Intention and behavior toward eating whole grain pasta on a college dining campus: Theory of Planned Behavior and message framing

Giovanni Sogari, Rungsaran Wongprawmas, Giulia Andreani, Michele Lefebvre, Nicoletta Pellegrini, Miguel I. Gómez, Cristina Mora, Davide Menozzi

This article has been accepted for publication and undergone full peer review but has not been through the copyediting, typesetting, pagination, and proofreading process, which may lead to differences between this version and the Version of Record.
Please cite this article as:
Sogari G., Wongprawmas R., Andreani G., Lefebvre M., Pellegrini N., Gómez M.I., Mora C., Menozzi D. (2024). Intention and behavior toward eating whole grain pasta on a college dining campus: Theory of Planned Behavior and message framing. Bio-based and Applied Economics, Just Accepted. DOI: 10.36253/bae-15456.

Abstract

The consumption of whole grains has several health benefits, however, most US consumers – including young adults – do not meet the recommended consumption intake. To understand the underlying factors affecting the intention and consumption of whole grain pasta, a survey based on the Theory of Planned Behavior (TPB) was developed and administered to US college students. For four weeks, participants (n = 325) either did not receive any information (control) or received weekly messages on the health benefits of whole grain pasta (e.g., high fiber and niacin contents) in the forms of gain- (treatment 1) or loss-framed (treatment 2) information. Variables of the TPB model and consumers' perceptions were investigated both at Time 1, when the first message was received (week 0), and at Time 2, one month after the intervention (week 4). Results from the two moments were compared. We found that the TPB measures and perceived usefulness were not influenced by the treatment group; however, the gain-framed message engendered greater message engagement than the loss-framed one. Finally, results from the structural equation model showed that attitude, subjective norms, and perceived behavioral control were positively associated with the intention to consume whole grain pasta, and the intention was a strong determinant of participants' behavior. Based on our results, implications and suggestions for future studies are discussed.

1. Introduction

Substantial socio-environmental changes from adolescence to college can be challenging for many young adults (Christoph, Ellison, & Meador, 2016). In a situation in which young adults are now faced with making their own dietary choices, this transition is often associated with unhealthy eating habits (Quick, Wall, Larson, Haines, & Neumark-Sztainer, 2013; Stok, Renner, Clarys, & Deliens, 2018), which can contribute to overweight and obesity and other diet-related diseases (Kann et al., 2018; World Health Organization, 2014). Therefore, campus dining programs are working to change the perception of nutrition and healthy eating within their food eateries (Franchini, Biasini, Rosi, & Scazzina, 2023). From new and innovative design strategies and different approaches to healthy menus to the inclusion of more produce, many campus dining programs have tested and used health principles and guidelines to nudge customers' decisions (Andreani, Sogari, Wongprawmas, Menozzi, & Mora, 2023). One example comes from the US-based Menus of Change program. Menus of Change, founded in 2012 by the CIA and Harvard School of Public Health, is an initiative to achieve healthy and sustainable menus, with the tagline "The Business of Healthy, Sustainable, and Delicious Food Choices". Menus of Change University Research Collaborative (MCURC) was established with working groups of scholars and campus dining leaders interested in using college and university dining as a platform to establish and accelerate efforts to move campus diners towards healthy menus.

Healthy eating habits should include high consumption of food considered to be healthy, such as fruit, vegetables, and other high-fiber options, such as whole grains[1] and legumes (U.S. Department of Health and Human Services and U.S. Department of Agriculture & US

[1] "Grains and grain products made from the entire grain seed, usually called the kernel, which consists of the bran, germ, and endosperm. If the kernel has been cracked, crushed, or flaked, it must retain the same relative proportions of bran, germ, and endosperm as the original grain in order to be called whole grain. Many, but not all, whole grains are also sources of dietary fiber."(U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2015, pag.96).

Department of Agriculture, 2015). Among healthy food choices, whole grain intake is a pivotal aspect to be considered in weight management and overall health of young adulthood, which helps in overweight and obesity prevention (Quick et al., 2013).

Grains, including whole grains, are staple foods in many countries of the world (European Commission, 2019) and can be consumed as single foods (e.g., rice, oatmeal), or included as an ingredient in many food products (e.g., breads, cereals, crackers, and pasta) (U.S. Department of Health and Human Services and U.S. Department of Agriculture & US Department of Agriculture, 2015). Evidence showed that higher consumption of whole grains and dietary fiber is inversely associated with the risk of obesity and weight gain (Maki et al., 2019; Slavin, 2005), type 2 diabetes mellitus and cardiovascular disease (Ye, Chacko, Chou, Kugizaki, & Liu, 2012). Because of the health benefits linked to dietary fiber (see Jones & Engleson, 2010 for a more comprehensive review), governmental institutions and nutritional experts have developed nutrition education and health promotion campaigns to recommend the inclusion of whole grains in the diet (Jones & Engleson, 2010; Marquart, Wiemer, Jones, & Jacob, 2003; Shepherd et al., 2012). For instance, the 2015–2020 Dietary Guidelines for Americans suggests that a healthy eating pattern should include grains, at least half of which should be from whole grains (U.S. Department of Health and Human Services and U.S. Department of Agriculture & US Department of Agriculture, 2015).

Previous reserach (e.g., Wongprawmas et al., 2021) indicates that the availability of whole grain options at comparable prices to conventional ones could be beneficial for students since it may mitigate consumption barriers such as availability and price (Meynier, Chanson-Rollé, & Riou, 2020). Moreover, another barrier to consuming whole grain products is consumers' negative

perceptions of their sensory attributes (i.e., taste and texture) (Bisanz & Krogstrand, 2007; Dammann, Hauge, Rosen, Schroeder, & Marquart, 2013).

Despite the relevance whole grains have in a healthy diet, limited research (Ugunesh, Siau, Mohd Sanip, & Koo, 2023; Weingarten & Hartmann, 2023) has investigated the links between consumer attitudes, intention, and behavior to consume whole grain foods, especially among young adults. Therefore, we tested the Theory of Planned Behavior (TPB) (Ajzen, 1991) – which is an expectancy-value model of behavior change – to measure the variables influencing the consumption of whole grain pasta. The TPB model postulates that behavioral intention is the central determinant of behavior. Previous systematic reviews have demonstrated that the TPB and similar psycho-social theories (e.g. the Theory of Reasoned Action, TRA) can serve as reliable tools for predicting sustainable (e.g., Biasini et al., 2021) and health-promoting behaviours (e.g., McEachan, Conner, Taylor, & Lawton, 2011), including healthy eating behaviours (e.g., McDermott et al., 2015). These reviews have shown that, in general, attitude towards the behaviour is the most significant predictor of intention, and intention is the most significant predictor of behaviour (McDermott et al., 2015; Biasini et al., 2021). Biasini et al. (2021) observed a wide range of explained variance in intention (7–87%) and/or behaviour (3–81%) across different applied models and study designs. As suggested by these authors, longitudinal studies can provide a prospective prediction analysing the causal relationship between dependent and independent variables, which would be otherwise precluded in cross-sectional investigations (McEachan et al., 2011; Biasini et al., 2021).

Based on these considerations, first, the model we tested hypothesizes that the intention to include whole grain pasta in the diet is influenced by the attitude (a person's favorable or unfavorable evaluation of the behavior), the subjective norms (what other people think one

should do), and the perceived behavioral control (the perceived ease or difficulty of performing the behavior). Second, we hypothesized that the prospective behavior (actually eating whole grain pasta), measured after four weeks (Time 2), is determined by the intention and perceived behavioral control. Figure 1 shows the theoretical framework.In addition, past studies suggest that whole grain food consumption could be promoted by using positive information about its health benefits presented at the point of consumption. One study by Sogari et al. (2019) found that a psychological health benefit (i.e., vitamin benefits reduce fatigue) related to whole grain foods significantly increased the number of individuals preferring whole grain vs. regular pasta. Another study by Weingarten and Hartmann (2023) showed that repeated exposure to positive information about the health benefits of whole grain increased attitudes and led to higher intentions to consume such products. Therefore, the use of health claims and messages to encourage the consumption of whole grain pasta over regular pasta is one communication strategy that could support the shift toward a healthy eating pattern. Based on this evidence, it is relevant to understand the effectiveness of different communication strategies on the attitude towards whole grain options in terms of the framing effect, i.e. decisions are influenced by the way the outcomes are presented (Dolgopolova, Li, Pirhonen, & Roosen, 2022). Meta-analysis results have recently indicated that product attributes framed as gains have a higher effect on attitudes and intentions than product attributes framed as losses (Dolgopolova et al., 2022). Other researches have indicated that encouraging positive behaviors by evoking loss aversion is not necessarily a guiding principle when it comes to health benefits (e.g., Gallagher & Updegraff, 2012). Dolgopolova et al. (2022) have suggested that loss-framed messages are mainly effective when it comes to decisions involving significant risk, and that food choices are not associated with an immediate high level of risk. Thus, a secondary aim of our study is to understand

whether providing information on the health benefits of whole grains, under two different framing conditions (gain vs. loss-framed), would influence the TPB measures as well as other variables (e.g., perceived usefulness of eating whole grain pasta).

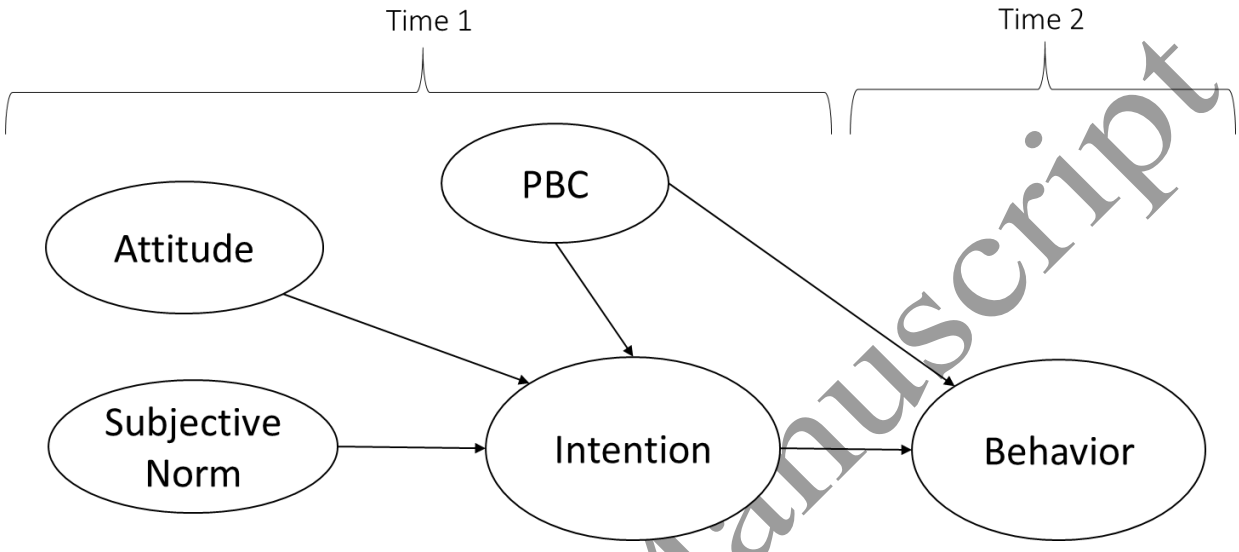


Figure 1 Theoretical framework of the Theory of Planned Behavior (TPB) in Time 1 (main survey in week 0) and Time 2 (follow-up survey after 4 weeks).

2. Methods

2.1 Data Collection and the Sample

Data collection was carried out across several dining halls at Cornell University, Ithaca, NY, US in spring 2019. An online questionnaire was distributed using the Qualtrics LLC platform (Provo, US), and included attitudinal and motivational items derived from the TPB framework, as well as questions on overall eating habits. Some survey sections, including the message frames, were revised to improve the clarity of their meaning and reduce the total survey length to approximately 12 minutes. The entire survey was pre-tested with 50 students and Faculty staff members. The data collection took place during dinner time in front of the pasta station in a

dining setting (Time 1). A final sample of 499 college students (female 53.6%, mean age 18.8y), all pasta consumers, participated in this study. Participants mostly had a healthy weight range (Body Mass Index between 18.5 and 24.9), were mainly omnivores with a slightly high proportion of flexitarian and vegan or vegetarian, and only 10% had dietary or healthy restrictions. Table 1 shows the full set of socio-demographics of the participants.

One month after Time 1 (Time 2), a follow-up questionnaire was sent via email to all the participants in order to evaluate whether any changes in their attitudinal variables occurred and to assess the reported consumption behavior of eating whole grain pasta over the last month. Most of the participants returned the electronic questionnaire on the day they received it, and few of them completed it in the following days. A final sample of 325 respondents returned the questionnaire. The full survey flow (Time 1 and Time 2) is shown in Figure A1 in the Appendix. The two surveys at the two time points were linked through the student ID number. Following the completion of the study, participants received a monetary compensation of $5. The study was approved by the Institutional Review Board (IRB) of the Office of Research Integrity and Assurance of Cornell University (Protocol Number: 1810008359).

Table 1. Socio-demographic characteristics, lifestyle variables, and health-related factors reported for the total sample and by the groups at time 1

Variables	**All**	**Information treatments**			***p*-value**
		Control	**Gained-frame**	**Loss-frame**	
n	499	100	202	197	
%	100	20.0	40.5	39.5	

Age[1] (mean, sd)	18.8	18.6	18.9	18.8	0.267
	(1.16)	(1.13)	(1.16)	(1.17)	
Gender[2]					0.451
Male	44.4	41.0	47.5	42.9	
Female	53.6	59.0	49.5	55.1	
Others or prefer not to answer	2.0	0.0	3.0	2.0	
BMI[1]	22.9	22.0	23.1	23.1	0.267
	(5.79)	(5.00)	(5.77)	(6.16)	
Eating behavior[2]					0.357
Omnivore	80.1	79.0	83.2	77.6	
Vegetarian	6.6	6.0	4.0	9.7	
Vegan	3.2	3.0	3.0	3.6	
Flexitarian	8.8	11.0	7.9	8.7	
Others	1.2	1.0	2.0	0.5	
Dietary/Healthy restrictions[2]					0.461
Yes	10.4	10.0	8.9	12.2	
No	87.8	90.0	88.6	85.7	
Prefer not to answer	1.8	0.0	2.5	2.0	
Self-perception of overall health[3]	5.0	6.0	5.0	5.0	0.145
	(4.0-6.0)	(4.2-6.0)	(4.0-6.0)	(4.0-6.0)	
Physical excercise[3]	4.0	4.0	4.0	4.0	0.255
	(3.0-5.0)	(3.0-5.0)	(3.0-5.0)	(3.0-5.0)	

Note: Data are presented as the mean (SDs) for continuous variables, as number (%) for nominal variables, and as the median (IQRs) for categorical variables. SDs = standard deviations. IQRs = Interquartile ranges. BMI: Body Mass Index. N = 498 for age, gender, eating behavior, dietary/healthy restrictions, self-perception of overall health;

N=481 for BMI; and N=495 for physical exercise.

[1]ANOVA. [2]Pearson chi-square. [3]Kruskal–Wallis Test.

Self-perception of overall health: How healthy do you consider yourself? (from very bad = 1 to very well= 7) Physical exercise: How often do you usually engage in physical exercise (30 minutes of exercise)? (from never = 1 to more than 3 times per week = 5. They can choose "I do not want to answer").

2.2 Measures

The main survey (Time 1) consisted of three sections. The first section included the message or framing treatment (control, gain-framed, and loss-framed messages) – details are reported in section 2.3. In the two treatment groups, the participants were asked to carefully read the information provided. The second section was structured to measure the various components of the TPB (Ajzen, 1991) and other factors in relation to the participant's behavior of including whole grain pasta in the diet over the next month (for details see Table A1). The TPB survey items and the health claims were based on a review of the existing literature (Fishbein & Ajzen, 2011) followed by a revision by two nutrition experts as well as three experts in social sciences. Finally, the third section of the survey included socio-demographic data (i.e., participants' age, gender, and Body Mass Index[2]), self-perception of overall health, physical exercise, eating behavior, and dietary/healthy restrictions.

For the TPB section, all measures were assessed using a 7-point scale, from strongly disagree (1) to strongly agree (7). Two items measured the Perceived Behavioral Control (PBC), which is related to the control of performing the behavior. Three items assessed the Subjective Norms (SN), which is an individual's perception of social pressure on the way a person should or should

[2] The body mass index, abbreviated as BMI, is a measure of a person's weight relative to height that correlates well with body fat (Eurostat, 2017). A person is considered underweight if they have a BMI below 18.5, normal weight between 18.5-24.9, and overweight if they have a BMI greater than or equal to 25.

not demonstrate a specific behavior. Attitude towards the behavior (ATT), which represent the degree of a favorable or unfavorable evaluation of a specific behavior, was based on two items about the likelihood that consuming whole grain pasta would result in personal beliefs (i.e., tasty, easy). Behavioral Intention (INT) is the willingness of an individual to perform a specific behavior and it was measured using three items.

The factors of the TPB model have prior determinants: ATT is guided by behavioral beliefs about the likely consequences of performing the behavior, SN is driven by the normative beliefs about the opinions/expectations of important others, and PBC is influenced by the control beliefs about barriers and facilitators to perform that behavior (Fishbein & Ajzen, 2011). All these beliefs (n=12) were measured using a 7-point Likert scale from strongly disagree (1) to strongly agree (7).

In addition, we asked about the perceived usefulness of whole grain pasta, which measured subjects' perceptions of performance and effectiveness gains from eating whole grain pasta (e.g., stay in shape, improve work performance) by using three 7-point Likert scaled items.

Two factors were also used to evaluate the quality of the messages provided in the two information conditions. The first factor was the consumer evaluation of the message (Hung & Verbeke, 2019), which was based on five items with a 7-point Likert scale, to measure several characteristics of the health claim, including familiarity, understandability, credibility, interest, and importance. The second factor was the argument quality of the message (Bhattacherjee & Sanford, 2006), which was used to measure whether the information provided was helpful, valuable, informative, and persuasive, by using four 7-point Likert scaled items.

Four weeks after the initial survey (Time 2), assessed participants' behavior was also assessed by using two measures of reported behavior using a 7-point scale (Fishbein & Ajzen, 2011). In the first item, respondents were asked to indicate how frequently they consume whole grain pasta, on average, ranging from 'never' to 'almost every day'. In the second item, participants were asked whether they had included whole grain pasta in their diet at least once over the past month. In addition, attitude, intention, and perceived usefulness were measured again in Time 2 using the same items as in Time 1. Note that all canteens on the Campus offer whole grain dishes daily; therefore, product availability is not a barrier for the participants.

2.3 Intervention with health messages

At the beginning of the study, participants were randomly assigned to either a no-information group (control, n=77) or one of the two treatment groups, namely gain-framed (n=134) or loss-framed (n=114) messages. Students in the gain or loss-framed treatment received four messages about whole grain pasta health benefits. The health benefits were adapted by authorized health claims.

In the US, a food-related health claim[3] must be approved by public authorities (i.e. the Food and Drug Administration, FDA) and must be supported by a significant body of research showing the relationship between the food/constituent and a health effect in humans. Based on this context, four specific health claims related to whole grains were considered (Table A2). Moreover, following previous works (see Deliens et al., 2016 for a systematic review) a media-based approach was used to communicate such expected healthy benefits. In our study, we decided to

[3] "Health claim means any claim made on the label or in labeling of a food, including a dietary supplement, that expressly or by implication, including "third party" references, written statements (e.g., a brand name including a term such as "heart"), symbols (e.g., a heart symbol), or vignettes, characterizes the relationship of any substance to a disease or health-related condition." (Food and Drug Administration, 2023).

use health claims in the form of messages considering both general benefits of whole grain foods (e.g., fibers have positive effects on weight management) and more specific ones (e.g., the relationship between fibers and gut health or bowel function) (EFSA Panel on Dietetic Products, Nutrition, and Allergies (NDA), 2010).

For the two treatment groups, we decided to convey identical information but differently framed in terms of gains or losses associated with an expected outcome (Dolgopolova et al., 2022). A gain-framed message might take the form of ‘‘If you perform the advocated action, desirable outcome X will be obtained’’, whereas a loss-framed message might be “If you do not perform the advocated action, desirable outcome X will be avoided” (O’Keefe & Jensen, 2008). The rationale is that one type of framing may be more effective than another at promoting health behavioral change (Gallagher & Updegraff, 2012). Participants in the treatment groups read a similar health message that differentiated for details of either the benefits of including whole grain pasta (gain-framed), or the health dangers of not including whole grain pasta (loss-framed). In addition, participants in the two treatment groups received four emails (one per week) that included a different health claim message, still considering the same framework group (gain-framed or loss-framed) and were blinded to the other intervention.

Thanks to the online platform used to send out personalized emails (mailchimp.com), we were able to electronically assess whether the recipient opened the email with the health claim message. For those who did not open it, a reminder was sent the following day. However, we cannot be sure whether the participants actually read the text incorporated in the email. The information sent via email was different every week to avoid the boredom of reading the same message and the risk of dropping out of the study. The messages were sent to participants in a

246 random order. In this way, the subjects were exposed to all four types of claims (see Table A2) in
247 order to have a broader knowledge of the several beneficial roles of eating whole grain food.
248
249 *2.4 Data Analysis*
250 Descriptive statistics were used to report the percentages, median, means, and standard
251 deviations. One-way ANOVA, Pearson Chi-square, and Kruskal-Wallis tests for independent
252 samples were performed in order to determine the existence of significant differences between
253 the control and treatment groups regarding the socio-demographic data, lifestyle variables, and
254 health-related factors.
255 The internal consistency, validity, and reliability of ATT, SN, PBC, INT, and Perceived
256 Usefulness (PU) factors were tested using Cronbach's alpha, factor loadings (λ), and composite
257 reliability (CR), respectively, and considering all participants at each time point (Time 1 and
258 Time 2). Discriminant validity was tested by comparing the square root of the AVE of each
259 construct with the inter-construct correlation (Bagozzi & Yi, 2012). Then, the internal
260 consistency was assessed for each factor at each time point in all groups. Almost all of
261 Cronbach's alphas of each factor at each time point were above the acceptable threshold (α >
262 .60) (van Griethuijsen et al., 2015). Eleven composite variables were created by averaging the
263 items within each factor (Table 2). Details of the internal consistency of each factor of the TPB
264 model and other variables in Time 1 and Time 2 are presented in Table A3.
265 One-way ANOVA tests were used to analyze the impacts of different health claim messages as
266 well as the effects of providing information under two different framing scenarios (gain vs. loss-
267 framed) on the TPB measures.

Repeated measures ANOVA was used to examine the interaction of time and information treatments on attitude, intentions, and perceived usefulness at baseline (week 0) and week 4. The results indicated that there were no different effects between the control and the framings nor differences among health claim messages.

Therefore, the following Structural Equation Modelling (SEM) model analysis was performed on the total sample without separating groups according to the framings. A SEM approach was used to test the theoretical framework presented in Figure 1. SEM allows the specification of a model with both latent (e.g., attitude towards including whole grain pasta in the diet) and observed variables (e.g., the questionnaire items) (Kline, 2016). The latent variables, namely the abstract phenomena that cannot be directly measured by the researcher, have been analyzed using confirmatory factor analysis (Byrne, 2010). Confirmatory Factor Analysis (CFA), often referred to as the measurement model, is used when the researcher has some knowledge of the underlying latent variable structure or wishes to evaluate a priori hypotheses driven by theory. In our case, to improve the overall goodness-of-fit of the model, we decided to apply the latent variable structure for all TPB variables but PBC, for which we used the observed averaged variable. The goodness-of-fit of the models was assessed using χ^2 and their degrees of freedom (df), Tucker-Lewis Index (TLI), comparative fit index (CFI), root mean square error of approximation (RMSEA) with a 90 % confidence interval, and the standardized root mean square residual (SRMR). Statistical analysis was performed using SPSS v.28.0 and AMOS v.27.0 statistical software (IBM Corporation, Armonk, NY, USA).

3. Results

3.1. Descriptive statistics

Table 2 shows the descriptive statistics of the latent and observable variables: the factor loadings of the variables items (λ) above 0.50, CR values above 0.70, Cronbach's α above 0.70 with the only exception of PBC (0.62), and AVE values above 0.50 show strong reliability, and convergent validity of all factors in the measurement model. The results demonstrate a moderately positive consumer attitude toward including whole grain pasta in their diet (mean score: 4.75). Nevertheless, subjective norms did not show to greatly influence consumers (3.57) whereas they reported relatively strong control over the behavior (5.49). Again, consumers exhibited a moderately positive intention to include whole grain pasta in their diet (4.23). In general, participants reported consuming whole grain pasta occasionally (4.63).

As shown in Table 3, the squared root of the AVE of each construct was greater than the Spearman's rank-order correlation between the constructs, which also indicates the discriminant validity of the model.

305 **Table 2.** Mean values (standard deviation, SD) of single items and TPB constructs, factor
306 loadings (λ), composite reliability (CR), average variance extracted (AVE) and Cronbach's α of
307 the total sample (N=499) and follow-up (N=325)

Time 1	**N**	**Mean (SD)**	**λ**	**CR**	**AVE**	**α**
Attitude (Including whole grain pasta in my diet over the next month will be)	499	4.75 (1.48)		0.74	0.59	0.70
Difficult/Easy	499	4.98 (1.67)	0.59			
Not tasty/Tasty	499	4.51 (1.72)	0.92			
Subjective norm	499	3.57 (1.41)		0.92	0.79	0.90
Most people who are important to me think that I should include whole grain pasta in my diet over the next month	499	3.69 (1.54)	0.95			
Most people who influence my decisions think that I should include whole grain pasta in my diet over the next month	499	3.61 (1.45)	0.93			
It is expected that I should include whole grain pasta in my diet over the next month	499	3.41 (1.65)	0.78			
Perceived behavioral control	499	5.49 (1.13)		0.84	0.72	0.62
I believe that including whole grain pasta in my diet over the next month is possible	499	5.43 (1.33)	0.85			
The decision to include whole grain pasta in my diet over the next month will be only up	499	5.56 (1.34)	0.85			

to me						
Intention	499	4.23 (1.55)		0.91	0.77	0.91
I intend to include whole grain pasta in my diet over the next month	499	4.40 (1.64)	0.89			
I will try in anyway to include whole grain pasta in my diet over the next month	499	4.25 (1.68)	0.84			
I will definitely include whole grain pasta in my diet over the next month	499	4.03 (1.74)	0.89			
Follow Up (Time 2)	**N**	**Mean (SD)**	**λ**	**CR**	**AVE**	**α**
Behavior	325	4.63 (1.71)		0.77	0.62	0.76
In the past month, how often have you included a meal with whole grain pasta in your diet?	325	3.84 (1.70)	0.83			
I have included whole grain pasta in my diet at least once in the past month	325	5.42 (2.10)	0.75			

Table 3. Spearman's rank-order correlations (ρ) between the TPB constructs including the squared root of the AVE of each construct (reported in bold)

	ATT	**SN**	**PBC**	**INT**	**BEH**
ATT	**0.77**	0.22***	0.30***	0.45***	0.32***
SN		**0.89**	n.s.	0.58***	0.31***
PBC			**0.85**	0.25***	0.16**
INT				**0.88**	0.55***

BEH	**0.79**

Note: ATT = attitudes; SN = subjective norms; PBC = perceived behavioral control; INT = Intentions; BEH = behavior; *** indicates significance at p<0.001, ** significant at p<0.01, ns=not significant

We also testedthe effects of information (gain vs. loss-framed) on the TPB constructs and other variables in Time 1 and Time 2 (see details in Appendix Table A3). No significant differences between control, gain- and loss-framed groups were found for the TPB measures and PU, neither in Time 1 nor Time 2. Regarding how participants evaluate the type of message and the quality of the argument, significant differences were found between the gain- and loss-framed condition. The gain-framed message was found to slightly but significantly engender greater message engagement in terms of overall evaluation (M= 4.86) and quality of the message (M=4.77) than the loss-framed message (overall evaluation: M=4.16, and quality of the message: M = 3.96). Interestingly, the results of repeated measures ANOVA (Table 4) suggested that time (Time 1 vs. Time 2) had a positive impact on perceived usefulness ($p < 0.001$), intention ($p < 0.001$) and attitude ($p = 0.006$). Nevertheless, there was no significant effect of the interaction of time and treatments (framing) for perceived usefulness (Wilks lambda = 0.99, F =2.41, $p = 0.092$), intention (Wilks lambda = 0.99, F =1.10, $p = 0.334$) and attitude (Wilks lambda = 0.99, F =0.42, $p = 0.659$). The explanation for this finding could be that the request to fill out a follow-up questionnaire in the control group might have positively affected the perceived usefulness of and intention to consume whole grain pasta in Time 2.

Table 4. Results of repeated measures ANOVA

Variables	Times				Wilks lambda	F	Partial eta squared	*p*-value
	Time 1		Time 2					
	M	SD	M	SD				
ATT (N = 325)	5.20	1.46	5.52	1.34	0.95	7.73	0.05	0.006
PU (N = 325)	4.35	1.10	4.84	1.12	0.86	51.99	0.14	<0.001
INT (N = 325)	4.18	1.55	4.41	1.49	0.96	13.70	0.04	<0.001

Note: ATT = Attitude; PU = Perceived usefulness; INT = Intentions; M = Means; SD = Standard Deviation.

3.2. Effect of beliefs

The correlations (ρ) between behavioral, normative, and control beliefs with their relative constructs (attitudes, subjective norms, and PBC, respectively), intention to eat whole grain pasta over the next month, and behavior are reported in Table 5.

Intermediate correlation levels (ρ = 0.40–0.70) are reported for the association of normative beliefs with subjective norms and behavioral beliefs with attitude to eating whole grain pasta (ρ = 0.40). In particular, parents' and friends'/partners' opinions are the two normative beliefs that primarily affect subjective norms and intention. Regarding behavioral beliefs, the two most relevant beliefs associated with eating whole grain pasta are a long-term investment for the individual and less diet-related diseases. Control beliefs are negatively associated with PBC, in particular, for the higher costs of whole grain pasta and the perceived lack of availability in the dining halls. These represent the main barriers that decrease the perceived ability of respondents to perform the behavior. Finally, the link between control beliefs and intention has positive values, although it is almost non-significant.

350 The effect of the beliefs on behavior is less relevant ($\rho \leq 0.30$) and significant only for normative
351 and behavioral beliefs.
352
353

Table 5. Spearman's rank order correlations (ρ) between beliefs and their respective direct measure (attitude, subjective norm, and perceived behavioral control – PBC), intention, and behavior.

Beliefs	ρ	Sig.	ρ	Sig.	ρ	Sig.
Control beliefs	**PBC**		**Intention**		**Behavior**	
ConBel1	0.11	**	0.11	**	0.03	ns
ConBel2	-0.28	***	0.08	*	-0.03	ns
ConBel3	-0.28	***	0.20	***	0.06	ns
ConBel4	-0.09	**	0.08	*	0.06	ns
Behavioral beliefs	**Attitude**		**Intention**		**Behavior**	
BehBel1	0.40	***	0.40	***	0.24	***
BehBel2	0.43	***	0.38	***	0.18	**
BehBel3	0.45	***	0.42	***	0.22	***
Normative beliefs	**Subjective norms**		**Intention**		**Behavior**	
NorBel1	0.62	***	0.41	***	0.14	**
NorBel2	0.66	***	0.41	***	0.18	**
NorBel3	0.45	***	0.32	***	0.08	ns
NorBel4	0.51	***	0.35	***	0.09	*
NorBel5	0.54	***	0.33	***	0.17	**

Note: *** indicates significance at the 1% level, ** significant at 5% level, * indicates significance at the 10% level, ns=not significant.

3.3. Structural equation model results

The results of the SEM analysis with standardized path coefficients and R^2 are reported in Figure 2, while the unstandardized coefficients and standard errors are reported in Table A4. The SEM analysis was performed on the entire sample because framing had no effect on the TPB measures. The results show that there is a satisfactory fit between the hypothesized model and the data ($\chi 2$ (df) = 112.61 (37); CFI = 0.975; TLI = 0.955; RMSEA (90% C.I.) = 0.064 (0.051–0.078)). Overall, the TPB model explains 53.2% of the variance for the intention to consume whole grain pasta over the next month (measured in Time 1), and 44.5% of the variance in the self-reported behavior measured in Time 2. Attitude, subjective norms, and perceived behavioral control are significant predictors of the intention to consume whole grain pasta over the coming month. Specifically, subjective norms (β = 0.50, $p < 0.001$) and attitude (β = 0.36, $p < 0.001$) have a greater influence on the intention than the PBC (β = 0.16, $p < 0.001$). The intention is also a strong determinant of the behavior to consume whole grain pasta (β = 0.68, p < 0.001), measured after four weeks (self-reported behavior).

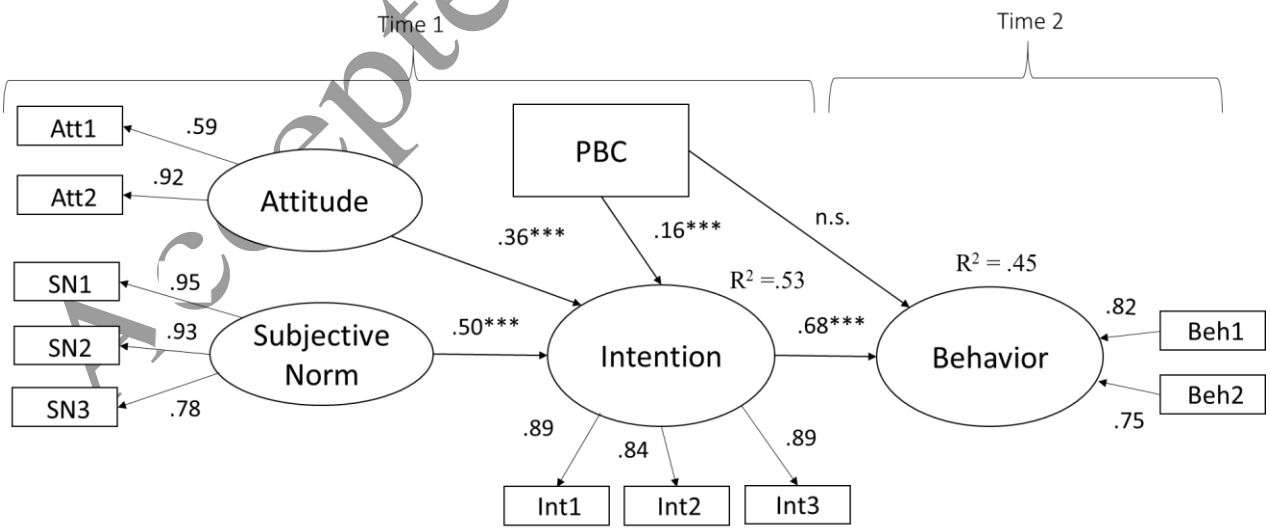


Figure 2. Results of the TPB model in Time 1 (n=499) and in Time 2 (n=325).

Notes: *** indicates a significant difference at $p < 0.001$, n.s. = not significant. Goodness-of-fit statistics: χ^2 (df) = 112.61 (37); CFI = 0.975; TLI = 0.955, RMSEA (90% C.I.) = 0.064 (0.051-0.078).

4. Discussion and Conclusions

Understanding how the behavior towards the inclusion of whole grain products is formed becomes a crucial stage to develop efficient healthy food choice strategies. In our study, the TPB model provides a significant explanation for the variance of the intention to consume whole grain pasta over the next month (R^2=0.53), as well as the (self-reported) prospective behavior (R^2=0.45). Thus, our results of the TPB model show that when individuals have strong attitudes, subjective norms, and perceived behavioral control toward eating whole grain pasta, their intention to eat this product increases, and this higher motivation would be strongly associated with the actual behavior. Similar results were found in other studies with regard to healthy dieting; for instance, in studies conducted by Hagger et al. (2006), the applied models explained 69% (Hagger & Chatzisarantis, 2006) and 56% (Hagger, Chatzisarantis, & Harris, 2006) of the intention, with relatively high variability in the explained behavior (66% and 32%, respectively). In line with previous studies (Biasini, Rosi, Scazzina, & Menozzi, 2023; Sogari et al., 2022), the intention well predicts young adults' behavior. In particular, subjective norms (i.e., the perceived social influence) affected the intention more than the attitude and PBC (Li, Long, Laubayeva, Cai, & Zhu, 2020). Usually, adolescents or young adults are more influenced by social and peers than other age groups, and this may explain why subjective norms have a stronger influence on intention in the TPB model (Barberis, Gugliandolo, Costa, & Cannavò, 2022; Friedman et al., 2022). In our case, the effect of behaviors of other students in the canteen (the social context) might affect the participant's motivation to comply.

399 Providing health messages at the point of consumption could, however, steer consumer decisions
400 and be an effective method of delivering strategies to increase healthy eating. A message can
401 be framed either to promote the advantages of consuming a particular food (gain-framed) or to
402 stress the negative outcomes of not consuming that particular food (loss-framed) (Gallagher &
403 Updegraff, 2012). The success of various message-framing strategies is usually assessed by
404 measuring consumer behaviors, intentions, or attitudes (Dolgopolova et al., 2022).
405 Our findings show no effect of frame condition on the TPB measures in Time 1. This is in line
406 with a review by Gallagher & Updegraff (2012) that showed no significant effect of framing on
407 attitudes and intentions. Moreover, our results align with recent findings by Weingarten and
408 Hartmann (Weingarten & Hartmann, 2023), who found that participants did not change their
409 behavior toward whole grain consumption directly after receiving the first messages on the
410 health benefits. Ottersen et al., (2022) conducted a study with Norwegian consumers to test
411 whether daily mobile phone text message reminders about animal welfare, and the environmental
412 and health consequences of meat would reduce people's meat consumption. They showed that
413 meat consumption did not change. Therefore, simply reminding consumers about these issues
414 may not be enough without further interventions as eating and dietary habits are strongly
415 entrenched behaviors that are primarily controlled by autonomic processes.
416 Our study is one of the few to assess the self-reported prospective behavior change (after four
417 weeks of intervention) as a measure of message framing persuasiveness (Gallagher & Updegraff,
418 2012). As suggested by Meynier et al., (2020) information provision will more likely lead to a
419 behavioral change if the information is provided on more than one occasion. For instance,
420 Weingarten and Hartmann (2023) found that providing information over time about the health
421 benefits of whole grain consumption contributed to increasing the positive attitude and

behavioral intentions to consume such products. However, in Time 2, we found no impact of the informative message (health information) on attitude, intention, and the reported behavior of eating whole grain pasta. This could be also due to the weekly information treatment (once per week), rather than a more intense exposure (daily messages for 14 days, as in the case of Weingarten and Hartmann (2023)). Another possible reason could be that information messages might have a short-lived effect on participants rather than other types of messages. For instance, Carfora et al., (2019) showed that participants exposed to emotional messages experienced a more enduring and long-lasting effect than information-type messages.

The specific characteristics of the sample (young adults with a healthy status) may be one reason why the health claim message did not have an impact in changing the perception towards whole grain. Past studies (e.g., Rothman & Updegraff, 2011) suggest that gain-framed and loss-framed messages may be amplified when the message is of high personal relevance, which might not be our case. Another possible reason for the lack of impact from the message is that it did not specifically target consumers' relevant beliefs (Fishbein & Ajzen, 2011; Weingarten & Hartmann, 2023). In our study, we found that the opinions of important others (e.g., parents, friends, and partners) were the strongest normative beliefs influencing the subjective norms (de Leeuw, Valois, Ajzen, & Schmidt, 2015); whereas the two most important behavioral beliefs relating to eating whole grain pasta were a personal long-term investment and the possibility of having fewer diet-related illnesses. Hence, the messages and interventions should target changing these key beliefs in order to lead to the desired changes.

However, gain-framed messages were evaluated in terms of “Consumer evaluation” and “Argument quality” better than loss-framed ones. The positive message about the health consequences associated with eating whole grain pasta was considered to be more appropriate,

helpful, valuable, and persuasive. Thus, in line with the literature (Dolgopolova et al., 2022; Gallagher & Updegraff, 2012; Rothman, Bartels, Wlaschin, & Salovey, 2006), our results confirm the higher appropriateness of gain-framed health messages when encouraging behavior with 'little risk' compared to loss-framed messages (more persuasive with a 'significant risky' behavior to perform).

Several limitations of our study occur. The first limitation is that we collected data only from a single University in the US, with a limited targeted population. Therefore, based also on the characteristics of this convenience sample (students enrolled in a US college), generalization of the findings to the broader population may be limited. Second, this study used self-report measures about the behavior of eating whole grain pasta which may be subject to response biases or limited memory. Third, although we focused our analysis on the individuals who actually opened the emailed messages, we cannot be sure whether the messages were truly read by the participants. Despite these limitations, we believe that our work will serve as a stimulus for further investigation on how to better develop communication strategies for the health benefits of whole grain products. Future research could explore different types of messages in terms of content and formats, as well as evaluate the results after a longer exposure. If concentrating on young adults, further studies could also consider testing the information across multiple dining halls to evaluate whether results are consistent across different cities. Finally, partnerships between nutrition, social scientists, and culinary professionals could support the development of relevant and useful information materials about whole grains consumption benefits.

References

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision*

Processes, *50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Andreani, G., Sogari, G., Wongprawmas, R., Menozzi, D., & Mora, C. (2023). Indulgent or informative logos? Effects on university students' intention to purchase healthy and sustainable food. *International Journal of Gastronomy and Food Science*, *33*, 100774. https://doi.org/https://doi.org/10.1016/j.ijgfs.2023.100774

Bagozzi, R. P., & Yi, Y. (2012). Specification, evaluation, and interpretation of structural equation models. *Journal of the Academy of Marketing Science*, *40*, 8–34. https://doi.org/10.1007/s11747-011-0278-x

Barberis, N., Gugliandolo, M. C., Costa, S., & Cannavò, M. (2022). Healthy and binge eating behaviours: the motivational processes underlying peer pressure. *Psychology, Health & Medicine*, *27*(5), 1144–1153. https://doi.org/10.1080/13548506.2021.1903054

Bhattacherjee, A., & Sanford, C. (2006). Influence Processes for Information Technology Acceptance: An Elaboration Likelihood Model. *MIS Quarterly*, *30*(4), 805–825. https://doi.org/10.2307/25148755

Biasini, B., Rosi, A., Giopp, F., Turgut, R., Scazzina, F., & Menozzi, D. (2021). Understanding, promoting and predicting sustainable diets: A systematic review. *Trends in Food Science & Technology*, *111*, 191–207. https://doi.org/https://doi.org/10.1016/j.tifs.2021.02.062

Biasini, B., Rosi, A., Scazzina, F., & Menozzi, D. (2023). Predicting the Adoption of a Sustainable Diet in Adults: A Cross-Sectional Study in Italy. *Nutrients*, Vol. 15. https://doi.org/10.3390/nu15122784

Bisanz, K. J., & Krogstrand, K. L. S. (2007). *Consumption & Attitudes about Whole Grain Foods of UNL Students Who Dine in a Campus Cafeteria*. Retrieved from

https://api.semanticscholar.org/CorpusID:70589297

Byrne, B. M. (2010). *Structural equation modeling with AMOS: Basic concepts, applications and programming* (2nd ed.). New York, US: Routledge/Taylor & Francis Group.

Carfora, V., Bertolotti, M., & Catellani, P. (2019). Informational and emotional daily messages to reduce red and processed meat consumption. *Appetite*, *141*, 104331. https://doi.org/10.1016/j.appet.2019.104331

Christoph, M. J., Ellison, B. D., & Meador, E. N. (2016). The Influence of Nutrition Label Placement on Awareness and Use among College Students in a Dining Hall Setting. *Journal of the Academy of Nutrition and Dietetics*, *116*(9), 1395–1405. https://doi.org/10.1016/j.jand.2016.05.003

Dammann, K. W., Hauge, D., Rosen, R. A., Schroeder, N., & Marquart, L. (2013). 6 - Consumption and consumer challenges of wholegrain foods. In J. A. Delcour & K. B. T.-F.-R. and W. F. Poutanen (Eds.), *Woodhead Publishing Series in Food Science, Technology and Nutrition* (pp. 120–149). https://doi.org/https://doi.org/10.1533/9780857095787.1.120

de Leeuw, A., Valois, P., Ajzen, I., & Schmidt, P. (2015). Using the theory of planned behavior to identify key beliefs underlying pro-environmental behavior in high-school students: Implications for educational interventions. *Journal of Environmental Psychology*, *42*, 128–138. https://doi.org/https://doi.org/10.1016/j.jenvp.2015.03.005

Deliens, T., Van Crombruggen, R., Verbruggen, S., De Bourdeaudhuij, I., Deforche, B., & Clarys, P. (2016). Dietary interventions among university students: A systematic review. *Appetite*, *105*, 14–26. https://doi.org/10.1016/j.appet.2016.05.003

Dolgopolova, I., Li, B., Pirhonen, H., & Roosen, J. (2022). The effect of attribute framing on

consumers' attitudes and intentions toward food: A Meta-analysis. *Bio-Based and Applied Economics*, *10*(4), 253–264. https://doi.org/10.36253/bae-11511

EFSA Panel on Dietetic Products, Nutrition, and Allergies (NDA). (2010). Scientific Opinion on Dietary Reference Values for carbohydrates and dietary fibre. *EFSA Journal*, *8*(3), 1462. https://doi.org/10.2903/j.efsa.2010.1462

European Commission. (2019). Whole grain. Retrieved from Health Promotion and Disease Prevention website: https://ec.europa.eu/jrc/en/health-knowledge-gateway/promotion-prevention/nutrition/whole-grain

Fishbein, M., & Ajzen, I. (2011). Predicting and changing behavior: The reasoned action approach. In *Predicting and Changing Behavior: The Reasoned Action Approach*. https://doi.org/10.4324/9780203838020

Food and Drug Administration. *21CFR101.14.* , (2023).

Franchini, C., Biasini, B., Rosi, A., & Scazzina, F. (2023). Best practices for making the university campus a supportive environment for healthy and sustainable diets. *Current Opinion in Environmental Science & Health*, *32*, 100436. https://doi.org/https://doi.org/10.1016/j.coesh.2022.100436

Friedman, V. J., Wright, C. J. C., Molenaar, A., McCaffrey, T., Brennan, L., & Lim, M. S. C. (2022). The Use of Social Media as a Persuasive Platform to Facilitate Nutrition and Health Behavior Change in Young Adults: Web-Based Conversation Study. *Journal of Medical Internet Research*, *24*(5), e28063. https://doi.org/10.2196/28063

Gallagher, K. M., & Updegraff, J. A. (2012). Health message framing effects on attitudes, intentions, and behavior: a meta-analytic review. *Annals of Behavioral Medicine : A*

Publication of the Society of Behavioral Medicine, *43*(1), 101–116. https://doi.org/10.1007/s12160-011-9308-7

Hagger, M. S., & Chatzisarantis, N. L. D. (2006). Self-identity and the theory of planned behaviour: Between- and within-participants analyses. *British Journal of Social Psychology*, *45*(4), 731–757. https://doi.org/https://doi.org/10.1348/014466605X85654

Hagger, M. S., Chatzisarantis, N. L. D., & Harris, J. (2006). The Process by Which Relative Autonomous Motivation Affects Intentional Behavior: Comparing Effects Across Dieting and Exercise Behaviors. *Motivation and Emotion*, *30*(4), 306–320. https://doi.org/10.1007/s11031-006-9046-5

Hung, Y., & Verbeke, W. (2019). Consumer evaluation, use and health relevance of health claims in the European Union. *Food Quality and Preference*, *74*, 88–99. https://doi.org/10.1016/J.FOODQUAL.2019.01.002

Jones, J. M., & Engleson, J. (2010). Whole Grains: Benefits and Challenges. *Annual Review of Food Science and Technology*, *1*(1), 19–40. https://doi.org/10.1146/annurev.food.112408.132746

Kann, L., McManu, T., Harris, W. A., Shanklin, S. L., Flint, K. H., Queen, B., … Ethier, K. A. (2018). *Youth Risk Behavior Surveillance — United States, 2017 MMWR Surveill Summ 2018;67(No. SS-8):* https://doi.org/http://dx.doi.org/10.15585/mmwr.ss6708a1

Kline, R. B. (2016). Principles and practice of structural equation modeling, 4th ed. In *Principles and practice of structural equation modeling, 4th ed.* New York, NY, US: Guilford Press.

Li, L., Long, X., Laubayeva, A., Cai, X., & Zhu, B. (2020). Behavioral intention of environmentally friendly agricultural food: the role of policy, perceived value, subjective

556 norm. *Environmental Science and Pollution Research*, *27*(15), 18949–18961.
557 https://doi.org/10.1007/s11356-020-08261-x

558 Maki, C. K., Palacios, M. O., Koecher, K., Sawicki, M. C., Livingston, A. K., Bell, M., …
559 McKeown, M. N. (2019). The Relationship between Whole Grain Intake and Body Weight:
560 Results of Meta-Analyses of Observational Studies and Randomized Controlled Trials.
561 *Nutrients* , Vol. 11. https://doi.org/10.3390/nu11061245

562 Marquart, L., Wiemer, K. L., Jones, J. M., & Jacob, B. (2003). Whole grain health claims in the
563 USA and other efforts to increase whole-grain consumption. *Proceedings of the Nutrition*
564 *Society*, *62*(1), 151–160. https://doi.org/DOI: 10.1079/PNS2003242

565 McDermott, M. S., Oliver, M., Simnadis, T., Beck, E. J., Coltman, T., Iverson, D., … Sharma, R.
566 (2015). The Theory of Planned Behaviour and dietary patterns: A systematic review and
567 meta-analysis. *Preventive Medicine*, *81*, 150–156.
568 https://doi.org/10.1016/j.ypmed.2015.08.020

569 McEachan, R. R. C., Conner, M., Taylor, N. J., & Lawton, R. J. (2011). Prospective prediction of
570 health-related behaviours with the Theory of Planned Behaviour: a meta-analysis. *Health*
571 *Psychology Review*, *5*(2), 97–144. https://doi.org/10.1080/17437199.2010.521684

572 Meynier, A., Chanson-Rollé, A., & Riou, E. (2020). Main Factors Influencing Whole Grain
573 Consumption in Children and Adults—A Narrative Review. *Nutrients*, *12*(8), 2217.
574 https://doi.org/10.3390/nu12082217

575 O'Keefe, D. J., & Jensen, J. D. (2008). Do Loss-Framed Persuasive Messages Engender Greater
576 Message Processing Than Do Gain-Framed Messages? A Meta-Analytic Review.
577 *Communication Studies*, *59*(1), 51–67. https://doi.org/10.1080/10510970701849388

578 Ottersen, I. S., Benningstad, N. C. G., & Kunst, J. R. (2022). Daily reminders about the animal-
579 welfare, environmental and health consequences of meat and their main and moderated
580 effects on meat consumption. *Cleaner and Responsible Consumption*, *5*, 100068.
581 https://doi.org/https://doi.org/10.1016/j.clrc.2022.100068

582 Quick, V., Wall, M., Larson, N., Haines, J., & Neumark-Sztainer, D. (2013). Personal,
583 behavioral and socio-environmental predictors of overweight incidence in young adults: 10-
584 yr longitudinal findings. *International Journal of Behavioral Nutrition and Physical*
585 *Activity*, *10*(1), 37. https://doi.org/10.1186/1479-5868-10-37

586 Rothman, A. J., Bartels, R. D., Wlaschin, J., & Salovey, P. (2006). The Strategic Use of Gain-
587 and Loss-Framed Messages to Promote Healthy Behavior: How Theory Can Inform
588 Practice. *Journal of Communication*, *56*(s1), S202–S220.
589 https://doi.org/https://doi.org/10.1111/j.1460-2466.2006.00290.x

590 Rothman, A. J., & Updegraff, J. A. (2011). Specifying when and how gain-and loss-framed
591 messages motivate healthy behavior : an integrated approach. In G. Keren (Ed.),
592 *Perspectives on framing*. Psychology Press.

593 Shepherd, R., Dean, M., Lampila, P., Arvola, A., Saba, A., Vassallo, M., … Lähteenmäki, L.
594 (2012). Communicating the benefits of wholegrain and functional grain products to
595 European consumers. *Trends in Food Science & Technology*, *25*(2), 63–69.
596 https://doi.org/https://doi.org/10.1016/j.tifs.2012.01.002

597 Slavin, J. L. (2005). Dietary fiber and body weight. *Nutrition (Burbank, Los Angeles County,*
598 *Calif.)*, *21*(3), 411–418. https://doi.org/10.1016/j.nut.2004.08.018

599 Sogari, G., Li, J., Lefebvre, M., Menozzi, D., Pellegrini, N., Cirelli, M., … Mora, C. (2019). The

influence of health messages in nudging consumption of whole grain pasta. *Nutrients*, *11*(12). https://doi.org/10.3390/nu11122993

Sogari, G., Li, J., Wang, Q., Lefebvre, M., Huang, S., Mora, C., & Gómez, M. I. (2022). Toward a reduced meat diet: University North American students' acceptance of a blended meat-mushroom burger. *Meat Science*, *187*, 108745. https://doi.org/https://doi.org/10.1016/j.meatsci.2022.108745

Stok, F. M., Renner, B., Clarys, P., & Deliens, T. (2018). Understanding Eating Behavior during the Transition from Adolescence to Young Adulthood : A Literature. *Nutrients*, *10*(667), 1–16. https://doi.org/10.3390/nu10060667

U.S. Department of Health and Human Services and U.S. Department of Agriculture, & US Department of Agriculture. (2015). 2015–2020 Dietary Guidelines for Americans. Retrieved April 4, 2019, from http://health.gov/dietaryguidelines/2015/guidelines/

Ugunesh, D., Siau, C. S., Mohd Sanip, M. N. A. Bin, & Koo, H. C. (2023). Perceived barriers towards whole grain consumption among the Malaysian adult population: findings from a theory-based qualitative study. *British Food Journal*, *125*(3), 1130–1147. https://doi.org/10.1108/BFJ-10-2021-1152

van Griethuijsen, R. A. L. F., van Eijck, M. W., Haste, H., den Brok, P. J., Skinner, N. C., Mansour, N., … BouJaoude, S. (2015). Global Patterns in Students' Views of Science and Interest in Science. *Research in Science Education*, *45*(4), 581–603. https://doi.org/10.1007/s11165-014-9438-6

Weingarten, N., & Hartmann, M. (2023). Fifty shades of grain – Increasing whole grain consumption through daily messages. *Appetite*, *187*, 106608.

https://doi.org/https://doi.org/10.1016/j.appet.2023.106608

Wongprawmas, R., Sogari, G., Menozzi, D., Pellegrini, N., Lefebvre, M., Gómez, M. I., & Mora, C. (2021). Determinants of US University Students' Willingness to Include Whole Grain Pasta in Their Diet. *International Journal of Environmental Research and Public Health*, *18*(6). https://doi.org/10.3390/ijerph18063173

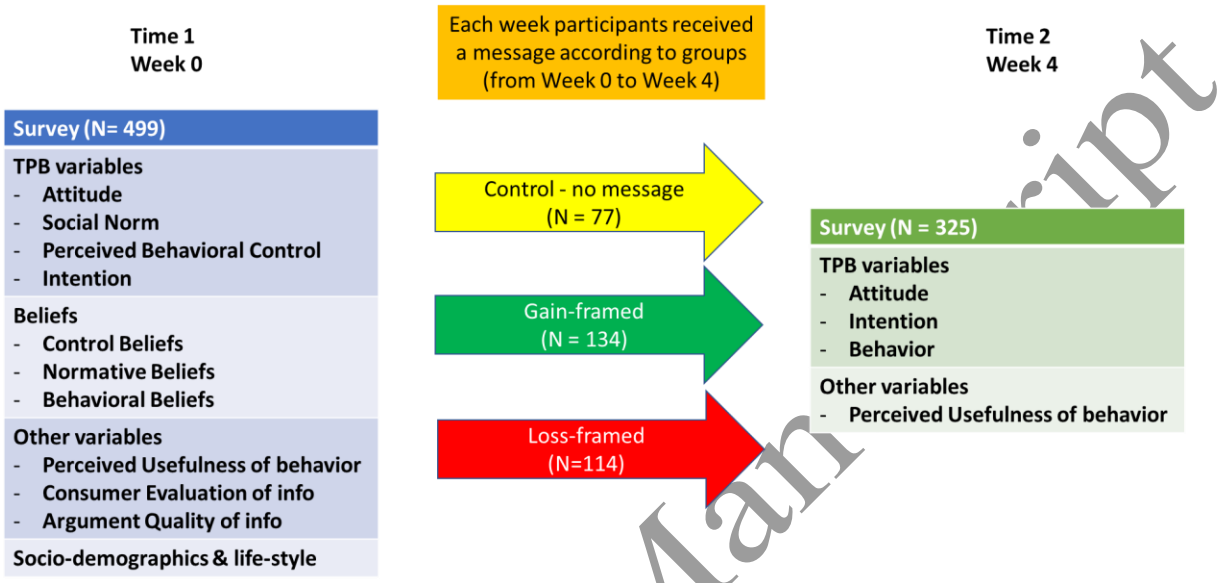
World Health Organization. (2014). Adolescents: health risks and solutions. Retrieved from Fact sheet N°345 website: http://www.searo.who.int/thailand/factsheets/fs0027/en/

Ye, E. Q., Chacko, S. A., Chou, E. L., Kugizaki, M., & Liu, S. (2012). Greater whole-grain intake is associated with lower risk of type 2 diabetes, cardiovascular disease, and weight gain. *Journal of Nutrition*, *142*(7), 1304–1313. https://doi.org/10.3945/jn.111.155325

634

635 **Appendices**

636



637

638 **Figure A1** Survey flow

639

640

641 **Table A1.** Constructs and Items

Codes	Constructs and items
	Behavioral beliefs *(1 = strongly disagree; 7 = strongly agree)* (time 1)
BehBel1	If I include whole grain pasta in my diet over the next month I believe I will live a better quality of life in my old age
BehBel2	If I include whole grain pasta in my diet over the next month I believe I will have made a long-term investment for myself
BehBel3	If I include whole grain pasta in my diet over the next month I believe I will have less diet-related diseases in my life
	Normative beliefs *(1 = strongly disagree; 7 = strongly agree)* (time 1)
NorBel1	My parents think I should include whole grain pasta in my diet over the next month
NorBel2	My friends/partner think I should include whole grain pasta in my diet over the next month
NorBel3	Nutritionists think I should include whole grain pasta in my diet over the next month
NorBel4	My doctor thinks I should include whole grain pasta in my diet over the next month
NorBel5	Chefs think I should include whole grain pasta in my diet over the next month
	Control beliefs *(1 = strongly disagree; 7 = strongly agree)* (time 1)
ConBel1	The limited advertising from the dining halls/restaurants I usually go does not encourage me to include whole grain pasta in my diet over the next month
ConBel2	The higher costs of whole grain pasta stops me from including this product in my diet over the next month
ConBel3	The lack of availability in the dining halls I usually go stops me from including whole grain pasta in my diet over the next month
ConBel4	The limited information from public authorities about whole grain benefits does not

	encourage me to include whole grain pasta in my diet over the next month
	Attitude towards the behavior *(time 1 and time 2)*
	For me, including whole grain pasta in my diet over the next month (7-point scale)
ATT1	Difficult - Easy
ATT2	Not tasty - Tasty
	Subjective norm *(1 = strongly disagree; 7 = strongly agree)* (time 1)
SN1	Most people who are important to me think that I should include whole grain pasta in my diet over the next month
SN2	Most people who influence my decisions think that I should include whole grain pasta in my diet over the next month
SN3	It is expected that I should include whole grain pasta in my diet over the next month
	Perceived behavioral control *(1 = strongly disagree; 7 = strongly agree)* (time 1)
PBC1	I believe that including whole grain pasta in my diet over the next month is possible
PBC2	The decision to include whole grain pasta in my diet over the next month will be only up to me
	Behavioral Intention (1 = strongly disagree; 7 = strongly agree) *(time 1 and time 2)*
INT1	I intend to include whole grain pasta in my diet over the next month
INT2	I will try in anyway to include whole grain pasta in my diet over the next month
INT3	I will definitely include whole grain pasta in my diet over the next month
	Behavior *(after one month)* (7-point scale) (time 2)
Beh1	In the past month, how often have you included a meal with whole grain pasta in your diet? Never - Almost always
Beh2	I have included whole grain pasta in my diet at least once in the past month. False-True

642

643 **Table A1.** (Cont.)

Codes	Constructs and items
	Consumer evaluation of the claim *(1 = strongly disagree; 7 = strongly agree) (time 1)*
ConsEval1	I am familiar with the health claim I just read
ConsEval2	I understand this health claim
ConsEval3	This health claim is credible
ConsEval4	This health claim is interesting
ConsEval5	This health claim is important
	Argument quality *(1 = strongly disagree; 7 = strongly agree) (time 1)*
ArgQua1	The information provided about whole grain pasta is informative
ArgQua2	The information provided about whole grain pasta is helpful
ArgQua3	The information provided about whole grain pasta is valuable
ArgQua4	The information provided about whole grain pasta is persuasive
	Perceived Usefulness *(1 = strongly disagree; 7 = strongly agree) (time 1 and time 2)*
PercUse1	Including whole grain pasta in my diet will help me to stay in shape (e.g., maintaining my body weight).
PercUse2	Including whole grain pasta in my diet will improve my work performance (e.g., make my working/studying life more productive).
PercUse3	Including whole grain pasta in my diet will make my diet more balanced and healthy (e.g., right amount of fiber intake).

644

645

646

Table A2. In italic the messages shown to participants.

Message	Health benefits of eating whole grain	Gain framed message (Gfm)	Loss-framed message (Lfm)
1	Better chance of success in maintaining your body weight (BW)	*If you include whole grain pasta in your diet, you might have a better chance of success in maintaining your body weight.*	*If you do not include whole grain pasta in your diet, you might not have a better chance of success in maintaining your body weight.*
2	Its fiber content will contribute to your normal bowel function (BF)	*If you include whole grain pasta in your diet, its fiber content will contribute to your normal bowel function.*	*If you do not include whole grain pasta in your diet, a lack of fiber content will not contribute to normal bowel function.*
3	Niacin content (vitamin B3) will contribute to the reduction of tiredness and fatigue (T&F)	*If you include whole grain pasta in your diet, its niacin content (vitamin B3) will contribute to the reduction of tiredness and fatigue.*	*If you do not include whole grain pasta in your diet, a lack of niacin (Vitamin B3) will not contribute to the reduction of tiredness and fatigue.*
4	Its fiber content will promote your healthy gut (HG)	*If you include whole grain pasta in your diet, its fiber content will promote your healthy gut.*	*If you do not include whole grain pasta in your diet, a lack of fiber content will not promote your gut health.*

Four different types of health messages were developed, based on the latest scientific opinion on the substantiation of health claims related to (1) whole grain (EFSA Panel on Dietetic Products, Nutrition and Allergies (NDA), 2010), (2) wheat bran fibre and increase in faecal bulk (EFSA Panel on Dietetic Products, Nutrition and Allergies (NDA), 2010a), and (3) niacin and reduction of tiredness and fatigue (EFSA Panel on Dietetic Products, Nutrition and Allergies (NDA), 2010a).

Table A3. Internal consistency of TPB constructs and other variables in Time 1 and Time 2

Variable	N. of Items	Control				Gain Frame				Loss Frame				*p*-value [a]
		N	Cronbach's alpha	M	SD	N	Cronbach's alpha	M	SD	N	Cronbach's alpha	M	SD	
Time 1 ATT	2	100	0.628	4.750	1.319	202	0.717	4.849	1.566	197	0.702	4.655	1.473	0.426
Time 2 ATT	2	77	0.598	4.773	1.344	134	0.748	4.787	1.516	114	0.756	4.956	1.351	0.572
Time 1 PU	3	100	0.762	4.443	1.062	202	0.825	4.315	1.141	197	0.847	4.201	1.221	0.225
Time 2 PU	3	77	0.837	4.714	1.016	134	0.861	4.925	1.157	114	0.824	4.818	1.140	0.408
Time 1 SN	3	100	0.857	3.443	1.311	202	0.905	3.705	1.370	197	0.897	3.504	1.497	0.216
Time 1 PBC	2	100	0.559	5.505	1.067	202	0.616	5.505	1.116	197	0.643	5.472	1.185	0.951
Time 1 INT	3	100	0.902	4.120	1.496	202	0.918	4.297	1.611	197	0.897	4.191	1.517	0.613
Time 2 INT	3	77	0.933	4.416	1.369	134	0.931	4.368	1.572	114	0.907	4.450	1.479	0.910
Time 2 Bahavior	2	77	0.732	4.727	1.572	134	0.760	4.493	1.746	114	0.768	4.676	1.803	0.566
Time 1 ConsEval	5	-	-	-	-	202	0.622	4.857	0.886	197	0.742	4.154	1.127	<0.001
Time 1 ArgQua	4	-	-	-	-	202	0.859	4.774	1.132	197	0.908	3.956	1.415	<0.001

Note: TPB = theory of planned behavior; ATT = Attitude; PU = Perceived usefulness; SN = Subjective Norms; PBC = Perceived Behavioral Control; INT = Intention; ConsEval = Consumer evaluation of the claim; ArgQua = Argument Quality. M = Means; SD = Standard Deviation. [a] Comparison between groups using ANOVA tests.

Table A4. TPB Model: unstandardized beta coefficients, standard errors (S.E.), p-values, in Time 1 (n=499) and in Time 2 (n=325).

Predictors	**Path coefficients**		
Predictors of Behavioral Intention (in Time 1)	*Beta*	*S.E.*	*p*
ATT	0.565	0.076	<0.001
PBC	0.220	0.051	<0.001
SN	0.604	0.055	<0.001
Predictors of Behavior (in Time 2)	*Beta*	*S.E.*	*p*
INT	0.612	0.057	<0.001
PBC	0.077	0.067	0.250

Note: ATT: attitude towards the behavior; SN: subjective norms; PBC: perceived behavioral control