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Abstract

Exposure to social norms is a popular way to foster healthy food behavior. Testing the robustness of this effect we report a field study assessing the impact of a vegetable-related descriptive norm message on vegetables purchase. The first contribution was to rely on a cluster randomized crossover design: Two canteens were randomly selected to display either a vegetable-related or a neutral-behavior norm message. After a first period of data collection, the displays were reversed for a second period: The number of vegetable portions on the main plate were recorded before, during and after the message display (N = 12.994). The second contribution was to test the impact of a message describing vegetables as the normative choice beyond the mere selection of vegetables, on the quantity of vegetables purchased in lunches containing some. Results indicated that the vegetable-related norm message led to a sustained probability of choosing vegetables, contrary to a decrease observed in the control condition. Moreover, students who ordered vegetables ordered a higher quantity when exposed to a vegetable-related message than before whereas quantity declined in the control condition. By treating both canteens as experimental and control and by analyzing both the presence and the amount of vegetables, these results extend and strengthen those previously observed, bringing support for the effectiveness of a descriptive norm message in eliciting healthier food behavior.

*Keywords***:** Social norms; Descriptive norms; Field study; Cluster randomized crossover design; Vegetables purchase; Healthy eating

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Starting university is generally associated with an increased experience of autonomy and independence. Students organize their academic work (Stephens et al., 2018), their living arrangements and to some extent their financial budget. This autonomy also impacts students' dietary behavior (Papadaki et al., 2007). For example, the lack of experience in managing meals leads students living away from home to develop more unfavorable eating habits than those still living with their parents (Papadaki et al., 2007). Given the detrimental outcomes of poor eating habits on academic performance and health (Florence et al., 2008), helping students achieve a healthier diet is important. Recent studies (Thomas et al., 2017; Collins et al., 2018; Mollen et al., 2013) suggest that displaying prevention messages in student canteens can be an economic and efficient way to sensitize students to healthier food behaviors. The present paper tests the robustness of the positive impact of a social-norm intervention on vegetable purchase in a field study in university canteens relying on a design with a large sample and a control group. We also aim to extend the existing literature by investigating whether a norm-based message can induce both a greater selection of vegetables and a larger amount of vegetables purchased.

1. Changing Behaviors with Social Norms

Social norms define the valued or common behaviors for a given social group (Göckeritz et al., 2010). According to the Focus Theory of Normative Conduct, social norms drive individuals' choices and actions (Cialdini et al., 1991). The social norms that are prominent in an environment shape people's behavior (Schultz et al., 2007). Indeed, literature on health and behavior indicates that individuals use norms as a guide to behave efficiently (general behaviors: Cialdini & Glodstein, 2004; food intake: Higgs and Thomas, 2016), and that young people's eating habits are linked to the perceived peer norms (Stok et al., 2016; Lally et al., 2011; Liu et al., 2019; Rice & Klein, 2019).

To better understand how people's behaviors are influenced by norms, two different aspects of normative conduct have been distinguished (Cialdini et al., 1990). First, *injunctive*

norms refer to what should be done, the behavior that is socially approved or disapproved. Second, *descriptive* norms refer to what is done by most people. The first type of norms prescribes behavior, while the second describes behavior.

Many public-health campaigns use injunctive norms (e.g. “For your health, no more than 2 alcohol drinks a day, and not every day”). However, injunctive norm messages can actually promote counter-normative behaviors under specific circumstances (Rivis & Sheeran, 2003; Lally et al., 2011). For example, teenagers exposed to an injunctive norm message prescribing fruit consumption (“a majority of high school students think other high school students should eat sufficient fruit”) reported lower fruit intake intentions than a group exposed to no normative information (Stok et al., 2014). Reactance against injunctive messages (Brehm, 1966) is especially likely among young people (Hong et al., 1994), for whom healthy behaviors are not valued by their social group (Stead et al., 2011). Hence, health behaviors interventions based on injunctive message could produce a “boomerang effect”, inadvertently leading students to act even less healthy.

Descriptive norms, which describe how people actually behave in a given situation and a given social group (Cialdini & Goldstein, 2004), have been found to be especially effective to promote healthy behaviors concerning tobacco (Sheikh, 2017), alcohol (Neighbors et al., 2004), and daily exercises (Burger & Shelton, 2011). Interestingly, describing how the majority acts influences behavior even in situations where individuals lack the cognitive resources needed for effortful and conscious information processing (Jacobson et al., 2011). Indeed, descriptive norms operate as a decision heuristic, indicating what is appropriate in the situation and driving behavior even if individuals are not influenced at a higher cognitive level. Hence, Stok et al. (2014) observed that a descriptive message in favor of fruit intake (“a majority of high school students try to eat sufficient fruit themselves”) increased self-reported fruit intake compared to an injunctive norm message, although it did not significantly influence the consumption intention declared by students. These findings are congruent with the idea that a descriptive message can impact behavior without affecting its corresponding cognition (Stok et al., 2014). The positive influence of descriptive norms on

food-related behaviors has been consistently observed in laboratory studies (Burger et al., 2010; Stok et al., 2014; Lapinski et al., 2017).

2. Increasing Vegetable selection via Descriptive-Norm Messages in Field Studies

Drawing on these laboratory findings, real-world interventions have been designed to assess the effect of descriptive-norm messages on eating behaviors. Mollen et al. (2013) were the first to compare the effect of a norm-based message on students' food choices (burger or salad) in a campus food-court. Students were exposed either to a healthy injunctive norm ("Have a tossed salad for lunch!"), a healthy descriptive norm ("Every day more than 150 [name of university] students have tossed salad for lunch here"), an unhealthy descriptive norm ("Every day more than 150 [name of university] students have a burger for lunch here") or no message (control condition). Food choices were recorded through a questionnaire administered after lunch. Among students who correctly reported seeing the message, those exposed to the healthy descriptive norm had higher chances of choosing a salad in comparison to students in the unhealthy or the control condition. The injunctive healthy norm had a significant effect on healthy decisions compared to the unhealthy descriptive norm condition but not to the control condition.

Moving beyond self-reported behavior, Thomas et al. (2017) explored the influence of a descriptive norm message ("Most people here choose to eat vegetables with their lunch") on actual food selection. Vegetable purchase was recorded in the cashier point of three workplace restaurants during three 2-week stages: A first no-message stage (pre-intervention stage), before displaying the descriptive-norm message for two weeks (intervention stage), followed by a 2-week stage without the message (post-intervention stage). The percentage of meals purchased with vegetables significantly increased when the norm message was displayed in comparison to the pre-intervention stage, and this effect persisted after the message removal. The benefit of descriptive norm intervention on actual vegetables selection was recently confirmed in two studies conducted in student canteens

(Collins et al., 2019). Relying on a similar three-stage design (i.e., pre-intervention, intervention, post-intervention), Collins et al. (2019) showed that a descriptive-norm message ("Did you know that most students here choose to eat vegetables with their meal") increased the percentage of meals with vegetables in comparison to the pre-intervention stage. This effect was sustained during post-intervention in their first study but in the second.

These findings plead in favor of the implementation of norm-based interventions in collective catering sites. And indeed, exposure to social norms is often presented as an easy and efficient way to change individuals' behavior (e.g., Higgs, 2015). This literature is popularized outside the academic world to inform policy making (e.g., Hallsworth et al., 2018; OECD, 2019) and has already been applied in large scale campaigns (e.g., Perkins et al., 2010). Despite this popularity - or maybe *because of* this popularity - the literature on social norms should tackle the current question of replication and findings robustness that shakes many scientific fields (e.g., Hetherington, 2018; Pashler & Wagenmakers, 2012). This paper aims at contributing to this important matter by (1) testing the impact of a descriptive-norm based message on vegetable purchase in a field study with (2) a large sample, a control group with a randomization by canteens (i.e., cluster-randomized crossover design) and an appropriate analytical strategy for such a design.

3. Methodological Limitations of Field Studies

The extant field studies on norm-based interventions to promote vegetable purchase suffer from two important limitations. The first limitation concerns suboptimal internal validity due to weak designs. One study used a one-group pretest-posttest design (Thomas et al., 2017) in which vegetable selection was recorded during a pre-intervention stage (i.e., no message displayed), then when the intervention message was displayed, then during a post-intervention stage after the message was removed. Because of the lack of a comparison group, no causality conclusion can be drawn about the effect of the intervention on vegetable selection, as any change from pre- to posttest could be due to time trend or individual changes unrelated to the intervention. Collins et al., (2019) used a similar pretest-posttest

design with a comparison group. Indeed, the norm-based message was displayed in one canteen while a health message was displayed in another canteen. This however creates a confound between the type of message (norm vs. health) and the canteen, precluding again clear conclusion about whether changes in vegetable selection were caused by the type of message or preexisting differences between the canteens and their customers. Mollen et al., (2013) used an experimental design with three experimental messages (including descriptive norm) and a control group. However, they relied on self-reported food-choices limited to the participants who correctly recalled the experimental messages displayed in the canteens. This firstly limits their conclusion about the impact of the messages to this particular population. It secondly led to the exclusion of almost 78% of the participants in the experimental groups, resulting in small sample sizes (n ranging from 33 to 42), which reduces the chances that the results reflect a true effect (Button et al., 2013). To our knowledge, only one other paper (Thorndike et al., 2016) presents a randomized controlled trial but the reported results show no significant increase from baseline of healthy food purchase for participants who received social norms feedback compared to the control group. Connected research was conducted on food selection in grocery stores, not restaurants. The field studies on this related behavior however suffer similar limitations, with a confound between stores and type of messages (control vs. norm-based; Payne et al., 2015), small samples and results above the conventional level of significance (Salmon et al., 2015), or combining social norm message with another nudge (Huitink et al., 2020).

The available evidence documenting the effectiveness of using social norms to increase vegetable selection in field studies is not strong. Although great efforts have been made to test the impact of such interventions, more compelling evidence needs to be provided. The current research was specifically designed to address this issue. We recorded a large sample of actual vegetable purchase in a pretest-posttest design implemented in two similar student canteens. To allow for stronger conclusions about causality, canteens were randomly assigned to a vegetable-related norm message and a neutral behavior-related norm message. More specifically, our study relied on a cluster randomized crossover design,

in which each message was administered to each cluster in separate periods of time (Arnup et al., 2017; Rietbergen & Moerbeek, 2011). During the first period, the experimental message was displayed in one canteen (cluster A) while the control message was displayed in the other canteen (Cluster B). During the second period, displays were reversed. We believe that such a stronger design does not only provide more reliable evidence about the effectiveness of a norm-based message to foster vegetable selection, it also provides a more robust test of the social norm theoretical approach. The present research also aimed to extend the extant literature by investigating whether descriptive norms about vegetable purchase can influence not only the selection of vegetables but also the quantity of vegetables purchased.

4. Of the Extended Impact of Descriptive-Norm Message: from vegetable selection to quantity

Previous studies focused on food selection as behavioral outcome, and assessed whether descriptive norm messages increase self-reported food choice (Mollen et al., 2013) or the percentage of actual meals containing vegetables (Collins et al., 2019; Thomas et al., 2017; Thorndike, et al., 2016). Nevertheless, an important question remains unanswered: Does a descriptive norm-message lead people who purchase vegetables, to purchase a greater amount of vegetables? Descriptive norms motivate individuals to behave in a certain way by providing information on what is effective or adaptative to do (Cialdini et al., 1991). If the behavior appears as efficient and adapted, we can expect that more individuals will make the decision to produce the behavior but also that individuals who decided to produce the behavior will produce it more. Accordingly, Agerström et al. (2016) observed that not only a descriptive norm message increased the number of students initiating the expected behavior, here donation, but it also increased the amount of donation. The positive impact of a descriptive norm message about prevalence on both frequency and intensity can also be expected on a health-related behavior. Indeed, health prevention messages often emphasize both the frequency and quantity of behaviours to be performed (e.g., World Health

Organization campaign “5 A Day” recommends eating at least 5 portions of fruits and vegetables per day). In doing so, public campaigns suggest that the appropriate behavior is the combination of these two factors. In a field study on food choice at school, Thompson et al. (2007) showed a positive correlation between perceived descriptive norms related to the selection of vegetable (e.g. “Most kids eat a serving of cooked vegetables at school lunch”) and the amount of vegetables consumed recorded over a week’s lunches. We therefore predicted that the descriptive norm message about healthy eating would increase both the frequency of the behavior (i.e., number of meals purchased with vegetables) and the intensity of the behavior (i.e. the amount of vegetables selected).

5. Overview and Hypotheses

We drew on previous studies in collective catering sites (Collins et al., 2019; Thomas et al., 2017) to conduct a field experiment testing the effect of a descriptive norm message on vegetable purchase in two university canteens. The number of portions of vegetables on the students’ main plate (from 0 to 4) was collected during three stages: a pre-intervention stage, an intervention stage (during which a vegetable-related norm message or a neutral behavior-related norm message was displayed) and a post-intervention stage (in which no message was displayed). The type of message was randomly displayed in one or the other canteen during the first period of observation, then crossed during a second period of observation.

We firstly hypothesized that the norm-based intervention would increase the likelihood of purchasing vegetables (presence on the plate versus not). In comparison to the pre-intervention stage, displaying a vegetable-related norm message should increase the number of plates with vegetables. The impact of the message might last after removal (Collins et al., 2019; Thomas et al., 2017) but should be less strong so we expect the number of plates containing vegetables in the post-intervention stage to still be higher than during the pre-intervention stage but to decrease compared to the intervention stage. When the neutral behavior-related norm message was displayed, we did not expect to observe this pattern. Secondly we expected the intervention to increase the amount of vegetables ordered. In

comparison to the pre-intervention stage, the vegetable-related norm message should increase the number of vegetable portions on the main plate. Again, the impact of the message should lessen after its removal so we expect the number of vegetable portions to decrease in the post-intervention stage compared to the intervention stage. When the neutral behavior-related norm message was displayed this pattern was not expected. These hypotheses were specified before the data were collected.

6. Method

6.1. Participants

Participants were students purchasing a meal from one of two on-campus canteens. All aspects of this study were performed in accordance with the ethical standards and we obtained a posteriori ethical approval (CERT-TP n°2020-07-03). A total of 12.994 meal purchases were recorded (47.08% by women, 52.54% by men, 0.38% by a person of undetermined gender – gender was categorized on visual appraisal by the observers).

6.2. Design

The study took place in the two larger university canteens of the University of Poitiers. Located in the same area (distant from 0.68 miles) and run by the same public service, they mainly serve students and offer the same self-service meals five days a week. The daily offer includes a main course and two side dishes. At the food counters, a choice between meat and fish is available as well as at least one type of carbs and two types of vegetables. During a first period of observation, one canteen was randomly selected to display the vegetable descriptive-norm message, while the other displayed the neutral behavior descriptive-norm message. During the second period of observation the messages were reversed at both locations. For each period of observation, data was collected during three days (Monday, Tuesday and Thursday) for three consecutive weeks corresponding to three stages: the first week formed the pre-intervention stage, the second week the intervention stage (i.e., messages are displayed), and the last week the post-intervention stage (i.e., after the message removal). Data collection took place from the 20th of November to the 7th of

December 2017 for the first period, and from the 22th of January to the 8th of February 2018 for the second one[1].

6.3. Sample size

Small effects have been documented in previous field studies testing the influence of social norm interventions on vegetable purchase in canteens (Collins et al., 2019: 1.24 < OR < 1.62, 0.04 < F < 0.09; Thomas et al., 2017: 1.2 < OR < 1.4, 0.03 < F < 0.08). Using simulation (Reich et al., 2012), we estimated the smallest effect size detectable in our cluster-randomized crossover design with 80% power and a 5% alpha level. The numbers of canteens and periods were fixed at 2 and the smallest canteen-period size to 2800 observations. We set the vegetable purchase baseline rate to be 60% (Collins et al., 2019) and the variation in purchase rate across canteens to be of .01. We simulated 500 datasets assuming data would be analyzed using a fixed-effects logistic regression model. The results indicated that we had sufficient power to detect an effect associated with an odd ratio of 1.12.

6.4. Material

The messages were conveyed via posters. In the experimental condition, the message described normative vegetable purchase (“Most students here choose to eat vegetables at lunch”) whereas in the control condition the norm was about a recycling behavior (“Most students here sort their tray after lunch”). The vegetable-related descriptive norm message was based on the one used by Thomas et al.’s (2017) and Collins et al.’s (2019)[2]. The posters were printed in colour in two formats: the three biggest (210 mm x 297

[1] Beginning the data collection too early in the semester (September) is problematic with respect to the low frequentation of the canteens by new arriving students, and ending it too lately also because students attend less the canteens during exams period (after December, the 15th). Moreover, a one-week holiday divides each semester (at the end of October and end of February). Finally, we wanted the type of menu to be relatively constant and then to collect the data in the same season.

[2] Observations made during the first stage of our study confirmed the accuracy of the descriptive norm message (48% of trays contained vegetables).

mm) were displayed in the waiting area of the canteens and the two smallest (148 mm x 210 mm) were placed on each food-selection counter.

6.5. Measures

Five observers alternatively stood behind the cashier of both canteens to record the customers' tray content. Data was collected at the lunchtime between 11:50 and 13:00 on every Monday, Tuesday and Thursday. The tray content was recorded using a grid including four items: "meat or fish" (V: meat; P: fish), "portions of vegetables in the main plate" that is the proportion of the plate occupied by vegetables (from 0 = 0% to 4 = 100%), "appetizer"[3] (crudités; half crudités; soup; cold meat; pasta salad), "fruit" (0 to 2). As in other studies, potatoes and lettuce leaves (as decoration) were not counted as vegetables.

To assess inter-rater reliability, the five observers all coded the same trays during a training session before actual data collection. The analysis of the inter-rater agreement indicated satisfactory Cohen Kappa coefficients ranging from 0.73 (starters coding) to 0.83 (gender coding). Moreover, during actual data collection, as menus changed every day, the observers of the two canteens daily reached agreement by phone on the coding for the suggestion of the day.

6.6. Data Analyses

A pre-specified generalized linear model with canteen and period fixed effects was used to examine the selection and amount of vegetables depending on the interaction between the stage of intervention and the type of message. Because observations were nested in periods and canteens, the data structure violates the assumption of independence of residuals. To address this issue both fixed-effects models and multi-level models can be performed. A fixed-effects model was preferred over a multi-level model because the latter can produce biased estimates when the number of higher-order units is low (Maas & Hox, 2005; Sommet & Morselli, 2017). Fixed-effects models control for any canteen-period variation and estimate the within canteen-period impact of the intervention.

[3] Readers interested in the results on appetizers can find them in supplemental material

To test both our hypotheses on the selection of vegetables and the amount of vegetables, and because the outcome (number of portions of vegetables) was highly skewed with many zeros, we modeled those data with a negative binomial hurdle model (Atkins et al., 2013). The hurdle model combines two simultaneous models: (i) a logistic regression model for zeros vs. non zeros (i.e., presence or absence of vegetables), and (ii) a Poisson regression (or "zero truncated count regression") for the distribution of nonzero values (e.g., number of portions of vegetable in lunches with vegetables). Effect sizes are expressed with an Odd Ratio (*OR*) for the logistic regression, and with an Incident Rate Ratio (*IRR*) for the truncated Poisson regression. Values over 1.0 indicate an upper likelihood of having vegetables on the plate, and of having a higher number of portions on the plate.

We hypothesized that when the message is related to vegetable-purchase norm the presence of vegetables is more likely and the number of portions is higher during the intervention stage than before and decreases after the intervention without falling back to the baseline point (i.e., a moderate lasting impact of the intervention). To test this prediction, we created two orthogonal contrasts coding the stages. The contrast of interest compared the pre-intervention stage with the intervention stage (pre-intervention coded -0.5, intervention coded +0.5, post-intervention coded 0). The contrast testing the residual variance compared the post-intervention stage (coded 2/3) to the two other stages (pre-intervention and intervention both coded -1/3). The type of message was also contrast coded (-0.5 for the control message, +0.5 for the vegetable-related norm message). A pattern consistent with our hypothesis would result in a significant interaction between the type of message and the first contrast coding the stages – the vegetable purchase should increase from the pre- to the intervention stage, especially in the vegetable-related norm condition. Simultaneously, the type of message should not significantly interact with the second contrast coding the stages. Indeed, in both conditions we expect the post-intervention stage to not significantly differ from the two previous stages: In the vegetable-related norm condition because we expect the purchase of vegetables to decrease after the intervention without falling back to pre-

intervention level then placing the post-intervention between the two other stages; in the control condition no differences are expected between stages.

7. Results

Table 1

Observed number (and percentage) of meals as a function of the number of portions of vegetables purchased, the type of message displayed, during each stage of intervention.

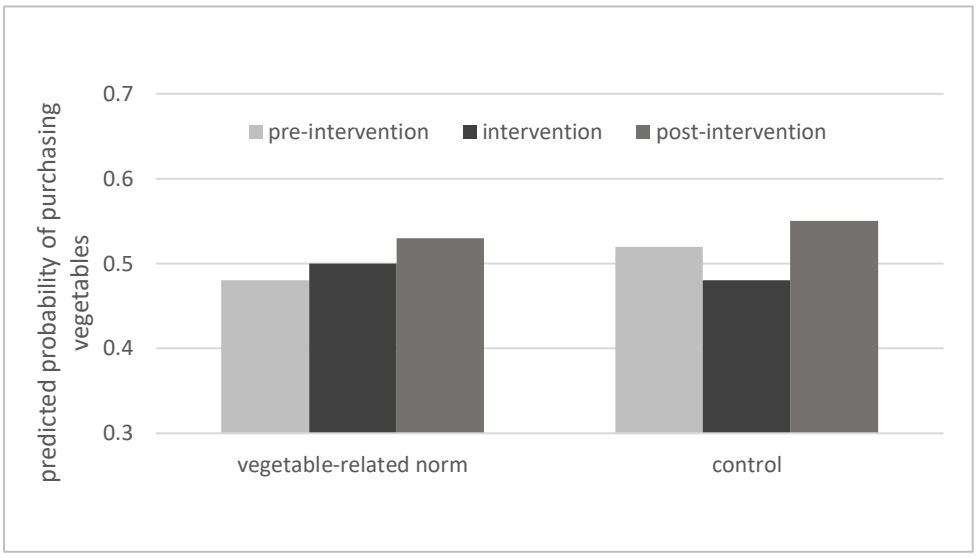
Study stages	Vegetable-related norm					Control				
	Without vegetables	1 portion	2 portions	3 portions	4 portions	Without vegetables	1 portion	2 portions	3 portions	4 portions
Pre-intervention	1257 (51.60%)	958 (39.33%)	185 (7.59%)	30 (1.23%)	6 (0.25%)	995 (47.70%)	878 (42.09%)	130 (6.23%)	80 (3.84%)	3 (0.14%)
Intervention	999 (49.97%)	739 (36.97%)	191 (9.55%)	58 (2.90%)	12 (0.60%)	1236 (52.28%)	954 (40.36%)	131 (5.54%)	42 (1.78%)	1 (0.04%)
Post-intervention	927 (47.25%)	865 (44.09%)	109 (5.56%)	60 (3.06%)	1 (0.05%)	971 (45.23%)	979 (45.60%)	142 (6.61%)	51 (2.38%)	4 (0.19%)

Data are available at https://osf.io/5qgk3/?view_only=dbe1fa96d0894314aa7dcb68078b0825. Details about the observed meals across the three stages and the two conditions are presented in Table 1. The logistic part of the model testing the presence vs. absence of vegetable on the plates showed, as expected, a significant interaction between the message type and the contrast of interest comparing the pre-intervention and the intervention stage, *OR* = 1.23, *p* = .016, 95% CI = [1.04, 1.46] (see Figure 1). Simple slopes analyses showed that students in the control condition were 17% less likely to purchase vegetables during the intervention stage than before, *OR* = .83, *p* = .003, 95% CI [0.74, 0.94]. Students exposed to the vegetable-related norm message did not show this decrease, as their chances to purchase vegetables did not significantly change from the baseline to the intervention stage, *OR* = 1.03, *p* = .671, 95% CI [0.91, 1.16]. As expected also, the interaction between the message type and the residual variance contrast comparing the post-intervention stage with the two previous stages was not significant, OR = 0.93, *p* = .346, 95% CI [0.80, 1.08]. However, contrary to expectations, results indicated that on average across message type, the likelihood of purchasing

vegetables was higher in the post-intervention stage than in the combined two previous stages, *OR* = 1.16, $p < .001$, 95% CI [1.08, 1.26].

Figure 1.

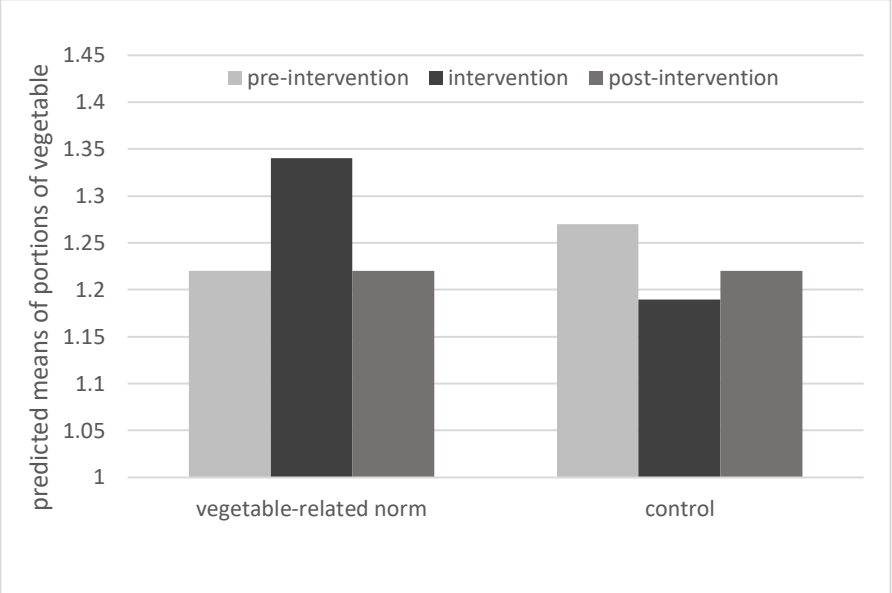
Predicted probability of purchasing vegetables (vs. no vegetable) as a function of the type of message and the stages, within canteens and periods of observation.



The positive count model testing the amount of vegetables among those who purchased some revealed a significant interaction between the message type and the contrast of interest comparing the pre- and intervention stage, *IRR* = 2.12; $p < .001$, 95% CI = [1.69, 2.67] (see Figure 2). Among students who purchased vegetables in the control condition, the amount of vegetable purchased during the intervention stage is 0.26 times the amount before the intervention, *IRR* = 0.74, $p < .001$, 95% CI [0.63, 0.87]. Among students who purchased vegetables in the vegetable descriptive-norm condition, the amount of vegetable purchased increased by 1.57 times from the pre- to the intervention stage, *IRR* = 1.57, $p < .001$, 95% CI [1.38, 1.84]. The interaction between the type of message and the residual variance contrast was not significant, *IRR* = 0.94, $p = .59$, 95% CI [0.77, 1.16]. Consistent with the hypothesis, on average across message type, the level of purchase in the post-intervention stage did not significantly differ from the level of purchase in both the pre- and intervention stage, *IRR* = 0.90, $p = .055$, 95% CI [0.81, 1.002].

Figure 2.

Predicted means of portions of vegetable in plates containing vegetable as a function of the type of message and the stages, within canteens and periods of observation.



7. Discussion

This field study drew on previous studies testing the effect of a vegetable-related descriptive norm messages on vegetable purchase. This literature suggested that simply describing that most people eat vegetables can increase healthy food selection. However, this literature suffered from some methodological shortcomings – absence of a control group, confounds between restaurants and conditions, small sample sizes – that limited the conclusions. To address these limitations, we implemented a design with a vegetable-related norm message versus a control message randomly displayed in two canteens. The display was crossed over canteens in two different periods to avoid confound and the canteens and periods variations were accounted for in the analytical strategy. Vegetable purchase was recorded from over 12,900 meals to test whether the increase in the number of plates containing vegetables induced by the display of a norm-based message could be replicated. The results showed that the vegetable-related norm message led to a sustained number of plates containing vegetables, contrary to the decrease observed in the control condition.

Though we expected an increase in purchase rather than a non-decrease, the results do show a more positive trend in the vegetable-related norm condition than in the neutral norm condition and is therefore consistent with the hypothesis. The vegetable-related norm message seems to have shielded students from a decline. This unexpected decline in the control condition could be due to the specificities of the menus offered at the times of observation, which could as well be an explanation for the unexpected overall increase in vegetable selection in the post-intervention stage. Importantly however, the daily menus were identical in both canteens so the more positive trend observed in the vegetable-related norm condition compared to the control condition can not be explained by differences in menus. This study therefore brings evidence consistent with the previous field studies showing that a message describing vegetable purchase as produced by a majority of their social group can positively influence students' choice to order vegetables (Collins et al., 2019).

A second goal of this research was to test the extended influence of a norm-based message beyond the mere selection of vegetables, by recording the quantity of vegetables (i.e., number of portions) purchased by those who selected vegetables. The results showed that students who ordered vegetables ordered a higher quantity when surrounded by a vegetable-related norm message than before, whereas the quantity decreased from the pre- to the intervention stage in the control condition. The increase observed when the vegetable-related message was displayed was however not sustained after its removal, which is consistent with other field studies (Collins et al., 2019). This finding brings new insight about the impact of descriptive norms. Although the message did not directly mention quantity ("most students here choose to eat vegetables"), it influenced the number of portions purchased. This is especially important for health-related behavior as in many cases a healthy behavior implies not only to produce a behavior but also to produce it with a certain intensity. More research should investigate which type of message – either describing the prevalence of the behavior or describing the quantity – most effectively influences both the frequency and intensity of

subsequent healthy behavior. It would be interesting to compare the impact of a "frequency and quantity related message" (*"Most students here, choose to eat 2 portions of vegetable with their lunch"*) that proved its effectiveness (Agerström et al. , 2016), a "frequency related message" (*"Most students here, choose to eat vegetables with their lunch"*) a "quantity related message" (*"Students purchased 2 portions of vegetables when they choose to eat some"*) and a control message. The fact that a message about the prevalence of the behavior in the social group makes the behavior more likely to be produced both in terms of frequency (selection of vegetable) and intensity (amount of vegetables) is consistent with the theoretical claim of the social norm approach that descriptive norms inform about the efficiency of a behavior, as an efficient behavior should be both produced more often and/or more intensively (Cialdini et al, 1991). To design more effective policy campaign message, it could be important to ensure that the quantity selected be displayed explicitly.

Despite these contributions, the present field study has several limitations. The first limit, outlined by the unexpected results (decreasing selection of vegetables in the control condition, overall higher selection in the post-intervention stage), lies in the short duration of observation. Data collection was conducted for only 3 days at each stage (pre-, intervention, post-intervention), which led to a measure of behavior that is sensitive to temporary and random external influences such as variations in menus, or in specificities of individuals attending the canteens from one day to another. The presence of a control group subjected to the same random influences limits the risk of erroneous conclusions about the effectiveness of the intervention but future studies would benefit from longer observation duration to better estimate the behavioral tendencies. Longer observation duration would also offer the possibility to further investigate the immediate effect of the message by increasing exposure and its mid-term influence after removal.

Second, as often in observational studies with large samples (e.g., Collins et al., 2019; Thomas et al., 2017) it was not possible to follow individual students across the stages of the experiment due to technical limitations. Consequently, we could neither assess the

behavioral change within students nor account for between individual variations. This leaves open the question of whether the vegetable-related norm message made people who previously did not order vegetables to start doing so and/or reinforced the behavior among people who already produced it. Future research would benefit from a longitudinal design to establish how descriptive norms can lead to within-individuals changes and whether some individuals are more sensitive to the message than others.

Third, both messages displayed in this study presented a descriptive norm, one about vegetable purchase, the other about sorting one's tray. This procedure was chosen to rule out the idea that merely activating a descriptive norm is enough to increase vegetable purchase. However, this leaves the possibility that it is the mere mention of vegetables that increased purchase. Other field studies used a comparison message mentioning vegetables but not based on a descriptive norm (e.g., health benefits of vegetables, Collins et al., 2019; injunctive or unhealthy norms, Mollen et al., 2013). Future studies could use two comparison messages, one mentioning vegetables, the other displaying a descriptive norm on a different topic to further test the effectiveness of the present vegetable-related descriptive norm message.

Fourth, vegetable purchase was collected, as in previous studies (Collins et al., 2019 ; Mollen et al., 2013 ; Thomas et al., 2017), but actual consumption was not measured. Hence, the results indicated that vegetable descriptive norm message led students to sustainably order vegetables and in greater quantity, but no conclusion can be drawn about actual consumption. Future research is needed to assess the amount of vegetables left on the plate.

Finally, two factors could have minimized the impact of our intervention on vegetable purchase. First, as in previous studies, the posters were placed on the service counters, being then accessible to the attention at the very moment students choose their meal. Nevertheless, we did not assess whether participants actually saw the posters. Given that the influence of the message displayed in the posters was observed to be effective only among students who saw them (Mollen et al., 2013), our results might underestimate the effect of the message on vegetable purchase by including data from students who did not

see the posters. Second, the two canteens were located on the same campus and students could have attended both canteens, either in the same period, or in the two periods separated by a two-month delay. In both cases, if some students did attend both canteens, it could weaken the difference between the control and experimental conditions. The potential contamination between conditions could have led to an underestimation of the impact of the vegetable norm intervention relatively to the control intervention but it can hardly account for the observed interactions.

In conclusion, the original cluster randomized cross-over design, in which both messages (Control, Experimental) are administered to each cluster (Canteen A, Canteen B), combined with the statistical control for canteen and period variations, provides strong evidence that displaying a vegetable-related descriptive norm message in canteens is effective in increasing vegetable purchase. This research strengthens the scientific literature fueling theory- and evidence-based behavior change interventions. Although more research is needed to assess actual consumption, social norms messages seem to be a promising lever for public authorities to set up cost-efficient campaigns.

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Authors contributions:

Emilie Guichard, Jean-Claude Croizet and Stephane Jouffre designed the study. Emilie Guichard supervised and carried out the data collection. Emilie Guichard and Frédérique Autin performed the analyses. Emilie Guichard, Frédérique Autin, and Stephane Jouffre drafted the manuscript. Emilie Guichard, Frédérique Autin, Jean-Claude Croizet, and Stephane Jouffre provided substantial comments and all approved the final version of the manuscript.

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