Where Do You Keep Your Running Shoes?

The Influence of Perceived Control and Self-Nudging on Health Behavior

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Abstract

In the Covid-19 crisis, people from all over the world were forced to spend a lot of time at home. For many, this meant having to come up with new strategies to create a home environment supportive of a healthy diet and exercise. This study aims to predict at-home health behavior by using a combination of nudge theory and the theory of planned action. Specifically, this study investigates whether three self-nudge types (visibility, accessibility, availability) and perceived control can be used as predictors of healthy eating and exercise. In this context, perceived control is defined as the estimation of how difficult or easy the execution of the behavior is going to be, based on both external resources and internal factors. To test the hypothesis of a covariate interaction between nudge and perceived control, an online 55-item survey regarding health habits and home arrangements was administered to 100 participants aged 17-73. The responses were analyzed using two multiple linear regressions, one for healthy eating and one for exercise. The results pointed towards a covariate interaction between nudge visibility and perceived control for healthy eating but not exercise, where the only significant predictor was perceived control. These results suggests that the most effective strategy to implement healthy eating is a combination of heightened perceived control and an increase in the visibility of healthy eating self-nudges in the home environment. Concretely, this means that healthy eating habits can be promoted by fostering a 'can-do' attitude and by heightening the salience of the healthy eating nudges already present in our living spaces.

Keywords: nudge theory, theory of planned action, perceived control, self-nudge

Literature Review

In the light of the Covid-19 crisis, we are spending a lot of time in our homes. For many, this has proven to be a be a challenge to maintaining the healthy habits that were in place before the pandemic (Arora & Grey, 2020). A Polish study on the habits of locals during the 2020 Covid-19 lockdown observed that on one hand, people who have a positive attitude towards physical exercise were found to be more likely to exercise during the lockdown, while on the other hand, people who were already showing signs of physical unhealthiness (e.g., smokers, overweight people) had their behaviors to be exacerbated by the quarantine (Sidor & Rzymski, 2020).

Even before Covid-19, influencing people to make healthy choices was a challenge for the health sciences. Nowadays, unhealthy lifestyles are a common health concern as seen in the numerous deaths that are caused by unhealthy personal choices (Lozano et al, 2012). In fact, unhealthy diets and sedentary behavior are strongly linked to four of the primary causes of death in the US, namely coronary heart disease, cancer, stroke, and diabetes, accounting for almost 50% of the total deaths (Centers for Disease Control and Prevention, 2010). Even when not deadly, unhealthy lifestyles are linked to life unsatisfaction and discomfort.

For this reason, many modern countries have a keen interest in developing ways to make citizens form and follow healthy habits. For example, the UK has founded a governmental institution dedicated to researching the processes leading to healthy decision-making in public spaces, focusing on the use of nudges – elements of the surroundings that can be used to guide health behaviors (Behavioral Insights Team, 2011; U.K. Cabinet Office, 2011). However, since we are now spending more time at home and less time in public spaces, it is up to the individual person to come up with health-promoting strategies that can be implemented at home. Therefore, the aim of this paper is to outline the influences on health behavior when spending time at home, so that people can influence their own behavior by utilizing the nudges in their home environment to his or her advantage. To do so, we will be joining two of the most important theories of behavior, Ajzen's theory of planned action and nudge theory.

1.1 Definition of Health Behavior

Before we can review both these theories it is important to define what 'health behavior' means in the context of this study. From here on out, 'health behavior' will be used as an overarching term to include both eating behavior and exercise. The operational definition of healthy eating and exercising that will be used in this report was drawn from the

World Health Organization (WHO) guidelines. While unified European guidelines were deemed not feasible because of different dietary habits and food availability in the various European countries (EFSA, 2010), the food-related guidelines for each country have numerous principles in common. The commonalities include: a varied diet with lots of vegetables, whole grains, fruits, and variety of protein; reduced intake of sweets and fats; no skipping meals, between 3 and five meals a day; eating slowly and at least 2 hours before bedtime.

Physical activity guidelines include at least 150 minutes of moderate physical activity weekly, aerobic activity in bouts of at least 10 minutes at a time, muscle-strengthening activities weekly. While these are the official WHO physical activity guidelines, numerous research reviews have found that health benefits are already present when exercising below the recommended dose, with marked health befits increases already occurring at 75 minutes per week (Warburton and Bredin, 2017; Warburton and Bredin, 2016). Considering both these perspectives, we will define a healthy activity level as exercising for more than an hour in the last two days.

1.2 Conscious and Unconscious Influences on Health Behavior

Being aware of the guidelines for healthy eating and exercise is only the first step in our quest to help people influence their own behavior. The second step is understanding what cognitive psychology considers the most renown antecedents of behavior. There are two main schools of thought: the first, focusing on conscious influences on behavior, and the second, focusing on unconscious influences. The most famous theory regarding conscious predictors of behavior is called Theory of Planned Action (Ajzen, 1985; Ajzen, 1991). This theory reports attitudes and intentions as the primary precursors of behavior. The attitude towards a behavior is defined as one's positive or negative evaluation of the behavior. The intention to perform a behavior is defined as a concrete plan to carry out the behavior. An additional concept mentioned by the theory is that of perceived behavioral control. Perceived behavioral control is the estimation of how difficult or easy the execution of the behavior is going to be, based on both external resources (e.g., sufficient money to carry out the behavior, social support) and internal factors (e.g., skill, information). According to the theory of planned action a positive attitude towards a behavior positively influences both the perceived behavioral control and the intention to perform that behavior. Both the perceived behavioral control and the intention directly affect behavior.

A key theory looking at unconscious influences on behavior is nudge theory (Thaler and Sunstein, 2008). A nudge is defined as the process of structuring the environment in a certain way to influence behavior. According to this theory, automatic processes, in particular impulses and habits, are the determinants of behavior. Creating a nudge involves altering the placing and the properties of objects in the environment and are implementing the changes in the same environment in which the target behavior is performed (Dolan et al, 2012). Nudges are different from health interventions relying on conscious precursors of behavior because when health behaviors are prompted by nudges minimal conscious effort is placed on the person performing the behavior. For example, to influence people in the cafeteria to buy more water instead of juice, nudge theory suggests making changes to the cafeteria environment itself as opposed to educating customers in being more health conscious. The nudge strategy has been argued to be more efficient since it requires a lower cognitive load for the participant while retaining its effectiveness (Thaler and Sunstein, 2008).

1.3 Current Study

The most studied category of nudges are priming nudges, which affect the perceived visibility, accessibility, and availability of target objects. While these three appear to be quite similar, they focus on slightly different aspects. For instance, if we want to use a bowl of fruit as a nudge to promote the eating of more fruit, we could make the bowl a nudge by making it more visible (e.g. placing it on the kitchen table rather than in the fridge), by making it more accessible (e.g. by placing it in the place we spend most time in rather than in a room we do not spend as much time in), or by making it more available (e.g. by buying a bag of oranges instead of a few oranges). Both visibility, accessibility, and availability nudges have been found to influence health behaviors (Wansink & Hanks, 2013; Rozin et al, 2011; van Kleef et al, 2012).

When talking about nudges, the literature usually refers to an aspect of the environment that influence a person's behavior without him or her being aware of the nudge. In a research context, this has translated to the researchers placing nudges in the experimental environment without the participant being notified of the changes (Wansink & Hanks, 2013; Levy et al, 2012; Rozin et al, 2011). The other option, just recently introduced to the research world, is to use self-nudges – nudges placed by the participants themselves, with participants being aware of both the nudges and their purpose (Torma, Aschemann-Witzel, & Thøgersen, 2018). The difference between regular nudges and self-nudges raises the question of whether the two nudge types operate in the same way and how disruptive can subject awareness be. A

recent study attempting to answer these questions, concluded that nudges do not need to operate below consciousness for them to be effective and that awareness does not decrease nudge effectiveness, therefore allowing us to consider self-nudges as regular nudges (Cheung et al, 2019).

Self-nudges give us a chance to study a much larger a portion of the nudges to which we are exposed every day. Despite the recent introduction to the research world, the concept of self-nudges is hardly a novel one. Schelling (1978) observes that "many of us have little tricks we play on ourselves to make us do the things we ought to do or to keep us from the things we ought to foreswear" (p. 290), for example by placing letters that need to be mailed by the door or eliminating unhealthy foods from our apartment when we go on a diet. An extensive argument for the effectiveness of self-nudges has been made by Reijula & Hertwig (2020); the article also comments that health policies utilizing self-nudges have yet to be established. At the time of writing this report, there are only two other reports openly mentioning self-nudges: a book on healthy decision-making which mentions self-nudging as one of the possible strategies (Gallager, 2017) and a study which looks at the efficacy of default self-nudges (Torma, Aschemann-Witzel, & Thøgersen, 2018). Both add supporting evidence to the idea that self-nudges qualify as nudges in all rights.

To gain a more comprehensive understanding of at-home health behavior, the present study attempts to connect nudge theory to the theory of planned action. Our research question investigates the relationship between perceived control and three different types of self-nudges, and their joint influence on health behavior. Since both perceived control and nudges have been found to be predictors of health behavior when studied individually, our hypothesis predicts a joint effect of perceived control and nudge visibility, accessibility, and availability on health behavior (Figure 1). We will be using two regression models to test this hypothesis, one looking at the effect on healthy eating and the other looking at the effect on exercise.

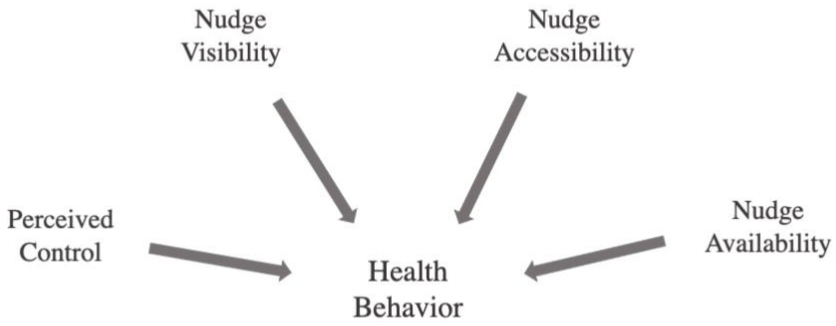

Figure 1. Schematic overview of the research hypothesis. Perceived control, nudge visibility, nudge accessibility and nudge availability are all predictors of health behavior.

2.0 Methods

2.1 Participants

One hundred participants were recruited for this study; 17 were male, and 82 were female. One participant identified as non-binary. The participants were aged between 19 and 73, with mean age $M = 35.59$ and $SD = 15.32$. The survey was offered in three languages: English, Dutch, and Italian; 39 participants chose English as the survey language, 24 participants chose Dutch, and 37 participants chose Italian. The employment status was as follows: 45% were students, 43% were employed, 5% unemployed and 7% retired. When asked how much time they spend at home, 7% of participants stated they only spend a few hours at home, 19% said they spend half their day at home, 55% that they spend most of their day at home, and 19% stated they spend their whole day at home. This study was reviewed and approved by the Faculty Ethical Review Board of the Faculty of Social Sciences, Utrecht University. All participants gave their consent by ticking a box before beginning the experiment. The participants were let known they could quit the experiment and withdraw their consent at any time and without any consequences.

2.2 Experimental Design

Two separated multiple linear regressions were chosen as the research design, one for which healthy eating was the dependent variable and the other for which exercising was the dependent variable. In later paragraphs these are sometimes referred collectively as ‘health behavior’. The independent variables (predictors) were the same in both regressions: intensity of nudge visibility, intensity of nudge accessibility, intensity of nudge availability, and perceived control.

2.3 Materials

A 55-item survey was created to answer the research question. All survey items, except for the personal questions, utilized a 1-5 Likert scale. The survey was administered online through the Gorilla research platform. We chose a survey for two reasons. First, a survey is suited to assess personal values and opinions such as the participant’s perceived control towards healthy eating and exercising. Second, the self-report methodology allowed us to gather data regarding the behavior of participants over a span of a few days.
Each of the four constructs assessed by the survey (nudge intensity, perceived control, attitude, and health behavior) had its own subset of questions. In addition, a final section

asked for some personal information, such as personal conditions that may have influenced their answers, age, and time spent at home.

Perceived Control

Perceived control items wanted to assess the degree to which the participant believed that their health behavior was dependent on their own actions and beliefs as opposed to external circumstances. E.g., *I believe anyone can learn how to follow a healthy diet* and *If you are short on time, you'll have a hard time exercising regularly*.

Nudge Intensity

To assess nudge intensity, participants were first asked to select from a list an item they owned – that item would be the one evaluated as a nudge. If they did not own any of the items on the list, they were free to state so and their answers for that item would not be considered. After choosing the item they had to answer three questions for that item, each question referring to a different nudge type. The process was repeated for a total of 2 food-related items, and 3 exercise-related items.

	Category	**Options**
Food nudges	Healthy snacks	*Nuts, fruit*
	Healthy meals	Legumes, vegetables
Exercise nudges	Sport clothes	*tops, bottoms*
	Sport shoes	*I have a pair at home, I do not have a pair at home*
	Sport equipment	*Weights, balls, skates, bikes*

Table 1. List of items in the nudge intensity section of the survey. Each line of the table represents a different 'choice' that had to be made by the participant, for a total of 5 choices.

Nudge intensity was assessed for three aspects of nudges: nudge visibility, accessibility, and availability. Visibility was measured by how easily the target item could be seen by the participant. Accessibility was measured as a matter of the number of doors (including cabinet doors) the participant needed to open to access the target item. Availability was measured in terms of how worried the participant was of running out of a certain item. All questions considered the room in which the individual participant spends most time as the 'viewpoint' from which the nudge questions are answered.

Attitude

Attitude items were aimed at assessing the participant's beliefs, in particular whether the participant believed healthy eating and exercising was beneficial to their overall life. E.g., *I believe eating vegetables and legumes is important to live a long, healthy life.*

Health Behavior

Health behavior items aimed to assess the survey participants' health levels. The questions noted eating and exercise behaviors that had occurred in the two days before the survey. Healthy eating questions asked how often participants had eaten vegetables, legumes, nuts, fruit, as opposed to chocolate, pastries, or chips. Meanwhile, healthy exercise was defined as performing a physical activity for at least an hour total.

2.4 Procedure

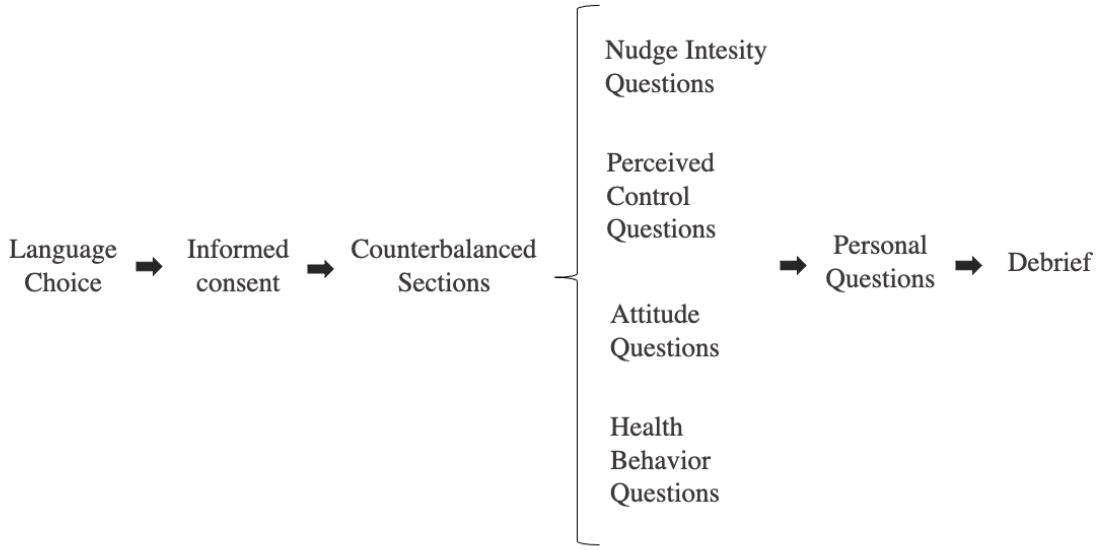

Figure 2. Overview of experimental procedure. For the full list of questions in each section, see Appendix.

Before beginning the experiment, participants had the opportunity to choose between three languages: English, Dutch, and Italian. This was done to facilitate the participation of non-English speakers. After choosing their preferred language, participants were given a brief description of the experiment and were presented with the informed consent form. The participants could access the rest of the survey only if they first gave their consent by checking an agree button. After agreeing, participants were presented with four survey

sections, the order of which was counterbalanced within each language. Each of the sections focused on testing one of the constructs: nudge intensity, perceived control, attitude, and health behavior. The questions within these sections were also presented in a random order. Successively, participants had to answer a few personal questions concluding the experiment. At the end of the survey, participants were thanked and asked whether they would like to receive the results of the study once published as a debrief procedure.

2.5 Analysis

To compute scores for each participant on the constructs tested, we computed the average of all items assessing a certain construct. For example, the perceived control score was obtained by summing all the answers (ranging 1-5) from that section of the survey, and then dividing it by the number of perceived control items. In this way, the final scores always had 1 as the lowest possible score, and 5 as the maximum.

Before moving on to the research questions, we wanted to confirm that all participants could be included in the analysis. We had two main concerns: that many participants (N = 28) declared to have a condition related to healthy eating and/or exercising, and that participants varied in the amount of control they had over what they ate. Possible related conditions included, for example, disabilities, eating disorders, or special exercise regimens. Before moving on to more complex analyses, it was important to check whether the people who said to have a personal condition gave significantly different answers from the people who denied having any such condition. For this purpose, a series of independent t-tests were used to compare the two groups on attitude, different nudge types and intensity, perceived control, and health behavior. Each of these tests was run first for healthy eating behavior and second for exercising behavior. When normality of distribution could not be assumed because of a significant Shapiro-Wilk test, a Mann-Whitney U-test was used in place of the independent samples t-test. The answers of the two groups were found to be comparable across all conditions, with no significant difference between the two groups. Table 2 shows all test statistics and p-values.

Variable	**Test**	**Statistic**	**p-value**
Eating attitude	Mann-Whitney	$U = 1045.00$	0.77
Exercise attitude	Mann-Whitney	$U = 1043.00$	0.79
Eating behavior	Mann-Whitney	$U = 900.50$	0.41
Exercise behavior	Mann-Whitney	$U = 1007.00$	0.99

Visibility of eating nudge	Mann-Whitney	$U = 1054.00$	0.72
Accessibility of eating nudge	Mann-Whitney	$U = 1164.50$	0.22
Availability of eating nudge	Mann-Whitney	$U = 1238.00$	0.07
Visibility of exercise nudge	Mann-Whitney	$U = 1124.00$	0.37
Accessibility of exercise nudge	Mann-Whitney	$U = 1079.50$	0.58
Eating perceived control	Independent samples T-test	$t(98) = 0.07$	0.95
Exercise perceived control	Independent samples T-test	$t(98) = 0.65$	0.51

Table 2. Group comparisons between participants with a related condition and participants without a related condition. The Bonferroni-corrected critical p-value was 0.004.

The second issue was with varying degrees of autonomy in choose meals. That was potentially problematic because if you can't control what you eat you also have no control over how healthy your diet is. Meal choice autonomy was rated on a 1-3 scale ranging from *I never pick my meals* to *I always pick my meals.* A one-way ANOVA was run to determine differences in healthy eating based on different degrees of meal choice autonomy. Assumption checks confirmed the variances to be equal and the data to be approximately normally distributed. The degree of autonomy in meal decision played no significant role in how healthy the diets of participants were, $F(2,97) = 2.77$, $p = 0.70$, $\eta_p^2 = 0.05$.

After these checks, we moved on to the research question. Our question investigates whether perceived control and nudge intensity can be used to predict at-home health behavior. To answer this question, a multiple linear regression was performed utilizing health behavior as the outcome variable, perceived control and the three different nudges (visibility, accessibility, availability) as predictors. The same analyses were connected for healthy eating and exercise.

3.0 Results

3.1 Healthy Eating

A multiple linear regression having perceived control and nudge intensities as predictors and healthy eating as the outcome variable was carried out. The scatterplot of standardized predicted values versus standardized residuals showed that the data met the assumptions of homogeneity of variance and linearity, and that the residuals were approximately normally distributed. The results of the regression indicated that the model explained 18.3% of the variance in healthy eating behavior, and that the model was significant, $F(4,95) = 5.32$, $p < 0.001$. Both eating perceived control and visibility of healthy eating nudge were found to be significant coefficients, $B_{1,}= 0.30$, 95% CI [0.12, 0.48], $p = 0.002$ and $B_{1,}= 0.13$, 95% CI [0.02, 0.24], $p = 0.02$ respectively. The other predictors were not found to be significant: accessibility of healthy eating nudge ($p = 0.72$), availability of healthy eating nudge ($p = 0.90$).

The final predicted model for healthy eating behavior therefore was:

Healthy eating behavior = 3.49 + 0.30 * eating perceived control + 0.13 * visibility of healthy eating nudge.

According to this model, self-reports on the healthy eating Likert scale averaged at 3.49 out of 5. The eating score increased by 0.30 for every point on the perceived control Likert scale and 0.13 for every point on the visibility of healthy eating nudge Likert scale.

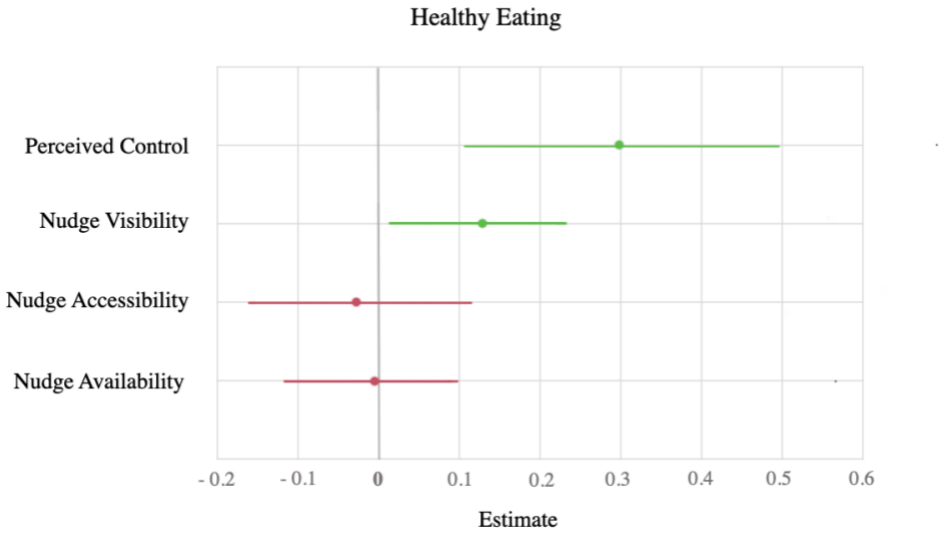

Figure 3. The dots represent the predictors' regression point estimate while the horizontal lines stand for a 95% confidence interval. The predictors that were found to be significant are marked in green,

while red was used for the ones that were not significant. The plot shows that perceived control (B_1 = 0.30; 95% CI [0.12, 0.48]) and visibility of healthy nudge (B_1 = 0.13; 95% CI [0.02, 0.24]) are positively correlated with healthy eating.

3.2 Exercise

A multiple linear regression having perceived control and nudge intensity as predictors and exercise as the outcome variable was carried out. The scatterplot of standardized predicted values versus standardized residuals showed that the data met the assumptions of homogeneity of variance and linearity, and that the residuals were approximately normally distributed. The regression results showed that the model explained 13.9% of the variance in exercise, and that the model was significant $F(3,96) = 5.15$, $p = 0.002$. The only significant coefficient was exercise perceived control, $B_{1,} = 0.59$, 95% CI [0.29, 0.89], $p < 0.001$. The other predictors were not found to be significant: visibility of exercise nudge ($p = 0.99$) and accessibility of exercise nudge ($p = 0.85$).

The final predicted model for exercise therefore was:

Healthy exercise = 2.83 + 0.59 * exercise perceived control.

According to this model, self-reports on the exercise Likert scale averaged at 2.83 out of 5. The exercise score then increased by 0.59 for every point on the perceived control Likert scale.

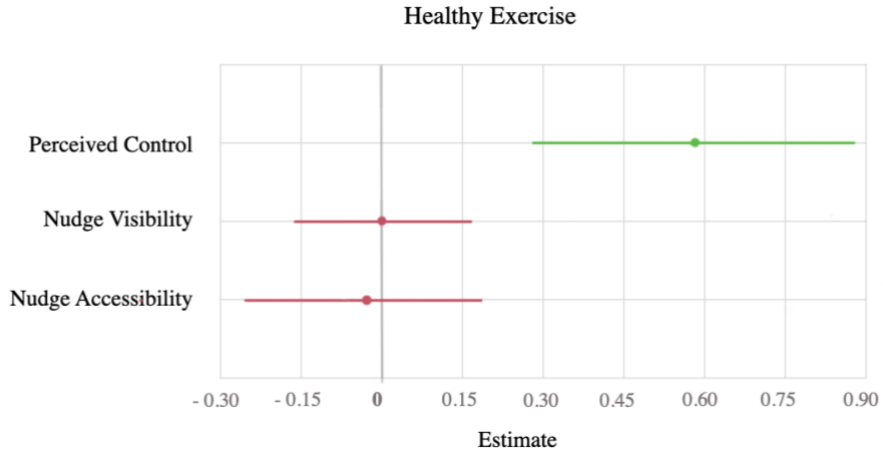

Figure 4. The dots represent the predictors' regression point estimate while the horizontal lines stand for a 95% confidence interval. The predictors that were found to be significant are marked in green, while red was used for the ones that were not significant. The plot shows that perceived control (B_1 = 0.59; 95% CI [0.29, 0.89]) is positively correlated with healthy exercise.

3.3 Exploratory Question: Does Age Have An Effect on Health Behavior?

A potentially interesting predictor of health behavior which was not considered in the main model is age. Since we are looking at a wide range of ages in our sample, it is possible that a portion of the health behavior variance can be linked back to age. Therefore, it was important to know how much of the variance in the health behavior could be explained by age alone.

A two-tailed correlation was carried out to investigate the relationship between healthy eating behavior and age. The correlation was found to be statistically significant, $r(99) = 0.36$, $p < 0.001$. These results show that 13.2% of the variance in eating behavior can be explained by age and also indicate that older participants report healthier diets than their younger counterparts. Another two-tailed correlation was run to investigate the relationship between age and exercise. The latter correlation was not found to be significant, $r(99) = 0.11$, $p = 0.27$.

3.4 Exploratory Question: Is There a Correlation between Attitude and Nudge Intensity?

As a second exploratory question, we were interested in whether a positive attitude towards health behavior is reflected in a "stronger" nudge (e.g., more visible, more easily accessible, or higher in number). Pearson correlation was used for the comparisons. No significant positive correlation was found between healthy eating attitude and visibility of eating nudge ($r = - 0.01$, $p = 0.52$), accessibility of eating nudge ($r = 0.05$, $p = 0.32$), or availability of eating nudge ($r = - 0.05$, $p = 0.70$). Similarly, no positive correlation was found between exercise and visibility of exercise nudge ($r = - 0.10$, $p = 0.83$), or accessibility of exercise nudge ($r = - 0.12$, $p = 0.70$).

3.5 Exploratory Question: Do Time at Home and Nudge Intensity Have a Shared Effect on Health Behavior?

As a third exploratory question, we were interested in understanding whether time at home could affect the nudges' influence on health behavior. In fact, time at home acts as a variable measuring the participants' time of exposure to nudges. The literature reports that the effectiveness of a nudge decreases over time, usually as a result of habituation effects (Venema, Kroese, & de Ridder, 2017). Similarly, in our study participants that spend a lot of time at home may show habituation to the nudges, with the amount of health behavior decreasing the more time participants spend at home.

An ANCOVA was run with healthy eating as the dependent variable and visibility of eating nudge, accessibility of eating nudge, and availability of eating nudge as covariates. Levene's tests and normality checks were performed, and the assumptions met. There was no shared effect of time at home and nudge intensity on healthy eating, $F(3,93) = 2.19$, $p = 0.94$.

A second ANCOVA was run with exercise as the dependent variable, and visibility of exercise nudge and accessibility of exercise nudge as covariates. Levene's tests and normality checks were performed, and the assumptions met. We found no shared effect of time at home and nudge intensity on exercise, $F(3,94) = 3.10$, $p = 0.10$.

3.6 Exploratory Question: Do Dutch and Italian Participants Differ in Health Behavior, Attitude, and Perceived Control?

A last interesting comparison concerns the different nationalities of our participants. While the English respondents include people with different nationalities, participants who set the survey language to Dutch or Italian belong to the respective nationalities. This allows us to compare Dutch and Italian participants.

European diets are as varied as the countries that are part of the EU. This was confirmed by the WHO stating that the resources available to European countries are too diverse to formulate an overarching diet. While in the 60s the diets of the northern countries reported higher fat, saturated fats and sugars compared to the southern countries, more recently northern countries reported a decrease in the same macronutrients, while an increase was found in the southern countries. This reversal trend has brought the two countries closer together in terms of diet healthiness (James, 1988). When it comes to physical exercise, some studies report differences between northern and southern countries of the EU in the activity levels and exercise attitudes of adults, with lower levels of physical activity and desire to become active reported more frequently by the southern Europeans (Kafatos et al, 1999; Haftenberger et al, 2002).

Following these studies, we ran a series of independent samples t-tests to compare Dutch (N = 24) and Italian (N = 37) participants on health behavior, attitude, and perceived control. When normality or equality of variances could not be assumed, a Mann-Whitney U-test was used instead. The results of the comparison are showed in Table 3. No significant differences were found between Dutch and Italian participants. Thus, the results of this study appear to be generalizable over northern and southern Europeans.

Variable	Test	Statistic	p-value
Eating behavior	Independent samples T-test	$t(59) = 0.74$	0.46
Exercise behavior	Mann-Whitney	$U = 558.0$	0.09
Eating attitude	Mann-Whitney	$U = 396.5$	0.48
Exercise attitude	Mann-Whitney	$U = 338.5$	0.11
Eating perceived control	Independent samples T-test	$t(59) = 1.80$	0.08
Exercise perceived control	Independent samples T-test	$t(59) = 1.31$	0.20

Table 3. Group comparisons between Dutch and Italian participants. The Bonferroni-corrected critical p-value was 0.008.

4.0 Discussion

Our hypotheses predicted that, for both healthy eating and exercise, perceived control and the three nudge types would be predictors of health behavior. However, our study found that only perceived control and nudge visibility have an effect on healthy eating, while perceived control alone has an effect on exercise. Therefore, our results only partially align with our hypotheses: nudge accessibility and availability were not found to affect healthy eating, and no nudges were found to affect exercise. Nevertheless, our study was successful in its attempt to integrate nudge theory and the theory of planned action, at least in the case of healthy eating, thanks to the observed covariate interaction between perceived control and nudge visibility. In addition, since our study looked at self-nudges, and not researcher-placed nudges, this report places itself in the growing library of self-nudging studies. Our results point to a significant effect of self-nudges on healthy eating, reinforcing the idea that self-nudges have a similar effect and function as previously studied eating nudges.

In the case of healthy eating, perceived control and nudge visibility were found to influence the participants' behavior. This finding aligns with the literature on both perceived control (Ajzen, 2015; Bogers et al, 2004) and visibility (Couke et al, 2019; Wansink & Hanks, 2013; for a review, Bucher et al, 2016). In addition, our results point towards an interesting covariate interaction between visibility and perceived control. Because in Ajzen's theory perceived control is defined as an estimate of how easily a behavior can be performed, we interpreted the interaction as nudge visibility affecting participants' perceived difficulty of healthy eating. Supporting of this interpretation is a recent review by Sunstein (2019) stating that nudges have the potential to affect the ease and convenience of a behavior. In fact, Sunstein (2015) affirms that nudges work for different reasons, "Some nudges work because they inform people; other nudges work because they make certain choices easier; still other nudges work because of the power of inertia and procrastination" (p. 2). Therefore, our study reinforces the notion that to promote healthy eating we need to focus on heightening our perceived control and making the nudges related to the healthy habits we want to establish more salient and visible. To connect this to the initial example of the bowl of fruit, the biggest change we can make to influence our perceived control and facilitate fruit-eating is placing the fruit bowl where it can be easily seen from the room where we spend most time.

Different results were found for the exercise model – the only significant predictor being perceived control. This result is aligned with the well-established pattern linking higher perceived control with an improvement in performance and behavior present both in older and newer literature (Perlmuter & Monty, 1977; Trafimow et al, 2002; Rhodes & Courneya,

2003). However, to our surprise none of the nudge predictors were found to affect exercise behavior. A potential explanation can be found in a writing by Sunstein (2017) discussing why some nudges fail while others are more successful. In his view, there are two main reasons for the failure of nudges: some nudges only produce short-term effects and become ineffective after a while, while other nudges are not clearly linked to the target behavior and therefore produce confusion in the recipients. According to this view, it could be that the results of the exercise nudges were rendered ineffective by the time occurring between the nudge and the actual behavior. In real life, this is a necessary delay since exercise sessions require planning and a reasonable chunk of time, making them not suitable to be spur-of-the-moment activities. Alternatively, it could be that some of the exercise nudges used by this study (e.g., exercise clothes and shoes) may not be uniquely linked to exercise since they could be worn for activities that have nothing to do with sport, resulting in them failing to nudge exercise behavior.

The case of exercise was only one example of how our hypotheses were not always reflected in the results. For healthy eating, out of the three nudge types chosen for this study only visibility was found to be a significant predictor. There are a few reasons for why this may have occurred. First, the way we measured nudges looked only at the room in which the participants spend the most time, not at the nudges spread throughout the house in general. Thus, it is possible that some nudges were simply not placed in the observed room and therefore could not be assessed by the survey, forcing participants to assign a score of "one" to that nudge type without giving further explanations. Second, it is a reality that people do not always have full control over where an item is placed in their house. This can happen in the instance of designated spaces and shared environments. Designated spaces occur when a nudge, because of its nature, tends to always be found in a specific space of the house. For example, a healthy nudge such as vegetables is rarely found outside the fridge because heat would cause it to spoil. On the other hand, shared environments occur in living arrangements with multiple people, where the positioning and presence of items results from a shared agreement between cohabitants.

4.1 Generalizability and Future Directions

It is important to note that, while our study looked at people of different nationalities, when testing differences between Dutch and Italian participants the groups were found to be comparable in terms of health behavior, perceived control, and attitude. Therefore, our study appears to be generalizable to both northern and southern European countries.

Our results point towards an interesting covariate interaction between visibility and perceived control. Future studies may want to look at direction of this relationship. A first possibility is that visibility is affecting behavior by modifying the perceived control in performing the nudged activity. For example, having a healthy snack well visible on the desk near us may make the healthy eating look easier that if the healthy snack was in a non-visible cabinet. A second possibility is that the relationship is reversed – it is the apparent ease of an activity that makes it more likely for a nudge to be positioned in a location that makes the nudge more visible and accessible. Either way, powerful conclusions can arise from further investigation of the direction of this relationship. In addition, further research should focus on whether intention is correlated with nudges. In this case, intention means having a concrete plan to carry out a behavior – for example, being determined to exercise for at least 75 minutes in a week. It is possible that, rather than attitude, it is intention that is correlated with nudge strength. Furthermore, it would be interesting to investigate whether the effectiveness of healthy nudges is dependent on a pre-existent intention to behave according to health standards. Lastly, a positive correlation was found between healthy eating and age, meaning the diets of older participants were on average healthier than the diets of younger participants. We did not consider age as a predictor when building our regression model for healthy eating, but we suggest further research takes into account the aforementioned effect.

4.2 Conclusions

In conclusion, this study demonstrates that, for healthy eating, the most helpful solution to implement healthy habits is a combination between a ‘can-do’ attitude and heightened salience of a relevant nudge. In particular, self-nudges were effective precursors of healthy eating. This study demonstrates that an integration between Ajzen’s theory and nudge theory is possible, opening the doors for a more comprehensive look at heath behavior. A greater understanding of the application of self-nudges in home environments may provide, on a theoretical level, a more comprehensive theory of health behavior, and on the practical level, an effective framework for the common people to restructure their homes in a way that facilitates their eating and exercise goals, especially in situations which limit the freedom of movement such as the restrictions imposed by the Covid-19 pandemic.

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Appendix
Survey Sections and Items

Note: questions marked with /R were subject to reverse scoring.

Nudge intensity level questions

In this section, I will ask you some questions about a few items you may have at home.

When prompted, choose one item from a list. The item has to be something you have at home.

*Then you will **answer a few questions for the chosen item.***

*If you own more of one item from the list, choose the one you **use most frequently**.*

*In the questions, **X** stands for the item of your choice.*

Healthy snacks (dried nuts, fruit)

I can see X from the room of the house I spend most time in.
I can reach X by opening the number of doors indicated below (including cabinet doors).
More than 2, 2, don't know/can't answer, 1, 0
I am afraid of running out of X.

Healthy meal components (legumes, vegetables)

I can see X from the room of the house I spend most time in.
I can reach X by opening the number of doors indicated below (including cabinet doors).
More than 2, 2, don't know/can't answer, 1, 0
I am afraid of running out of X.

Sport clothes (sport jackets and shirts, sport pants)

I can see X from the room of the house I spend most time in.
I can reach X by opening the number of doors indicated below (including cabinet doors).
More than 2, 2, don't know/can't answer, 1, 0
I am afraid of running out of X.

Sport shoes

I can see X from the room of the house I spend most time in.
I can reach X by opening the number of doors indicated below (including cabinet doors).
More than 2, 2, don't know/can't answer, 1, 0

Sport equipment (weights, balls, skates, bikes)

I can see X from the room of the house I spend most time in.
I can reach X by opening the number of doors indicated below (including cabinet doors).
More than 2, 2, don't know/can't answer, 1, 0

Perceived control questions

In this section, I will ask you about your opinions on dieting and physical exercise through a series of statements.

*You will rate, on a scale from true to false, **how much each statement reflects your opinion**.*

I believe anyone can learn how to follow a healthy diet.

I believe anyone can work out regularly.
I have the right mindset to follow a diet.
I have the right mindset for regular physical exercise.
If you are tight on money, you'll have a hard time following a healthy diet. /R
If you are short on time, it will be difficult to follow a healthy diet. /R
If you don't have the right body type, you'll have a hard time benefiting from a diet. /R
If you are tight on money, you'll have a hard time exercising regularly. /R
If you are short on time, you'll have a hard time exercising regularly. /R
If you don't have the right skills, you'll find regular physical exercise hard. /R

Health behavior questions

In this section, I will ask you about your eating and exercising habits through a series of statements.

You will rate, on a scale from true to false, ***how much each statement reflects your experience***.

In the past two days…
- I have eaten vegetables at every meal.
- I have eaten legumes at least once.
- I have eaten nuts as a snack at least once.
- I have eaten fruit as a snack at least once.
- I have eaten pastries as a snack at least once. /R
- I have eaten candy or chocolate as a snack at least once. /R
- I have eaten chips as a snack at least once. /R
- I have done a light physical activity (such as walking) for less than an hour total. /R
- I have done a physical activity raising my heartbeat for at least an hour total.

I consider my lifestyle generally unhealthy. /R
I consider my food choices to be healthy.
I am satisfied with I much I move my body daily.

Attitude questions

In this section, I will ask you about your opinions on eating and exercising through a series of statements.

You will rate on a scale from true to false ***how much each statement reflects your opinion***.

I believe eating vegetables and legumes is important to live a long, healthy life.
I believe eating vegetables and legumes plays no role in preventing illnesses. /R
I consider nuts to be healthy snacks.
I consider fruit to be a healthy snack.
I believe there are some types of foods that make your body feel healthy.
I believe regular physical exercise plays no role in how long you live. /R
I believe regular physical exercise is important to prevent illnesses.
I believe regular physical exercise makes you feel tired and sore. /R

Personal questions

As the last portion of this survey, I will now ask you some personal questions.

Age
What is your employment status?

Student – employed – unemployed – retired

What is your gender:

Male – female – nonbinary

How many people do you currently live with?

How much time do you spend at home every day?

No time – a few hours – half my day – most of my day – all day

How often do you decide what you want to eat?

Never – sometimes – everyday

What is your country of residence?

Is your job involved in food or sports industries?

If yes, specify…

Do you think any of your personal conditions has influenced any of the answers you have given?

Yes

No

If yes, please specify your condition…

Physical or mental disability

Eating disorder

Special conditions at home

Being on a special exercise regimen or diet

Other