

1 **When are “Dish of the Day” nudges most effective to increase vegetable selection?**

2 Laure Saulais^{1,2}, Camille Massey¹, Armando Federico Perez-Cueto³, Katherine M Appleton⁴, Caterina
3 Dinnella⁵, Erminio Monteleone⁵, Laurence Depezay⁶, Heather Hartwell⁴, Agnès Giboreau¹

4
5 1 Center for Food and Hospitality Research, Institut Paul Bocuse, Château du vivier, BP 25, 69131
6 Ecully Cedex France.

7 2 Present address: Department of Agricultural Economics and Consumer Science, Laval University,
8 Quebec, QC, G1V0A6, Canada

9 3 University of Copenhagen, Department of Food Science, Design and Consumer Behaviour Section,
10 Rolighedsvej 26, 1958 Frederiksberg C, Denmark

11 4 University of Bournemouth

12 5 University of Florence

13 6 Groupe Bonduelle

14

15 Corresponding Author:

16 Laure SAULAIS, Department of Agricultural Economics and Consumer Science, Laval University,
17 Quebec, QC, G1V0A6, Canada

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45 **1 Introduction**

46 Almost 1.8 million deaths were estimated to be specifically attributable to insufficient vegetable
47 consumption worldwide in 2010 (Lim et al., 2012). In more than half of all European countries,
48 including France, the intake of fruits and vegetables is well under the WHO-issued recommendation of
49 400 g of fruits and vegetables per day (Dubuisson et al., 2010), prompting public health action to
50 promote increased consumption. While this generally targets fruits and vegetables as a single food
51 group, vegetables often account for fewer than 50% of intake within the category. Yet, vegetables
52 present specific health benefits, distinct sensory properties and consumption characteristics,
53 suggesting a need for more targeted actions (Appleton et al., 2016; Glasson, Chapman, & James, 2011).
54 Over the years, out-of-home eating has gained a prominent role in Europe, accounting, for example,
55 for 15 to 20% of meals in France (Orfanos et al., 2007).

56 Therefore, the foodservice sector has become a necessary player in this public health issue
57 (Lachat, Roberfroid, Huybregts, Van Camp, & Kolsteren, 2008) and is increasingly considered as such
58 in the public policy debate surrounding healthy eating environments. In Europe, public intervention in
59 this domain has focused primarily on the food offer itself, in particular in institutional foodservice,
60 with, for instance, the introduction of mandatory standards for offer in school canteens in several
61 countries (Saulais, 2015). Another approach, in commercial foodservice especially, is to target
62 consumers behaviours at the point of decision (the restaurant), and design interventions that promote
63 both the selection and increased consumption of healthier dishes, and particularly of vegetables. The
64 majority of these point-of-choice interventions in foodservice have focused on providing nutritional
65 information to consumers through product labelling (calorie labelling, traffic light labelling, or healthy
66 food labels). Notably, in the United States, restaurant chains have, since 2018, been required to
67 provide calorie information on menus by the Patient Protection and Affordable Care Act (ACA).
68 However, such strategies seem to have unclear, and sometimes even adverse outcomes on consumers’
69 behaviours (Bleich et al., 2017; Cohen & Babey, 2012).

70 In parallel, there is increasing evidence that food choices rely on minimized cognitive efforts
71 (Adamowicz & Swait, 2013) achieved through the use of simple heuristics (Scheibehenne, Miesler, &
72 Todd, 2007). Heuristics are “rules of thumb” which reduce the cognitive effort necessary to make a
73 decision by relying on cues from the choice environment. According to this framework, the choice
74 architecture, that is to say the way choice tasks are framed in the environment, can have an impact on
75 the outcome decisions (Kahneman, 2003; Tversky & Kahneman, 1981). In the case of food choices,

76 factors such as the order and presentation of menu items (Dayan & Bar-Hillel, 2011), the variety of
77 food categories to choose from (Bucher, Siegrist, & van der Horst, 2013; Bucher, van der Horst, &
78 Siegrist, 2011), and the convenience of access to the food items at a buffet (Rozin et al., 2011) have all
79 been found to affect consumers' decisions at the point of choice. A behavioural change approach,
80 referred to as "nudging" (Thaler & Sunstein, 2008), is derived from this view. Contrary to information-
81 based interventions, nudges target the way choices are framed, with the purpose of guiding decision-
82 makers in a specific direction, while leaving the possibility of easily opting out if desired. This
83 framework has recently gained considerable interest for the promotion of healthier or more
84 sustainable food choices (Loewenstein, Asch, Friedman, Melichar, & Volpp, 2012), inspiring a large
85 number of field studies over the past few years. In foodservice environments specifically, there is some
86 evidence that healthier food choices can be achieved through salience (increasing attention to the
87 option, for instance through descriptive or personally-relevant information) and priming (providing
88 subconscious cues, for instance by changing visibility of healthy options or by altering the position of
89 healthier items through changing order or distance to the consumer) (Bucher et al., 2016; Ozturk,
90 McInnes, Blake, Frongillo, & Jones, 2016; Wilson, Buckley, Buckley, & Bogomolova, 2016).

91 'Nudging' restaurant customers at the point of choice therefore appears as an operationally viable
92 avenue for foodservice stakeholders. Changes in menu design have been considered especially
93 relevant. In 2010, the EU-funded HECTOR project conducted a SWOT analysis of the foodservice sector,
94 which resulted in the identification of five strategies to foster healthier behaviours. One of these
95 strategies was "to better market healthy options in and out of the catering environment, i.e. use the
96 'Chef's Recommendation' to promote healthier choices" ((Lachat et al., 2010), p.198). Although not
97 explicitly named a nudge by the authors, this strategy corresponds to a choice architecture
98 intervention, in the sense that it is based on the way the options are presented to consumers. Indeed,
99 identifying a dish as "Dish of the day" (DoD) alters the framing of the dish options within the choice
100 environment, which in turn impacts on the search process.

101 Scientific evidence regarding point-of-choice nudge interventions in foodservice contexts remains
102 limited in geographical scope and in precision, especially in commercial foodservice (Filimonau,
103 Lemmer, Marshall, & Bejjani, 2017). Several authors have called for more research grounded in
104 decision-making theory to identify the conditions of successful deployment of a 'nudging' strategy
105 (Kirman, 2016; Szaszi, Palinkas, Palfi, Szollosi, & Aczel, 2018). Several steps are needed to achieve such
106 a goal. One is the replication of choice architecture interventions in other settings to strengthen
107 existing evidence. Another crucial question is how the type and the number of alternatives in a nudged
108 choice set may impact the way the nudge impacts consumers' decisions (Marchiori, Adriaanse, & De
109 Ridder, 2017). Lastly, a more practical challenge is the assessment of the consequences of choice
110 architecture actions on consumer behaviour (Marchiori et al., 2017): if changes in the choice

111 architecture nudge consumers in a direction that they later regret, this might compromise the
112 persistence of the effect in the longer term, and impact the motivation of foodservice professionals to
113 implement such actions if they have adverse effects on consumer satisfaction – a concern that the
114 foodservice sector itself expressed regarding the implementation of DoD interventions (Lachat et al.,
115 2010).

116 This article presents the results of an experiment designed to study the effect of a DoD nudge
117 aiming to increase the probability that a consumer chooses a vegetable-based dish in a self-service
118 restaurant setting. More precisely, the primary objective is to replicate the DoD effect in this particular
119 setting, and to investigate how two key characteristics of the choice set, (i) the type and popularity of
120 dishes offered and (ii) the number of alternatives to choose from, impact the effectiveness of this
121 nudge. A secondary objective is to consider the consequences of nudging consumers towards healthier
122 dishes in terms of food intake, food waste, and overall satisfaction.

123 2 “Dish of the day” and decision-making for food away-from-home

124 2.1 What is a “Dish of the day” intervention?

125 In a survey conducted in 2016 on a sample of 461 French employees eating their lunch in restaurants
126 on workdays, 38.2% of respondents stated that “Dish of the day” or “Specialty of the house” was one
127 of the criteria that could affect their decision-making on what to choose¹. Foodservice operators have
128 themselves highlighted that they can promote healthier choices through their on-going practice of
129 “chef’s recommendation” or “Dish of the day” (Lachat et al, 2010). Promoting healthier options as DoD
130 therefore appears to have potential as an effective and feasible strategy to increase selection of such
131 options. Setting a dish as DoD in a restaurant affects the choice architecture by changing the way the
132 options are described, as well as the way the task (here, the task of selecting a dish among various
133 options) is structured (Johnson et al., 2012): when a dish is featured as DoD, the task becomes a
134 sequence that can be described as: (1) Choosing whether or not to accept the DoD option and (2) If
135 not accepted, then choose between the remaining alternatives.

136 Although there have been several attempts to classify choice architecture strategies in the past years
137 (eg. (Hollands et al., 2013)), including nudges for food choices (Broers, Van den Broucke, Taverne, &
138 Luminet, 2019), none, to our knowledge, has specifically included DoD interventions within such
139 typologies. Taking into consideration several of these typologies, Wilson et al. 2016, based on
140 Blumenthal-Barby & Burroughs (2012), propose that nudges for healthy food choices can be classified
141 in six categories: ‘Priming’, ‘salience’, ‘default’, ‘incentives’, ‘commitment and ego’, and ‘norm and
142 messengers’ (Blumenthal-Barby & Burroughs, 2012; Wilson et al., 2016). Advertising a dish as DoD in
143 a restaurant may alter the task of choosing a dish in ways that could fall into several of these categories.

144 First, featuring a dish by labelling it “Dish of the day” may make the featured option more salient than
145 the alternatives. In their systematic review on nudging for healthy food choices, Wilson et al. (2016)
146 identify several studies investigating salience as a nudging strategy to encourage healthier food choice,
147 using a variety of nudging techniques: calorie content labels, traffic light labels, descriptive labels,
148 descriptive labels coupled with taste-testing, and verbal invitations to describe portions. While
149 nutrition and health labelling tend to make one aspect of the dish more salient, featuring a dish as DoD
150 could make this option more salient by changing the description of the dish itself. The way a dish is
151 described has been hypothesized to have an impact on food perception and acceptance (Hartwell &
152 Edwards, 2009), attitudes (Lu & Chi, 2018), and purchase intentions (Fakih, Assaker, Assaf, & Hallak,

¹ Source: FOOD – Fighting Obesity Through Offer and Demand. 2016 Barometer. French sample.
<http://www.food-programme.eu/en/barometers/france/>

153 2016), however the effects on food selection are less clear (Wilson et al., 2016). In a school cafeteria
154 setting, Morizet et al. (2012) compared choices of familiar vs unfamiliar vegetable dishes in the
155 absence or presence of a descriptive label (basic description or a description referring to a model
156 character). They found that labelling may have a positive impact on children's selection of unfamiliar
157 vegetables, but this result was only observed for one of the two types of vegetables tested (Morizet,
158 Depezay, Combris, Picard, & Giboreau, 2012). Another study conducted among recreational sports
159 participants investigated salience as a potential nudge strategy, and found no effect of changing the
160 descriptive labelling of healthy food items on the selection of these items (Olstad, Goonewardene,
161 McCargar, & Raine, 2014).

162 In a real restaurant, a DoD may also act as a 'priming' intervention as it alters the visibility and
163 accessibility of the options. A DoD is typically visible in more forms and places than a regular dish: it
164 may for instance appear on menu displays and boards, leaflets within the menu, and sometimes as an
165 oral description by the waiter. Such a display increases exposure to the DoD option and may therefore
166 provide subconscious cues to the decision-maker regarding this option. Although DoD as priming
167 interventions have not, to our knowledge, been specifically investigated in previous studies, Wilson et
168 al. (2016) found evidence of a consistent positive influence of nudges combining salience and priming
169 on healthier food choices in foodservice settings.

170 Some authors also suggest that introducing featured dish options such as DoD may also, in specific
171 contexts, be perceived by some consumers as a recommendation and act as an implicit default choice
172 or a social norm (Wisdom, Downs, & Loewenstein, 2010). Depending on the choice procedure in the
173 restaurant, an option featured as DoD may indeed signal the option as a pre-set choice, easier to select
174 than alternatives.

175 The common feature of all these DoD interventions is that they aim to affect choice without making
176 the consumer reflect on the content of the option itself (in the case of food choice, the healthiness of
177 the dish relative to alternative options) (Hansen & Jespersen, 2013). Beyond that, the type of nudging
178 technique (salience, priming, default) that DoD interventions correspond to can be debated, mostly
179 because the methods by which such interventions are conducted in the field can vary greatly, and thus
180 impact the mechanism behind the DoD effect and its size. In the rest of this article, we focus more
181 closely on two possible factors of variation:

- 182 - Dish type: the dish featured as DoD, which can be appealing (that is to say, an option that is
183 popular and has a large market share) or unappealing (this is generally the case of dishes that
184 are rich in vegetables).

185 - Menu size: the number of options to choose from, and therefore the number of alternative
186 options to the DoD.

187 This study considers these two factors in the context of a DoD nudge aimed to increase selection of a
188 vegetable-enriched dish in a restaurant setting. The purpose of the study was to test three hypotheses,
189 drawn from previous choice architecture evidence, relating to the possible impact of DoD in the field:

190 **2.2 Hypotheses**

191 **2.2.1 The “Dish of the Day” effect: increase in relative choice**

192 The first aim of a DoD intervention is to increase the choice of the nudged option relative to the
193 other alternatives.

194 To our knowledge, only two published point-of-choice studies have used strategies featuring a
195 target (i.e. healthier or more sustainable) dish option as the primary choice, both with promising
196 results. The first study examined sandwich choices in a fast-food restaurant using a menu card with
197 “featured dishes” (sandwiches) that made the choice of healthier sandwich options slightly more
198 convenient to choose than less healthy options (Wisdom et al., 2010). The second study recorded the
199 hypothetical meal choices of student participants when presented either with default menus with
200 meat-free meal options (with the possibility of opting for meat-based options presented as a side
201 menu) or conventional menus with both meat-free and meat-based options (Campbell-Arvai, Arvai, &
202 Kalof, 2012). In both cases, recommending a healthy dish option had a positive impact on the selection
203 of that dish. Following these two studies, DoD could contribute to increased choice of the featured
204 option. The experiment presented in this article aimed to replicate this ‘DoD effect’ in a self-service
205 restaurant setting, using DoD to feature a target option. Hence our first hypothesis:

206 *H1: The relative choice for a given alternative will increase when the alternative is recommended*
207 *as DoD, compared to the control condition without DoD recommendation*

208 **2.2.2 The moderating role of dish popularity**

209 The type of options and number of alternatives are characteristics of the choice set that have
210 been previously identified as key elements of the choice task design (Marchiori et al., 2017) that are
211 needed in order to infer principles of choice architecture that could then be used by foodservice
212 professionals in their restaurants. Indeed, little is known of the conditions under which an intervention
213 gains or loses in effectiveness.

214 Regarding the type of dishes, the size of the effect of a nudge appears to be linked with the initial
215 selection share of the option, that is to say, its popularity. In the hypothetical dish choice study by
216 Campbell-Arvai et al. (2012), the introduction of default menus had a differential impact depending on
217 whether the target dish options were perceived as appealing or as unappealing: the increase in choice
218 probability was highest for unappealing options set as defaults (compared with a neutral situation),
219 although appealing options remained more frequently chosen than less appealing ones (Campbell-
220 Arvai et al., 2012). In a recently published study, Boers et al. (2019) looked at the effects of different
221 nudge approaches on increasing the selection of vegetables in a university buffet restaurant. The
222 results suggest that the effectiveness of nudging depends on the specificity and/or the familiarity of
223 the nudged products, which could also be related to dish popularity. Outside the food domain, this
224 effect has also been observed for other types of economic choices using pre-set choice or default
225 options (Roca, Hogarth, & Maule, 2006; Samuelson & Zeckhauser, 1988). The second hypothesis of this
226 study therefore concerns the popularity of the dish as a condition for DoD nudge effectiveness:

227 *H2: The DoD effect will be stronger for an unappealing dish compared to an appealing dish*

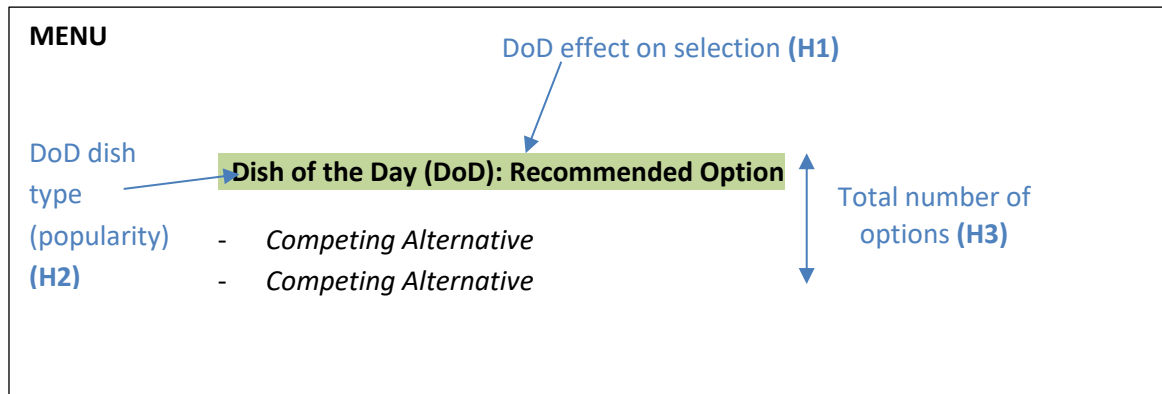
228 **2.2.3 The moderating role of menu size**

229 A second element to consider when investigating the choice task is whether the menu size – that
230 is to say, the number of options to choose from, impacts the effectiveness of the nudge. This is a key
231 operational question, as the number of options proposed in foodservice settings varies significantly
232 depending on the size of the restaurant, number of consumers, and the type of operator. Foodservice
233 companies may see a higher number of options as a benefit to consumers, since it provides them a
234 higher probability of optimizing their choices. Differentiation is thus a strategy commonly used in
235 supermarkets to create added value (Oppewal & Koelemeijer, 2005). Conversely, an extensive
236 literature review on choice avoidance (Iyengar & Lepper, 2000; Scheibehenne, Greifeneder, & Todd,
237 2010) suggests that the larger the number of options, the more decision-makers try to avoid making
238 active choices, as search costs increase. It can be hypothesized that, in the presence of a larger number
239 of dish options, consumers may be inclined to rely more on a decisional help such as a featured dish,
240 to minimize the cognitive effort of searching options at the point of decision. Hence our third
241 hypothesis:

242 *H3: The DoD effect will increase with the number of options to choose from*

243 To our knowledge, no study has specifically investigated this question for vegetable choices in
244 foodservice settings or has looked at how the number of options may moderate the effect of featuring
245 a dish as DoD.

246 Figure 1 summarizes the three hypotheses and main variables tested in this study. An experiment
 247 was conducted in a self-service experimental restaurant to study the impact of introducing a DoD
 248 option in the main dish selection task. The type of the nudged dish and the menu size (number of
 249 alternatives) varied across experimental conditions in order to compare the resulting probability of
 250 selecting the vegetable-enriched dish. The resulting intake, food waste, and consumer satisfaction,
 251 were also measured in each condition and compared in order to look at the potential consequences of
 252 variations in terms of consumer satisfaction and consumption behaviour.



253

254 **Figure 1: Summary of hypotheses**

255

256 3 Material and methods

257 3.1 Experimental approach

258 In order to test these hypotheses, a living lab experiment was set up. Living laboratories, or living
259 labs, are platforms of research and innovation where users are studied in their natural environment
260 (Niitamo, Kulkki, Eriksson, & Hribernik, 2006). In the present case, the living lab is an experimental
261 restaurant, and users are food consumers. This restaurant is composed of a kitchen and a restaurant
262 that are both equipped to be entirely flexible and allow reproduction of any type of ecological catering
263 environment (Dougkas, Saulais, & Giboreau, 2019). In such an experimental setting, contrary to that
264 of a classical laboratory, participants come with the primary goal of having a meal experience, and not
265 of completing a survey, even if they are aware that experimental studies may take place during their
266 meal. The living lab is located within a place identified locally as a restaurant, instead of a university
267 campus. Participants are not paid to participate, but they pay for their own meal, like in any restaurant.
268 They are not recruited for the experiment, but rather make a booking for a table. As standard
269 procedure, all customers sign a consent form at arrival even if they are not part of any study.
270 Foodservice professionals operate the restaurant (food preparation and service) even when no
271 experiments are conducted. However, like in a traditional laboratory, the platform allows researchers
272 to strictly control procedures as well as context, including the food offer (portions, number of options,
273 quality, prices), several physical ambiance variables (temperature, lighting), information provision, and
274 service procedures (Dougkas et al., 2019), and to record and manage social interactions, making it
275 possible to systematically investigate parameters of interest within a realistic environment. Although
276 the food offer and operational procedures are strictly controlled, this control is not made apparent to
277 consumers, and in terms of subject experience, living laboratory experiments are similar to *natural*
278 *field experiments* “where the environment is one where the subjects naturally undertake these tasks
279 and where the subjects do not know that they are in an experiment” (Carpenter et al., 2005, p.7), with
280 the difference that, for ethical reasons, participants are informed of the nature of the platform (but
281 usually not the nature of the study), as they have to sign a consent form to provide authorization for
282 their data to be recorded even when no tests are being conducted².

283 For this study, the restaurant was set up as a self-service restaurant. The experimental task
284 studied was the choice of food for a meal, a natural task which required neither supplementary

² An analogy could be made, to some extent, with medical research conducted in university hospitals, where patients may be asked to sign a consent form for their individual data to be used for research, although they primarily may have come with the objective of being examined or treated.

285 cognitive effort nor awareness of the experiment from participants. A questionnaire allowed the
286 recording of complementary variables, but it was filled out at the end of the meal rather than before.

287 **3.2 Participants**

288 In total, two-hundred and ninety-four (294) restaurant customers participated in the study [98
289 men and 196 women; mean age: 51,6 years, s.d. 17,1]. They booked a table at the restaurant following
290 advertisements that were sent via two primary means: (i) an email was sent to a database of
291 consumers who had volunteered to be updated on events at the experimental restaurant, including
292 tests and openings and (ii) advertisements (flyers and posters) were distributed in the local area, in
293 public places as well as local companies. The flyer advertised for the opportunity to try out an
294 ephemeral cafeteria concept at the living lab. To mirror the typical clientele of commercial cafeterias,
295 no specific exclusion criteria were defined for recruitment. However, for this article, only the adult
296 (over 18) sample was retained.

297 Participants booked a table on-line for one of the ten possible days of test, and were contacted
298 again by phone or email for confirmation. As standard procedure, the day prior to their reserved time,
299 participants were contacted again by phone to remind them of their registration for the following day.
300 Consumers on the waiting list were called in the event of another consumer's cancellation.

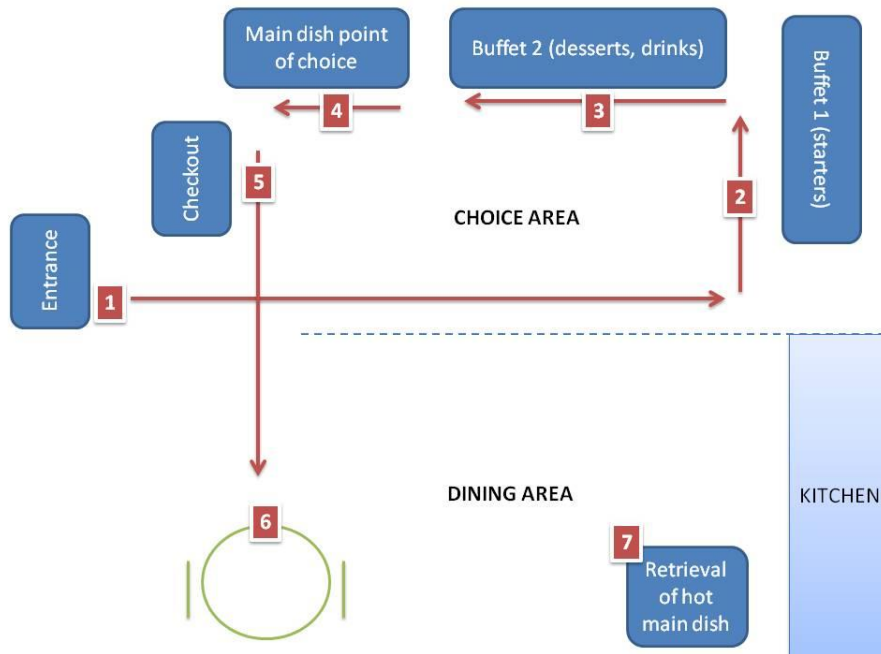
301

302 **3.3 Experimental setting**

303 The restaurant was arranged to reconstruct a self-service restaurant. It included two areas: a
304 choice area (where participants chose from the food presented in a buffet) and a dining area where
305 participants could eat their meal once chosen (Figure 2). The choice area was designed to mirror a
306 typical French cafeteria, where starters and desserts are chosen first, and the main (hot) dish is chosen
307 at the end of the line. Participants paid 10 euros for a full meal composed of a starter, a main dish, and
308 a dessert. Hot and cold beverages could be purchased in addition.

309

310



311

312 **Figure 2: Configuration of the self-service restaurant setting**

313 *The numbers indicate the sequence of the customer's experience.*

314 **3.4 Food offer**

315 The food options available at the buffet are described in the table below (Table 1). Portions
 316 were fixed and controlled for all foods. As the experiment focused on the choice of main course, there
 317 were no variations in the way the other courses were presented during the experimental campaign.
 318 For starter and dessert, some limited choice (described in the table below) was introduced to mirror
 319 real life cafeteria conditions. The buffet items in each section except the main dish (toppings, desserts,
 320 drinks) were displayed in a randomized order so as not to affect the choices of participants.

321 To ensure constant dish quality, all dishes (with the exception of desserts which were bought
 322 ready-made) were prepared and frozen on site in a single batch for the whole experimental campaign
 323 prior to the first session. The required number of portions was then re-heated for each lunch session.

324 The main course recipes were all hot dishes created by culinary arts professionals prior to the
 325 test. The Veggie Burger [vg1] and the Pea Pie [vg2] are vegetable-enriched dishes that were developed
 326 in the context of the European project VeggiEAT, following a specific recipe development process that
 327 included consumer feedback and acceptability evaluation. The recipe for the third dish, meatballs
 328 (nvg), was created specifically for this experiment as a meat-based alternative to the vegetable-
 329 enriched dishes. While the recipe using turkey and quinoa was innovative, meatballs are a typical and
 330 popular dish in French self-service restaurants.

331

332 **Table 1: Description of food offer**

Course	Dish	Portion size in g (Mean ± sd)	Choice
Starter	Corn soup contained in a casserole with cover	130g ± 0.92	One topping to choose among 3: Paprika (3.5g) / Chopped Chorizo (20g) / Chopped chervil (1.5g)
Main course	Vegetable Burger [vg1] (vegetable steaks made of red kidney beans, corn, chickpea, egg and flour), with burger bread, served with a seasoned salad as a side dish	268.7g ± 75.46	Type of dish (see experimental design)
	Peas Pie [vg2] (pie crust, filled with baked center made from baked peas, pea purée, eggs and cream) served with a seasoned salad as a side dish	262.08g ± 77.8	
	Meat Balls [nvg] (turkey meat balls with quinoa and tomato sauce) served with a seasoned salad as a side dish	267,85g ± 74.4	
Dessert	Fruits	1 pear or 1 apple or 2 clementines	Type of dessert
	Yogurt	100g	
	Millefeuille Pastry	140 g	Flavour of millefeuille (vanilla, chocolate, or caramel)
Drinks	tea, coffee, red wine, white wine, fruit juice, sparkling water		Type of drink

333 **3.5 Experimental design**

334 The experiment was designed to study the impact of a DoD nudge on the frequency of selecting
 335 the target dish, which was the vegetable burger (vg1). The experimental conditions tested two types
 336 of variations of the DoD setting: (1) Type of dish nudged as DoD option: either vg1 as the DoD, or nvg

337 as the DoD; and (2) Number of options: either 1 or 2 alternative choices to vg1. Two neutral conditions,
 338 where no dish was in the DoD position, were also studied as references to allow the measuring of
 339 effect sizes: T1-0 (two options, none is DoD) and T2-0 (three options, none is DoD). Five treatments
 340 were thus defined (Table 2). As the focus of the experiment was on vg1, we did not test DoD for vg2 in
 341 the three options version, and only considered the impact of increasing the number of alternative
 342 options when vg1 was DoD compared to a neutral setting where no dish was DoD.

343 **Table 2: Experimental Treatments**

Treatment	Dish of the day (DoD) option	Number of options	Number of sessions
T1-0 – Neutral (2 options)	None	2 (Veggie Burger + Meatballs)	2
T1a –vg1 as DoD, 1 alternative to DoD	Veggie Burger (vg1)	2 (Veggie Burger + Meatballs)	2
T1b – vg1 as alternative to DoD, 1 alternative to DoD	Meatballs (nvg)	2 (Veggie Burger + Meatballs)	2
T2-0 –Neutral (3 options)	None	3 (Veggie Burger + Pea Pie + meatballs)	2
T2a – vg1 as DoD, 2 alternatives to DoD (3 options)	Veggie Burger (vg1)	3 (Veggie Burger + Pea Pie + meatballs)	2

344

345 T1a and T1b allow measurement of the size of the DoD effect through the assessment of the
 346 proportion of participants who chose the DoD in these conditions in comparison with the neutral
 347 condition T1-0 (Hypothesis 1). Direct comparison of T1a and T1b allow assessment of the impacts of
 348 dish popularity (Hypothesis 2). T2-0 measures how choices are distributed when one extra dish option
 349 is proposed as a neutral choice, in comparison with T1-0. In T2a, vg1 is the DoD, and the choice of vg1
 350 can be compared to T2-0 to evaluate the relative effect. Differences in choice between T2a and T2-0
 351 versus T1a and T1-0 allow assessment of the impact of the number of options (Hypothesis 3).

352 **3.6 Experimental procedure**

353 The experimental campaign was conducted over 10 sessions in November 2015, which all took
 354 place at lunch time, from Monday to Friday, over the course of two weeks (2 non-consecutive sessions
 355 per treatment). Upon arrival, participants first signed a consent form (Figure 2, zone 1), to agree to the
 356 use of their data for research, although there was no information on the specific goals of the study.
 357 Participants were then given instructions to choose their food, which consisted of information such as

358 where to take a tray, the number of items that could be chosen, and where to pay. They were also
359 given a short questionnaire with instructions to complete one part during and one part after their
360 lunch, as well as a tray that was labelled with a unique identifier code to allow the recording of
361 individual choices. They then headed to the choice area, where they first took their starter (zone 2),
362 then one dessert (zone 3), and an optional drink. Finally, they headed to the zone of main course choice
363 (zone 4), before paying at the checkout (zone 5). They then headed to the dining area (zone 6) where
364 they consumed their meal and filled out the questionnaire.

365 The choice of main course went as follows. At the end of the self-service line (zone 4), an
366 experimenter (dressed like the restaurant operators) presented the consumers with the choice of main
367 hot dishes, always using the same pre-written discourse. The choice was based only on the description
368 of the dishes, as consumers could not see dishes at this stage (they were prepared in a separate
369 kitchen). This organization allowed for greater fluidity in customer flow, while also mirroring the
370 organization of most French self-service restaurants where the main dish is ordered at the same time
371 as the other dishes, but is served once the starter is consumed.

372 Depending on whether the treatment included a DoD option or not, the ordering procedure
373 was different. On days that included no DoD, the choices were presented orally to consumers by the
374 experimenter, who said “Today as a main dish, you have a choice between the options shown on the
375 menu board”. The dish options were shown on a clearly visible menu board, posted at the point of
376 choice. In conditions with a DoD, the experimenter (impersonating a waitress/waiter) said “today our
377 Dish of the day is [DoD]. Other alternatives are available on the menu board” and showed the menu
378 board, which featured the DoD and the other alternatives. To minimize the possibility that indicating
379 the terms “Dish of the day” provided extra information that could be considered by consumers for
380 their choice (for instance, DoD inducing a belief on the freshness of the dishes), it was specified from
381 the beginning of the test that all dishes were made by the Culinary Masters students on site, in order
382 to minimize beliefs on differentiated levels of freshness. Figure 3 shows the menu board presentation
383 for T1-0 and T1a. For treatments T1-0, T2-0 and T2a, where more than one dish was presented as a
384 non-DoD option, a randomization of order was conducted in each session. While randomization order
385 was balanced in sessions T1-0 and T2a, only two out of six combinations appeared for T2-0 (as only 2
386 sessions were conducted per treatment): vg1- vg2-nvg and vg2-nvg-vg1³.

³ This incomplete randomization plan for T2a sessions may lead to an overestimation of the effect when comparing T2-0 and T2a. Although the data does not allow us to exclude the existence of this potential bias, the absence of a fixed session effect in the two-option treatments suggests that its extent may be limited.

387 Consumers then indicated their choice to the operator at the checkout counter (which was
 388 located next to the point of dish choice, as seen in figure 2), and received a token for the dish that they
 389 had chosen. The consumers could see the menu board at this stage as well. Then they paid for their
 390 meal, ate their starter, and once finished, went to retrieve their hot dish (zone 7).



391
 392 **Figure 3: Examples of menu cards posted for dish choice in the 2-options treatments: Left: Neutral**
 393 *choice configuration in T1-0, Right: configuration in T1a, with vg1 as DoD.*

394 **3.7 Data collection and analysis**

395 For each participant, three types of variables were collected during the experiment: **choices**,
 396 **self-reported evaluations**, and **quantities consumed**. Each participant was identified by a unique code,
 397 which allowed the connection of all types of data to the same individual. The method of collection of
 398 each type of data is presented in Table 3.

399 **Table 3 : Variables collected and method of measurement**

Type of data	Method	Variables	Unit / scale
Choices	Photograph of tray at counter	Choice of topping	Category of dish chosen as observed through video observation
		Choice of main dish	
		Choice of dessert	
		Choice of drinks	
Quantities	Weighing of plate before and after the meal	Percentage plate waste of starter, main dish, dessert	Percentage (%) = (B-A)/B With A and B = respectively, weight in grams of plates and containers after (A) and before (B) the meal.
Self-reported evaluations	Questionnaire filled out	Year of birth	Number
		Gender	Male or Female

throughout the meal	Occupation	Farmer / Employee, / Worker, / Unemployed, / Retired / Student, Executive/Self employed
	Liking of starter, main dish, dessert	9-point scale ranging from “I dislike it very much” to “I like it very much”
	Hunger before and after meal	9 point scale from “I am not hungry at all” to “I am very hungry”
	Emotional state before and after meal	9-point scale from “I feel very unwell” to “I feel very well”
	Score of vegetable liking (/90)	Cumulated liking scores for 10 common vegetables (green beans, peas, corn, carrots, salad, tomatoes, zucchini, broccoli, cauliflower, spinach) rated each on a 9-pt scale (“How much do you generally like this vegetable”)
	Frequency of vegetable consumption	4-point frequency scale 1 : less than once a week 2 : several times a week 3 : Once a day 4 : More than once a day

400

401 All data were analysed using the R statistical environment (R core team, 2015). We conducted an
402 analysis of DoD effects at the aggregated group level, then at the individual level.

403 Main course choices were first examined across treatments, in order to assess the impact of the DoD
404 treatments on the probability of choosing vg1 versus nvg or vg2 at the group level. We examined the
405 differences in choice rates and calculated what we labelled (following the standards in the behavioural
406 economics literature) as a *bias*: that is to say, the difference between the selection of the dish when
407 placed in nudged versus in neutral (non-nudged) conditions.

408 For dish i , the absolute bias (additional choices made towards a dish when it is DoD), b^i and the relative
409 bias, r^i were calculated as :

410

411
$$b^i = \text{DOD}^i - \text{NEUT}^i \text{ and } r^i = (\text{DOD}^i - \text{NEUT}^i) / \text{NEUT}^i$$

412

413 *where* DOD^i and $NEUT^i$ are the proportions of participants who chose *i*, respectively, when it was the
414 DoD dish, and when it was in the neutral condition. Pearson's Chi-squared tests were used to compare
415 the proportions of *vg1* versus other options across all treatments, across the two-options treatments
416 (T1-0 vs T1a vs. T1b), and across the three-options treatments (T2-0 vs. T2a).

417

418 Secondly, we analysed individual-level data to estimate the determinants of the probability of
419 choosing the target dish *vg1*. We looked at two sets of factors potentially affecting this probability:

- 420 - Choice set factors: type of dish (whether *vg1* was the DoD, the alternative to DoD, or in a
421 neutral position), and number of alternatives (either two or three options in the choice set);
- 422 - Individual factors : age, occupation, gender, hunger, emotional state, liking of vegetables

423 To account for possible session-related effects, the probability of selecting *vg1* was estimated
424 through a linear mixed model with a binomial distribution, using the Laplace approximation for
425 random factor 'Session'. The estimation used function `glmer` from R package `lme4` (Bates, Mächler,
426 Bolker, & Walker, 2015).

427 For both the two- and three-option treatments, a fully specified model was estimated, as well as
428 a model selected using AIC calculations. The selection step was conducted to keep the most relevant
429 variables in the final model. Interactions between the experimental factors and individual
430 characteristics were also included in the model selection process. As the relative probability depends,
431 mechanically, on the number of alternatives, two databases were analysed separately, using,
432 respectively, the data from the treatments with two options (T1-0, T1a and T1b) and the data from
433 those with three options (T2-0 and T2a). Choices between two and three options on an individual level
434 were not estimated, since the two-and three-option treatments were intended as separate
435 experimental branches, with different factors of variation (type vs number of options), objectives and
436 hypotheses.

437 Finally, in order to assess the consequences of the treatments on consumers' intake and
438 satisfaction, the resulting quantities consumed and liking of the vegetable burger were compared
439 across conditions, using parametric tests (Student two-sample tests).

440 **4 Results**

441 **4.1 Participants' characteristics**

442 The characteristics of participants are presented in **Table 4**. The samples were balanced across
443 treatments in terms of gender distribution. However, the participants in the T1a treatment group were

444 on average slightly younger than those in the other groups. In terms of preferences for vegetables, the
 445 cumulated scores (as defined in **Table 4**) are not statistically different across groups. Self-reported
 446 initial and final hunger scores, as well as initial and final wellbeing scores, were not different between
 447 groups.

448 **Table 4: Participants' characteristics across treatments**

Treatment						F Value, Pr(>F)	Fisher 's exact test
	T1-0	T1a	T1b	T2-0	T2a		
N	61	57	56	60	60		
Mean Age (sd)	54,1 (17, 6)	46,2 (17,1)	48,6 (18,9)	55,5 (16,5)	52,9 (13,9)	F=3.1 ; p=0.01	
Gender (%F)	68,9%	73,7%	69,6%	61,7%	60,0%		<i>P=0,5 0</i>
Initial Hunger (9-pt scale) (sd)	7,3 (1,5)	7,3 (1,5)	7,1 (1, 6)	7,4 (1,2)	7,2 (1,1)	F=0.4 p=0.82	
Final Hunger (9-pt scale) (sd)	1,6 (1,5)	1,4 (1,1)	1,6 (1,4)	2,2 (2,1)	1,7 (1,4)	F=2.2; p=0.07	
Initial wellbeing (9- pt scale) (sd)	8,0 (1,3)	8,1 (1,1)	8,1 (1,2)	8,1 (1,1)	8,2 (0,9)	F=0.2; p=0.95	
Final wellbeing (9-pt scale) (sd)	7,9 (1,3)	7,7 (1,4)	7,7 (1,7)	7,8 (1,3)	7,8 (1,1)	F=0.4; p=0.81	
Liking of vegetables (/90) (sd)	72,4 (9, 9)	75,3 (9,6)	74,0(10, 4)	75,7 (8, 8)	76,8(10, 4)	F=1.7 p=0.15	

449 **4.2 Main course choices**

450 Table 5 summarizes main course choices in function of the experimental condition, as well as
 451 absolute and relative bias for the DOD with reference, respectively, to the T1-0 treatment (in the case
 452 of T1a and T1b) and to the T2-0 treatment (for T2a).

453 **Table 5: Proportions of main course dish choices across experimental condition**

T1-0	T1a	T1b	T2-0	T2a
(No DoD; 2 options)		(nvg is DoD, 2 options)	(No DoD, 3 options)	(vg1 is DoD, 3 options)

	(vg1 is DoD, 2 options)				
Nb	61	57	55	60	60
participants					
% vg1	34,4%	59,6%	27,3%	23,3%	53,3%
% nvg	65,6%	40,4%	72,7%	51,7%	35,0%
% vg2	x	x	x	25,0%	11,7%
Bias		25,2%	7.1%		30%
Relative bias		73%	11%		129%
Chi-squared tests	T1-0 vs. T1a vs. T1b :		T2-0 vs. T2a :		
	X-squared = 13.60, p-value = 0.001		X-squared = 11.42, p-value < 0.001		
	All treatments: X-squared = 25.13, p-value < 0.001				
	Relative bias: T1a vs. T1b vs. T2a : p-value < 0.001				

454

455 In the neutral treatment T1-0, 34,4% of participants chose vg1 over nvg. In both the two- and
456 the three -option conditions, the treatments had an impact on the distribution of choices among the
457 options ($p < 0.001$ in both cases), suggesting an effect of DoD on choice.

458 Differences in the size of this effect were observed depending of the type of the dish placed as
459 DoD. When vg1 was placed as DoD (T1a), 25,2% more participants chose vg1, for a total of 59.6%.
460 When nvg was the DoD, the bias in favour of this dish was smaller, and only amounted to 7.1%.
461 Likewise, the relative bias in favour of the DoD diminishes significantly when the initial share of the
462 dish (evaluated in neutral condition) increases: it is the highest in T2a (73%) and the smallest in T1b
463 (11%), suggesting that the least popular items benefit the most from the DoD intervention.

464 Increasing the number of alternatives affected the choice of vg1 and nvg in the neutral situation:
465 in T2-0, adding an option reduces selection of both vg1 (by 11.1%) and nvg (13.9%) in comparison with
466 T1-0. Presenting vg1 as the DoD in the 3-option situation (T2a), increased selection rate by 30% for this
467 dish, compared to the neutral, 3-option condition T2-0. The relative bias for vg1 increased significantly
468 between the 2 and 3-option treatments, going from 73% in T1a to 129% in T2a.

469 4.3 Determinants of choice of Dish of the Day

470 Based on the selection model step, the determinants of $\Pr(VG1^i=1)$, the probability of an individual i
 471 choosing the target dish $vg1$ in each database, were estimated using mixed-effects binomial
 472 regression models specified as follows:

473 For the two-option treatments: $\Pr(VG1^i) \sim VG1STATUS^i + Age^i$

474 For the three-option treatments: $\Pr(VG1^i) \sim VG1STATUS^i + Age^i$

475 Where

- 476 • **VG1STATUSⁱ** is a categorical variable whose value is 'NEUTRAL' if i was assigned to a
 477 treatment where there was no DoD (reference value in the model), 'DOD' if $vg1$ was the DoD
 478 in the treatment, and 'NDOD' if nvg was the DoD.
- 479 • **Age** is the age of the participant, in years

480 All other potential explanatory variables were excluded from the selected model as their addition
 481 increased AIC scores. The results of the model's estimation for both variety situations (one or two
 482 alternatives to $vg1$) are presented in Table 6, as well as the fully specified model (with all variables) for
 483 reference.

2-options models (T1-0, T1a, T1b)									
Taking into account sessions as random effects									
	<i>Selected model</i>				<i>Fully specified model</i>				
	<i>Std.</i>	<i>z</i>	<i>Pr(> z)</i>		<i>Std.</i>	<i>z</i>	<i>Pr(> z)</i>		
	<i>Estim.</i>	<i>Err. value</i>			<i>Estim.</i>	<i>Err. value</i>			
(Intercept)	1.06	0.60	1.76	0.08	1,88	1,32	1,43	0,15	
VG1STATUS = NDOD									
(Reference = NEUTRAL)	-0.55	0.49	-1.29	0.26	-0,57	0,43	-1,31	0,19	
VG1STATUS = DOD									
(Reference = NEUTRAL)	0.91	0.46	1.97	0.05	0,92	0,41	2,26	0,02	
Age	-0.03	0.01	-3.30	<0.001	-0,03	0,01	-3,18	0,00	
GENDER (1=male)					-0,62	0,39	-1,60	0,11	
HungerBefore (scale of 1-9)					-0,06	0,12	-0,53	0,60	

Frequency of vegetable consumption
(scale of 1 to 4)

-0,08 0,22 -0,39 0,70

484 **Table 6: Logit Model Coefficients Estimates for Probability of Choosing vg1 in the two-options**
485 **model**

486

	3-options models (T2-0, T2a)							
	Selected model				Full model			
	Estimate	Std. Error	z	Pr(> z)	Estimate	Std. Error	z	Pr(> z)
(Intercept)	0,9				1,6			
	1,69	0	1,87	0,06	0,03	6	0,02	0,99
VG1STATUS = DOD	0,6				0,4			
(Reference = NEUTRAL)	1,50	1	2.44	0.01	1,48	4	3,35	<0.01
	0,0		-		0,0		-	
Age	-0,06	2	3,40	<0,01	-0,06	2	3,50	<0,01
					0,4			
GENDER (1=male)					0,01	5	0,02	0,98
					0,1			
HungerBefore (scale of 1-9)					0,00	9	0,00	1,00
Frequency of vegetable consumption (scale of 1 to 4)					0,2			
					0,53	8	1,92	0,06

487 **Table 7: Logit Model Coefficients Estimates for Probability of Choosing vg1 in the three-options**
488 **model**

489 Two factors are significantly related to the probability of choosing vg1. The first factor is
490 experimental: when vg1 is the DoD, then the probability of choosing vg1 increases. This is true in both
491 models, although this effect appears to be weakly significant in the two-option model (p=0,05). The
492 second factor is individual: younger participants had a higher probability of choosing vg1,
493 independently of the experimental treatment.

494 Conversely, gender, initial state of hunger, and habitual preferences for vegetables, were not
495 robust predictors of the probability of choosing vg1. Likewise, no interaction effect between the
496 individual characteristics and the DoD conditions were found in the model selection process. Although

497 session effects were accounted for as random effects in the model estimation, other clustering
498 variables that have not been tested may have also affected the independence of individual data, such
499 as the number of participants in a session or the group sizes (at each table).

500 **4.4 Impact of nudging on liking, meal choice and quantity consumed**

501 Table 8 reports the percentage plate waste and liking of the dishes across treatments. Two two-
 502 factor ANOVAs were conducted at the group level to test whether (i) the amount of plate waste, and
 503 (ii) the liking score, are associated with the treatment and with the type of dish. Regarding (i) plate
 504 waste, the results do not suggest a statistically significant link between the amount of food wasted and
 505 the experimental condition ($F= 1.33$; $p=0,25$), between the plate waste and the type of dish ($F=2.29$;
 506 $p=0.10$), and between treatment x type of dish ($F=0.34$; $p=0.89$). Likewise, regarding (ii) liking, no
 507 difference in liking score could be identified between treatments ($F=1.83$; $p=0.12$), between dishes
 508 ($F=0.93$; $p=0,40$), nor between dish x treatment ($F= 2.16$; $p=0.06$).

509 **Table 8 : Mean plate waste and liking score of all dishes across treatments**

	T1-0		T1a		T1b		T2-0		T2a	
Mean (sd)	Liking									
	<i>N</i>	Liking score	<i>N</i>	Liking score	<i>N</i>	Liking score	<i>N</i>	Liking score	<i>N</i>	Liking score
vg1	21	5,81 (2,25)	34	6,21 (1,77)	15	6,13 (2,13)	14	6,57 (1,09)	32	6,31 (1,69)
nvg	40	6,88 (1,74)	23	6,35 (1,43)	40	5,55 (2,16)	31	5,97 (2,01)	21	6,19 (1,6)
vg2							15	4,93 (1,39)	7	6,86 (1,86)
Mean % (sd)	Waste									
	<i>N</i>	% waste	<i>N</i>	% waste	<i>N</i>	% waste	<i>N</i>	% waste	<i>N</i>	% waste
vg1	21	9% (10%)	34	9% (13%)	15	13% (15%)	14	10% (12%)	32	6% (8%)
nvg	40	9% (12%)	23	6% (12%)	40	9% (11%)	31	6% (8%)	21	6% (11%)
vg2							15	3% (7%)	7	2% (2%)

510

511

512 5 Discussion

513 A living lab experiment was conducted in a real self-service environment in order to examine the
514 effects of setting a dish as DoD on consumers' dish choices. The primary purpose of this research was
515 to replicate the DoD effect in this setting and to investigate under which conditions such a strategy
516 could effectively affect choice. Two factors that are crucial in the set-up of food choice in a cafeteria
517 environment were specifically investigated: the type of dishes available, and the number of
518 alternatives.

519 5.1 H1: replication of the "Dish of the Day" effect

520

521 Although featuring healthier dishes as DoD has been described as a simple, straightforward and
522 inexpensive way to encourage consumption of vegetables (Lachat et al., 2010), the 'DoD effect' has
523 only been investigated in a limited number of foodservice settings. The first hypothesis (H1) was
524 therefore that the DoD effect would replicate in this particular setting – in other words, that setting an
525 option as DoD would have a significant effect on dish selection. This hypothesis is verified in the
526 experiment: in all conditions, featuring a dish in the DoD position significantly increased the frequency
527 of its selection in comparison with the neutral position.

528 5.2 H2: effect of the popularity of the nudged dish

529

530 Beyond this replication, the experiment was designed to test two hypotheses regarding the
531 conditions of effectiveness of the DoD effect. Hypothesis H2 was that the size of the DoD effect would
532 be different depending on the initial popularity of the option set up as DoD, and larger for initially less
533 popular options. This hypothesis is overall verified: when comparing T1a and T1b, the size of the DoD
534 effect was the largest for T1a, in which the DoD was vg1, the least selected dish in neutral conditions.
535 In other words, the relative bias of selection was highest for the dish that had the lowest choice rate
536 in the neutral position: when vg1 was DoD (T1a), choices of nvg decreased by 26% (compared with T1-
537 0), whereas when nvg was DoD (T1b), choices of vg1 decreased only by 7%. This difference in absolute
538 effect size may be due to the fact that the initial proportion of nvg choice (revealed in T1-0) was higher;
539 leaving a lower number of people left to be "nudged". However, the difference in relative effect also
540 suggests differences in the way the nudge acted in T1a (where the nudge was targeting those who
541 would have chosen vg1 in T1-0) and in T1b (where the nudge targeted those who would have chosen
542 nvg in T1-0). A possible explanation for this asymmetry of effects could be an asymmetry of attention:
543 outside the food domain, Geng (2016) found that deviations (from what would be the predicted choice

544 in a neoclassical approach) are of greater magnitude when an option set as the default is an initially
545 less favoured option than when it is a most favoured, or dominant one (Geng, 2016).

546 **5.3 H3: effect of the number of alternatives**

547

548 The third hypothesis (H3) was that increasing the number of alternatives would reinforce the
549 impact of DoD. We observe this effect especially in terms of relative bias for the DoD. In absolute
550 terms, vg1 as the DoD option was chosen slightly more frequently in the situation with three
551 alternatives than with two alternatives, although this was not statistically significant. The relative bias,
552 on the other hand, was significantly stronger in the three-option task (129% versus 73% for the two-
553 option task). While a large body of literature has investigated the relations between variety and choice,
554 to our knowledge the link between number of alternatives and the effects of nudges for food have not
555 been investigated experimentally. Research on choice overload suggest that, although people are
556 more satisfied with variety, an excessive number of food choice options can be demotivating and can
557 lead to confusion (Iyengar & Lepper, 2000; Johnson et al., 2012). This phenomenon, sometimes
558 labelled the “Tyranny of Choice”, could explain why preference for the “path of least resistance” (as
559 coined by Samuelson and Zeckhauser (1988)) and, therefore, the influence of the DoD nudge, both
560 seem to increase with the number of alternatives in the choice set.

561 **5.4 Consequences of the nudge on subsequent behaviour and satisfaction**

562

563 A secondary objective of the study was to assess the consequences of the nudge on consumers’
564 satisfaction and consumption behaviour, and more generally the relevance and legitimacy of
565 interventions such as the one described in this paper to address behavioural changes in the long term
566 (Loewenstein et al., 2012; Lusk, 2014). If participants find themselves nudged to select a dish, but are
567 disappointed by it, then the intervention has a negative outcome for them, and there is a risk that they
568 may adapt their behaviour so as not to be affected by the nudge a second time. In the case of this
569 experiment, some evidence of the potential impact of the nudge for individuals was provided by
570 measures of the differences in plate waste and liking of the selected dish across treatments. We found
571 no significant difference in consumer satisfaction with the dish (which seems to indicate that those
572 who were “nudged” towards vg1 did not like or dislike it significantly more, and likewise for nvg) or in
573 plate waste across treatments and dishes. Using these particular measures of satisfaction, there was
574 therefore no evidence that consumers perceived the choice of the option labelled as DoD as a loss.
575 However, in some other nudge experiments, evidence suggests that consumer intake may be affected
576 by nudging. Just and Price (2013) for instance found that adding a piece of fruit by default to students’

577 trays (with the possibility of giving it back) increased selection but also induced more waste (Just &
578 Price, 2013). The difference could come from the palatability of the dish towards which the nudge was
579 operated, and the perceived substitutability of options. Raw fruits may not be strongly palatable
580 overall, while, in our experiment, the “target” product, vg1, was specifically designed and developed
581 to be acceptable in a self-service context, through prior product development steps in the project. This
582 increased attractiveness could have prevented a loss of satisfaction induced by nudging. Furthermore,
583 some of the measures in our experiment were obtained on small subgroups (for instance, only seven
584 participants evaluated vg2 in T2a), therefore, the test of the impact effects may be underpowered.
585 Further research should be dedicated to exploring this specific aspect of nudging interventions.
586 Additionally, participants in our study had also paid for their dish (as opposed to receiving a free dish),
587 thus they had already made a commitment to the dish or had invested interest in consuming and liking
588 it. However, an answer to this question would require further exploration of participants’ beliefs and
589 perceptions towards the different dishes.

590 **5.5 Policy implications**

591

592 The foodservice sector, and especially the commercial restaurant sector, has only recently come
593 under the attention of policy makers to address the challenge of fostering healthier eating behaviours,
594 and regulations have primarily focused on the provision of information, with mixed results regarding
595 actual food choice behaviours. Policy interventions targeting the market environment have been
596 identified as a potentially effective approach when it comes to fostering healthier behaviours
597 (Brambila-Macias et al., 2011). In particular, nudging interventions have shown some promising
598 empirical results (Bergeron, Doyon, Saulais, & Labrecque, 2019; Friis et al., 2017). However, several
599 recently published meta-analyses have concluded that the quality of evidence on nudging is still
600 insufficient to properly support implementation on a large scale (Bucher et al., 2016; Szaszi et al.,
601 2018).

602 The research presented in this article focuses on one type of intervention, DoD, which has been
603 recommended as a potential strategy to encourage healthier food choices. This research aimed to
604 contribute to this need for more data on nudges by, first, replicating the DoD effect in a specific
605 foodservice setting, and, second, by investigating the conditions of the effects of this nudge, using a
606 standardized and controlled approach.

607 In this living lab setting, the DoD effect was replicated and led to an increase in relative choice of
608 the nudged dishes. In terms of effectiveness, we show, firstly, that this DoD effect is greater for dishes
609 that are initially (in neutral conditions) less popular. Such strategies could then be beneficial in terms

610 of vegetable consumption, considering that taste, attractiveness and familiarity are amongst the main
611 barriers to vegetable consumption (Appleton et al., 2016). Secondly, we find that the menu size has an
612 impact on the DoD effect: the larger the number of options, the bigger the DoD effect size. DoD
613 strategies could therefore be most impacting in environments such as commercial cafeterias or chain
614 restaurants, where multiple options are available.

615 Another key point in the policy debate surrounding the use of nudges to encourage healthier
616 eating is the public acceptance of such measures to promote healthy eating, especially in comparison
617 to other possible policy instruments (Hagmann, Siegrist, & Hartmann, 2018), and their legitimacy to
618 promote what is identified by choice architects as a “more desirable” behaviour. By assessing the effect
619 of the nudge on consumer satisfaction and food intake, this research contributes to this debate by
620 measuring the consequences of the use of nudges to encourage vegetable consumption.

621 **5.6 Limitations**

622 This study is a pilot experiment that aimed to provide some insights for choice architecture in
623 foodservice settings, specifically on the question of how some conditions of implementation may
624 impact the effect of a DoD nudge intervention. Living lab experiments are becoming increasingly used
625 in the process of designing public health interventions in order to identify optimal conditions for
626 implementation of an intervention on a larger scale. However, this methodology does not guarantee
627 the generalizability of results to other settings (Sunstein, 2017). Although the living lab allows for
628 controlled, systematic experiments in realistic conditions and aims to increase the transferability of
629 results, the scope of our results remains limited by the specificity of the context. In particular, one of
630 the main limitations of this study is that it only considers variations within one version of a DoD nudge
631 intervention. As noted previously, “DoD interventions” can refer to different nudging techniques, and
632 other versions of this nudge can be found in the field, with variations regarding the media that is being
633 used to signal the DoD (it can be written on a board, displayed on a screen, announced by the waiter
634 at a table-service restaurant, in different fonts or colors...), the way the description is worded (“Dish
635 of the day”, “Chef’s recommendation”, “Featured dish”, etc.), or whether the ordering procedure is
636 differentiated for the featured dish and its alternative (is it easier to order the DoD?). This study tried
637 to minimize these variations in order to isolate the specific effects of the popularity of the dish and the
638 number of alternatives, but we cannot rule out the possibility that the aforementioned variations could
639 induce different decision-making mechanisms and lead to different effects. In particular, the food
640 ordering procedure used in this experiment, with the presence of an experimenter orally presenting
641 the choice, could have had an impact on decisions, and could potentially have strengthened the effect
642 of the nudge or induced demand effects for the DoD. Similarly, varying the dishes themselves – in

643 terms of familiarity, palatability and nutrition density- could have led to different effect sizes.
644 Replications of the experiment in other settings are therefore necessary to get a more robust view of
645 the effects studied.

646 Likewise, although the size of the effects measured in this study is consistent with previous studies
647 on featured dishes (eg. Wisdom et al. 2010), it is likely to be less important in other non-controlled,
648 real life environments where other drivers of consumers' choices could intervene. In particular, the
649 social cost of "refusing" the DoD to the experimenter may have been underestimated, and could have
650 contributed to the extent of the observed effect, while opting out in the field may be perceived as
651 easier. Furthermore, the design used in this study only allowed a partial exploration of the possible
652 individual differences in sensitivity to the nudge. Yet, individual traits and preferences may moderate
653 the effect of the intervention because of differences in prior preferences (Sunstein, 2017). In this study,
654 the population in T1-0 was older than in T1a, therefore the extent of the DoD effect in T1a could be
655 overestimated. Beyond socio-demographic characteristics, initial hunger and preferences for food, a
656 more thorough investigation of the role that variables such as stress, attention, and time pressure play
657 on individual sensitivity to the nudge would allow a better prediction of the possible factors of success
658 and failure in real-world conditions. This needs to be addressed to prevent possible negative side-
659 effects from nudges if some individuals are likely to be disproportionately affected by a nudge (Hansen,
660 Skov, & Skov, 2016).

661 In practical terms, some issues require further investigation for the design of acceptable and
662 optimal nudges for healthy eating in foodservice. In particular, this experiment looks at "one-shot"
663 nudging, and does not assess the impact of using this nudge over a long period of time. In practical
664 terms, it is important to ensure the persistence of the nudge effect, so that the nudge does not
665 negatively affect consumers' satisfaction. If consumers' satisfaction decreases due to nudging,
666 foodservice professionals may be discouraged to implement such measures in their restaurants to
667 prevent negative impacts on sales in the long term. Long-term studies should be encouraged to
668 investigate this question.

669 6 Conclusion

670

671 Although exploratory, this work aims to inform the debate on nudges in at least two ways. On the
672 one hand, it presents an experimental investigation of the conditions of the effectiveness of a nudge.
673 This topic has been identified as a key area for further research in recently published meta-analyses
674 (Szasz et al., 2018); particularly the links between the choice set characteristics and the effect of
675 nudges (Marchiori et al., 2017). Although our paper also describes a context-specific study, it attempts
676 to contribute to this reflection by using a controlled experimental approach in a realistic setting to test
677 hypotheses grounded in decision-making principles within and outside the food domain. It also
678 examines the consequences of the intervention on consumer satisfaction and consumption behaviour
679 in a real eating situation.

680 The results bring some elements of reflection to choice architects regarding the practical
681 implementation of nudge interventions to promote a healthier diet in the French population. To date,
682 the majority of nudge research has been conducted in the USA (Filimonau et al., 2017; Szasz et al.,
683 2018). However, the strong social and cultural dimensions of food choice call for more country-specific
684 perspectives on the effects of nudge interventions targeting healthy eating. Furthermore, there is
685 some evidence that consumers' attitudes to nudge interventions may vary across populations (Reisch,
686 Sunstein, & Gwozdz, 2017), which may lead to different reactions to such actions if they are made
687 transparent to consumers.

688 The results suggest that there is potential for the foodservice sector to help address the challenge
689 of increasing vegetable consumption using simple instruments. In particular, it appears that choice
690 architects in the food domain should consider the size of choice sets, as well as consumers' preferences
691 and the sensory characteristics of dish options, as crucial parameters in the design of adequate choice
692 tasks.

693 Nudges could constitute a valuable complementary approach to current economic models of food
694 decisions outside the home. Better knowledge of the characteristics of decisional processes for food,
695 and the role they play both in the short term (on decisions at the point of choice) and long term
696 (through the instalment of food habits) may provide useful clues to decrypt the mechanisms of food
697 decisions and increase the effectiveness of behavioural change programs. A combination of choice
698 architecture actions with other types of actions, such as culinary development interventions, allowing
699 for the development of healthy, but well-appreciated alternative recipes, is a potentially interesting
700 avenue.

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