns, N. and Kilburn, D., 2011. An exploratory study into the factors impeding ethical consumption. *J. Business Ethics,* 98, pp.597–608.

Broers, V. J., De Breucker, C., Van den Broucke, S. and Luminet, O., 2017. A systematic review and meta-analysis of the effectiveness of nudging to increase fruit and vegetable choice. *European Journal of Public Health,* 27(5), pp.912–920.

Bucher, T. et al., 2016. Nudging consumers towards healthier choices: a systematic review of positional influences on food choice. *British Journal of Nutrition,* 115, pp.2252–2263.

Campbell-Arvai, V., Arvai, J. and Kalof, L., 2014. Motivating sustainable food choices: the role of nudges, value orientation, and information provision. *Environment and Behavior,* 46(4), pp.453–475.

Campos, S., Doxey, J. and Hammond, D., 2011. Nutrition labels on. *Public Health Nutr,* 14, pp.1496–1506.

Carfona, V., Catellani, P., Caso, D. and Conner, M., 2019. How to reduce red processed meat consumption by daily text messages regarding environment or health benefits. *Journal of Environmental Psychology,* 65. https://doi.org/10.1016/j.jenvp.2019.101319

Carroll, R. and Vallen, B., 2014. Compromise and attraction effects in food. *Int. J. Consumer Stud,* 38, pp.636–641.

CEE, 2020. *Aims and Scope*. [Online] Available at: http://www.environmentalevidence.org/guidelines/aims-and-scope [Accessed 26 August 2020].

Chance, Z., Gorlin, M. and Dhar, R., 2014. Why choosing healthy foods is hard, and how to help: presenting the 4Ps framework for behavior change. *Cust. Need. and Solut,* 1, pp.253–262.

Collins, E. et al., 2019. Two observational studies examining the effect of a social norm and a health message on the purchase of vegetables in student canteen settings. *Appetite,* 132, pp.122–130.

Coucke, N., Vermeir, I., Slabbinck, H. and Van Kerckhove, A., 2019. Show me more! The influence of visibility on sustainable food choices. *Foods,* 8(186), pp.1–12.

Davis, K. F. et al., 2016. Meeting future food demand with current agricultural resources. *Global Environmental Chang,*. 3, pp.125–132.

de Boer, J., Boersema, J. J. and Aiking, H., 2009. Consumers' motivational associations favouring freee-range meat or less meat. *Ecol. Econ,* 68, pp.850–860.

de Grave, R. et al., 2020. A catalogue of UK household datasets to monitor transitions to sustainable diets. *Global Food Security,* 24, p.100344.

Demarque, C., Charalambides, L., Hilton, D. and Waroquier, L., 2015. Nudging sustainable consumption: The use of descriptive norms to promote a minority behavior in a realistic online shopping environment. *Journal of Environmental Psychology,* 43, pp.166–174.

Downs, J. S., Loewenstein, G. and Wisdom, J., 2009. Strategies for promoting healthier food choices. *American Economic Review,* 99, pp.159–164.

Doyle, J., O'Connor, D., Reynolds, G. and Bottomley, P., 1999. The robustness of the asymmetrically dominated effect: Buying frames, phantom alternatives, and in-store purchases. *Psychol. Mark,* 16, pp.225–243.

ElHaffar, G., Durifa, F. and Dubé, L., 2020. Towards closing the attitude-intention-behavior gap in green consumption: a narrative review of the literature and an overview of future research directions. *Journal of Cleaner Production,* 275. https://doi.org/10.1016/j.jclepro.2020.122556

Ethical Consumer, 2018. *Ethical consumer market report.* Manchester: Ethical Consumer.

FAO, 2019. *Sustainable healthy diets guiding principles.* Rome: WHO.

FAO, et al., 2020. *The state of food security and nutrition in the world 2020. Transforming food systems for affordable healthy diets.* Rome: FAO.

Feldman, C. et al., 2011. Menu engineering: a strategy for seniors to select healthier meals. *Perspectives in Public Health,* 131(6), pp.267–274.

Ferrari, L., Cavaliere, A., De Marchi, E. and Banterle, A., 2019. Can nudging improve the environmental impact of food supply chain? A systematic review. *Trends in Food Science and Technology,* 91, pp.184–192.

Fischer, J. et al., 2012. Human behaviour and sustainability. *Frontiers in Ecology and the Environment,* 10(3), pp.153–160.

Garnett, E. E. et al., 2019. Impact of increasing vegetarian availability on meal selection and sales in cafeterias. *PNAS,* 116(42), p.20923–20929.

Gravert, C. and Kurz, V., 2019. Nudging à la carte: a field experiment on climate-friendly food choice. *Behavioural Public Policy,* 5(3) pp.378–395. https://doi.org/10.1017/bpp.2019.11

Haddaway, N., Macura, B., Whaley, P. and Pullin, A., 2017. *ROSES Flow diagram for systematic reviews, Version 1.0.* doi:10.6084/m9.figshare.5897389.v3.

Hainmueller, J., Hiscox, M. and Sequeira, S., 2015. Consumer demand for fair trade: evidence from a multistore field experiment. *Rev. Econ,* 97(2), pp.42–256.

Hansen, P. G., 2016. *What is nudging? Behavioral Science and Policy Association.* [Online] Available at: https://behavioralpolicy.org/what-is-nudging/ [Accessed 4 September 2020].

Hartmann, C. and Siegrist, M., 2017. Consumer perception and behaviour regarding sustainable protein consumption: a systematic review. *Trends in Food Science and Technology,* 61, pp.11–25.

Hedin, B., Katzeff, C., Eriksson, E. and Pargman, D., 2019. A systematic review of digital behaviour change interventions for more sustainable food consumption. *Sustainability,* 11(9), pp.1–23.

Helmefalk, M. and Berndt, A., 2018. Shedding light on the use of single and multisensory cues and their effect on consumer behaviours. *Int. J. Retail Distrib. Manag,* 46, pp.1077–1091.

Henderson, S., Nink, E., Nierenberg, D. and Oakley, E., 2015. *The real cost of food: examining the social, environmental and health impacts of producing food,* Baltimore: Food Tank.

Hollands, G. et al., 2017. The TIPPME intervention typology for changing environments to change behaviour. *Nature Human Behaviour,* 1(0140), pp.1-14.

Holloway, T., Salter, A. and McCullough, F., 2012. Dietary intervention to reduce meat intake by 50% in university students – a pilot study. *Proc. Nutr. Soc,* 71, p.164.

Just, D. R. and Wansink, B., 2009. Smarter lunchrooms: using behavioral economics to improve meal selection. *Choices*, 24(3), pp.1–7.

Kácha, O. and Ruggeri, K., 2019. Nudging intrinsic motivation in environmental risk and social policy. *Journal of Risk Research*, 22(5), pp.581–592.

Kahneman, D., 2011. *Thinking, fast and slow*. New York: Farrar, Straus and Giroux.

Kaljonen, M., Salo, M., Lyytimaki, J. and Furman, E., 2020. From isolated labels and nudges to sustained tinkering: assessing long-term changes in sustainable eating at a lunch restaurant. *British Food Journal*, 122(11), pp.1–17.

Kasperbauer, T., 2017. The permissibility of nudging for sustainable energy consumption. *Energy Policy*, 111, pp.52–57.

Kearney, J., 2010. Food consumption trends and drivers. *Phil. Trans. Roy. Soc. B*, 365, pp.2793–2807.

Kerr, J. and Foster, L., 2011. Sustainable consumption – UK Government activity. *Nutrition Bulletin*, 36, pp.422–425.

Ketelsen, M., Janssen, M. and Hamm, U., 2020. Consumers' response to environmentally-friendly food packaging - a systematic review. *Journal of Cleaner Production*, 254, pp.120–123.

Kraak, V., Englund, T., Misyak, S. and Serrano, E., 2017. A novel marketing mix and choice architecture framework to nudge restaurant customers toward healthy food environments to reduce obesity in the United States. *Obesity Reviews*, 18, pp.852–868.

Kurz, V., 2018. Nudging to reduce meat consumption: immediate and persistent effects of an intervention at a university restaurant. *Journal of Environmental Economics and Management*, 90, pp.317–341.

Lassalette et al., 2014. Food and feed trade as a driver in the global nitrogen cycle: 50-year trends. *Biogeochemistry*, 118, pp.225–241.

Lea, E., Crawford, D. and Worsley, A., 2006. Public views of the benefits and the barriers to the consumption of a plant-based diet. *European Journal of Clinical Nutrition*, 60, pp.828–837.

Lehner, M., Mont, O. and Heiskanen, E., 2016. Nudging – a promising tool for sustainable consumption behaviour?. *Journal of Cleaner Production,* 134(A), pp.166–177.

Liu, J., Thomas, J. and Higgs, S., 2019. The relationship between social identity, descriptive social norms and eating intentions and behaviors. *Journal of Experimental Social Psychology,* 82, pp.217–230.

Löfgren, Å., Martinsson, P., Hennlock, M. and Sterner, T., 2012. Are experienced people affected by a pre-set default option – results from a field experiment. *Journal of Environmental Economics,* 63(1), pp.66–72

Lombardini, C. and Lankoski, L., 2013. Forced choice restriction in promoting sustainable food consumption: Intended and unintended effects of the mandatory vegetarian day inHelsinki schools. *J. Consum. Policy,* 36, pp.159–178.

Loschelder, D. D., Siepelmeyer, H., Fischer, D. and Rubele, J. A., 2019. Dynamic norms drive sustainable consumption: Norm-based nudging helps café customers to avoid disposable to-go-cups. *Journal of Economic Psychology,* 75(A). https://doi.org/10.1016/j.joep.2019.02.002

Marteau, T., 2017. Towards environmentally sustainable human behaviour: targeting non-conscious and conscious processes for effective and acceptable policies. *Phil. Trans. R. Soc A,* 375. https://doi: 10.1098/rsta.2016.0371

Masicampo, E. and Baumeister, R., 2008. Toward a physiology of dual−process reasoning and judgment: lemonade, willpower, and expensive rule−based analysis. *Psychol. Sci,* 19, pp.255–260.

McBey, D., Watts, D. and Johnstone, A. M., 2019. Nudging, formulating new products, and the lifecourse: a qualitative assessment of the viability of three methods for reducing Scottish meat consumption for health, ethical, and environmental reasons. *Appetite,* 142. https://doi.org/10.1016/j.appet.2019.104349

McDaniel, J. H., Hunt, A., Hackes, B. and Pope, J. F., 2001. Impact of dining room environment on nutritional intake of Alzheimer's residents: a case study. *American Journal of Alzheimer's Disease and Other Dementias,* 16(5), pp.297–302.

McDonald, R. I., Fielding, K. S. and Louis, W. R., 2014. Conflicting norms highlight the need for action. *Environment and Behavior,* 46, pp.139–162.

Morizet, D. et al., 2012. Effect of labeling on new vegetable dish. *Appetite,* 59, pp.399–402.

Nørnberg, T. R., Houlby, L., Skov, L. R. and Peréz-Cueto, F. J. A., 2015. Choice architecture interventions for increased vegetable intake and behaviour change in a school setting: a systematic review. *Perspectives in Public Health,* 136(3), pp.132–142.

Notarnicola et al., 2017. Environmental impacts of food consumption in Europe. *Journal of Cleaner Production,* 140, pp.753–765.

Ohlhausen, P. and Langen, N., 2020. When a combination of nudges decreases sustainable food choices out of home – the example of food decoys and descriptive name labels. *Foods,* 9(557), pp.1–18.

Peričić-Poklepović, T. and Tanveer, S., 2019. *Why systematic reviews matter,* [online] Available at: https://www.elsevier.com/connect/authors-update/why-systematic-reviews-matter [Accessed 26 August 2020].

Piester, H. E. et al., 2020. "I'll try the veggie burger": increasing purchases of sustainable foods with information about sustainability and taste. *Appetite,* 155. https://doi.org/10.1016/j.appet.2020.104842

Ratner, R. K. et al., 2008. How behavioral decision research can enhance consumer welfare: From freedom of choice to paternalistic intervention. *Marketing Letters,* 19, pp.383–397.

Rausch, T. and Kopplin, C., 2021. Bridge the gap: consumers' purchase intention and behavior regarding sustainable clothing. *Journal of Cleaner Production*, 278. https://doi.org/10.1016/j.jclepro.2020.123882

Ritchie, H. and Roser, M., 2020. *Environmental impacts of food production,* [online] Available at: https://ourworldindata.org/environmental-impacts-of-food[Accessed 25 August 2020].

Salmivaara, L. and Lankoski, L., 2019. Promoting sustainable consumer behaviour through the activation of injunctive social norms: a field experiment in 19 workplace restaurants. *Organization and Environment,* DOI: 10.1177/1086026619831651

Scarborough, P. e. a., 2014. Dietary greenhouse gas emissions of meat-eaters, fish-eaters, vegetarians and vegans in the UK. *Climate Change,* 125, pp.179–192.

Schanes, K., Dobernig, K. and Goezet, B., 2018. Food waste matters - a systematic review of household food waste practices and their policy implications. *Journal Of Cleaner Production,* 182, pp.978–991.

Schoesler, H., de Boer, J. and Boersema, J., 2014. Fostering more sustainable food choices: can Self-Determination Theory help?. *Food Quality And Preference,* 35, pp. 9–69.

SCORAI, 2018. *Third international conference of the sustainable consumption research and action initiative,* [online] Available at: https://scorai.net/2018conference/ [Accessed 4 September 2020].

Shiv, B. and Fedorikhin, A., 1999. Heart and mind in conflict: the interplay of affect and cognition in consumer decision-making. *Journal of Consumer Research*, 26, pp.278–292.

Simonson, I., 1989. Choice based on reasons: the case of attraction and compromise effects. *J. Consum, Res,* 16, pp.158–174.

Slapø, H. B. and Karevold, K. I., 2019. Simple eco-labels to nudge customers toward the most environmentally friendly warm dishes: an empirical study in a cafeteria setting. *Frontiers in Sustainable Food Systems,* 3(40), pp.1–9.

Sunstein, C., 2013. Behavioural Economics, Consumption, and Environmental Protection. In: L. Reisch and J. Thøgersen, eds. 2013. *Handbook on research in sustainable consumption.* pp.1-23. http://dx.doi.org/10.2139/ssrn.2296015

Sustainable Food Trust, 2019. *The hidden cost of UK food.* Bristol: Sustainable Food Trust.

Taghikhah, F., Voinov, A. and Shukla, N., 2019. Extending the supply chain to address sustainability. *Journal of Cleaner Production,* 229, pp.652-666.

Taufika, D., Verain, M., Bouwman, E. and Reinders, M., 2019. *Trends in Food Science and Technology,* 93, pp.281–303.

Thaler, R. and Sunstein, C., 2008. *Nudge: improving decisions about health, wealth, and happiness.* London: Penguin Books.

Thorndike, A. N., Riis, J., Sonnenberg, L. M. and Levy, D. E., 2014. Traffic-light labels and choice architecture: promoting healthy food choices. *Am. J. Prevent. Med,* 46, pp.143–149.

Tillman, D. and Clark, M., 2014. Global diets link environmental sustainability and human health. *Nature,* 515, pp.518-522.

Torma, G., Aschemann-Witzel, J. and Thøgersen, J., 2018. I nudge myself: exploring 'self-nudging' strategies to drive sustainable consumption behaviour. *Int J Consum Stud*, 42, pp.141-154.

UNCED, 1992. *Agenda 21: sustainable development knowledge platform.* [Online] Available at: https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf [Accessed 4 September 2020].

United Nations, 2020. *Sustainable consumption and production: United Nations Sustainable Development Goals,* [online] Available at: https://www.un.org/sustainabledevelopment/sustainable-consumption-production/ [Accessed 25 August 2020].

Van Doorn, J. and Verhoef, P., 2011. Willingness to pay for organic products: differences between virtue and vice foods. *Int. J. Res. Mark,* 28(3), pp.167–180.

Van Kleef, E., Otten, K. and Van Trijp, H., 2012. Healthy snacks at the checkout counter: a lab and field study on the impact of shelf arrangement and assortment structure on consumer choices. *BMC Public Health,* 12. https://doi.org/10.1186/1471-2458-12-1072

Vandenbroele, J., Slabbinck, H., Van Kerckhove, A. and Vermeir, I., 2018. Curbing portion size effects by adding smaller portions at the point of purchase. *Food Quality and Preference,* 64, pp.82–87.

Vandenbroele, J. et al., 2019. Nudging to get our food choices on a sustainable track. *Proceedings of The Nutrition Society,* 79(1), pp.1–14.

Vecchio, R. and Cavallo, C., 2019. Increasing healthy food choices through nudges: a systematic review. *Food Quality and Preference,* 78. https://doi.org/10.1016/j.foodqual.2019.05.014

Vermeer, W. M., Steenhuis, I. H. and Seidell, J. C., 2010. Portion size: a qualitative study of consumers' attitudes toward point-of-purchase interventions aimed at portion size. *Health Education Research,* 25, pp.109–120.

Viegas, C. and Lins, A., 2019. Changing the food for the future: food and sustainability. *European Journal Of Tourism Hospitality And Recreation,* 9(2), pp.52–57.

Wansink, B., 2015. Change their choice! changing behavior using the CAN approach and activism research. *Psychology and Marketing,* 32(5), pp.486–500.

White, K., Habib, R. and Hardisty, D., 2019. How to SHIFT consumer behaviors to be more sustainable: a literature review and guiding framework. *Journal of Marketing,* 8(3), pp.22–49.

Wilson, A., Buckley, E., Buckley, J. and Bogomolova, S., 2016. Nudging healthier food and beverage choices through salience and priming. Evidence from a systematic review. *Food Qual. Prefer,* 51, pp.47–64.

Worsley, A., Wang, W. C. and Farragher, T., 2016. The associations of vegetable consumption with food mavenism, personal values, food knowledge and demographic factors. *Appetite,* 97, pp.29–36.

Zakowska-Biemans, S., Pieniak, Z., Kostyra, E. and Gutkowska, K., 2019. Searching for a measure integrating sustainable and healthy eating behaviors. *Nutrients,* 11(95), pp.1–17.

Zhou, X. et al., 2019. Promotion of novel plant-based dishes among older consumers using the 'dish of the day' as a nudging strategy in 4 EU countries. *Food Quality and Preference,* 75, pp.260–272.