Explorations in Digital Nudging for Online Food Choices

Research-in-Progress

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Abstract

People increasingly seek for inspiration and make food choices using online recipe sites. Since the most popular recipes are often not the healthiest ones, the goal of our research is to nudge users towards healthier choices. Existing literature shows that digital nudging can be effective in this domain, but it often remains open if the observed effects are due to the specific way the nudge is implemented. In our research in progress, we examine the effectiveness of different nudges through user studies (N=225). Our results indicate that (a) not all types of popular nudges like setting defaults are necessarily effective, (b) that a hybrid nudge that in addition leverages social information is effective across food categories and (c) that considering ingredient information when nudging is promising to influence user decisions. Our results imply that various implementation alternatives should be explored to maximize the effects of digital nudging.

Keywords: Digital Nudging, Psychological Aspects of HCI, Consumer Behavior

Introduction

Food-focused social networks such as *allrecipes.com* are an increasingly popular source for online users looking for cooking inspirations. Previous analyses however show that the most popular recipes on the site are not the healthiest ones (Elsweiler et al. 2017). Unfortunately, these popular recipes are those which are frequently surfaced through search and recommendation functionalities on the site and which may thus receive increased attention through mere exposure. Given the persuasive potential of such search and recommendation functionalities in general (Yoo et al. 2011), the suggested recipes might therefore lead to unhealthier eating behavior of users.

Digital nudging (Meske and Potthoff 2017; Mirsch et al. 2017; Weinmann et al. 2016), which transfers the ideas of *nudging* (Thaler and Sunstein 2008) to the online world, has shown to be a promising tool to influence the decision-making behavior of users in a predictable direction. Importantly, this influence can be exerted without forbidding any of the available options and without significantly changing the economic incentives for individual options. A number of success stories of applying nudging in the physical world exist, including a prominent study that aimed at enticing healthier food choices in a university canteen (Chapman and Ogden 2012). There is also an increasing number of studies on digital nudging, including also the food domain (Elsweiler et al. 2017; Forwood et al. 2015; Lee et al. 2011). With the work of Elsweiler et al. (2017), for example, the authors showed that an appropriate choice of the food images on an online recipe site could influence users' choices towards healthier options. In other works, various other changes to the user interface were explored, including the setting of defaults (Lee et al. 2011) or highlighting (Turland et al. 2015).

Generally, the design space for digital nudges is rich (Caraban et al. 2019; Weinmann et al. 2016). Moreover, various alternatives may exist how to implement a nudge in the user interface (UI). Thus, the question arises to what extent the choice of the particular nudge and its implementation in the UI matter, i.e., if certain nudges are more effective than others for a given problem. Actually, some works exist that report that some digital nudges that were evaluated in user studies were not as effective as expected, e.g., (Forwood et al. 2015; Esposito et al. 2017).

Our ongoing research aims at understanding the finer details regarding the design of digital nudges, with a particular focus on the food and health domain. Ultimately, our goal is to design nudges that help a user make better choices, both in general choice scenarios where the order of the presented options carries no relevant information, and in scenarios where digital nudges should be combined with relevance-ordered recommendations, as recently discussed by Jesse and Jannach (2021).

To that purpose, we conducted two consecutive user studies (N=225), where participants were tasked to make food choices in different categories, and where the UI of the treatment group was enhanced with different nudges. The results of the first study revealed that not all nudges were equally effective and that a hybrid nudge that combines general social information with a default setting was particularly promising. In the follow-up study, we validated that the effectiveness of this hybrid nudge is not confined to a particular type of food. Moreover, in the first study, we found that a "semantic" nudge that warned participants about specific nutrition properties of the chosen option in around 40% of the cases stimulated them to revise their choices.

Overall, our work has immediate practical implications. First, it provides indications for practitioners regarding which types of nudges work in the food domain. Second, it emphasizes the importance of exploring different alternatives, also on the finer-grained level, when designing digital nudges.

Related Work

Research interest in digital nudging is continuously growing in recent years. Recent overview works, literature reviews, taxonomies of nudges, and design guidelines can for example be found in (Caraban et al. 2019; Jesse and Jannach 2021; Meske and Potthoff 2017; Mirsch et al. 2017; Mirsch et al. 2018; Schaer and Stanoevska-Slabeva 2019; Schneider et al. 2018; Weinmann et al. 2016).

In parallel, various studies on the effectiveness of digital nudging in various application domains were published in the past few years. The domains of food and health, which is the focus also of our work, are a common target for such studies. In one of the earlier works in that area, Lee et al. (2011) explored how insights from behavioral economics can inform the design of human-computer interfaces. Specifically, they explored to what extent present-based preferences, asymmetrically dominated choices and the default bias—as done in our work—can be leveraged to stimulate healthier choices by the study participants. Differently to our work, they found that setting a default was very effective.

In a more recent work in that area, Elsweiler et al. (2017) explored, among other aspects, if the provided food images may help influencing consumers' food choices towards the healthier option. In the last of several studies in (Elsweiler et al. 2017), study participants were tasked to choose between dishes based on provided images. The authors could show that a proper (automated) selection of food images can actually nudge users to a significant extent to the recipe with the least fat. We see the use of images as nudges as a promising area—see also recent work on artwork personalization at Netflix (Amat et al. 2018)—but beyond the scope of our current research. In contrast to the work of Elsweiler et al. (2017) our work also aims at exploring the effectiveness of different types of nudges.

Finally, another work on stimulating healthier food choices is presented in Forwood et al. (2015). In their study, participants were tasked to fill a shopping basket in an online supermarket using a given list of items. At different intervention points, e.g., at checkout, the system then proposed alternative, less energy-dense replacements for the items in the shopping basket. The work is only marginally related to ours, because the intervention was aimed to propose rational alternatives, whereas we focus on nudges,

which are not necessarily emphasizing on rational choice processes. One similarity of their and our study however is that not all interventions were effective, pointing to the problem of designing effective nudges.

Other societally important domains where digital nudges were previously explored include energy conservation, pro-environmental behavior or sustainable consumption (Demarque et al. 2015; Henkel et al. 2019; Starke et al. 2020, Székely et al. 2016). Starke et al. (2020), for example, explored to what extent different nudges are effective to convince users to adopt a proposed energy-saving measure. Similar to our work, their study revealed that not all nudges were effective as hypothesized. Székely et al. (2016) conducted an experiment where participants were stimulated to donate for the carbon emissions caused by a (virtually) booked flight with a default nudge, and the study showed that setting higher pre-selected values as defaults was actually effective. Differently from our work, where the default is binary, the default setting in their study might be based at least partially on an anchoring effect.

The use of digital nudging was finally also explored in business-oriented scenarios. Eigenbrod et al. (2018) for example proposed to examine to what extent nudging can help to increase users' trust in targeted ads and reduce privacy concerns. To our knowledge, no results are however yet available for the proposed study. Huang et al. (2018) finally investigate how nudges can stimulate users to share more on social networks. While the topic of their work differs from ours, their research shows that not all types of nudges are equally effective. This was attributed to an inappropriate design of some of the implemented nudges. Moreover, in their randomized field test they even found that some nudges could even have negative effects, a phenomenon that we did not observe in our experiments. A comparable result was found by Bammert et al. (2020). They investigated the use of nudges to mitigate the shortcomings of business process improvement methods. Their study led to conclusions that were similar to those of Huang et al. (2018) in the sense that the implemented nudges had various levels of effectiveness and could even result in a negative effect.

Study Design

To assess the effectiveness of different nudges, we conducted two consecutive studies using a specifically designed web application. Participants were first tasked to select three out of five food categories based on their preference within the application. In each category, they were then presented a selection of recipes and had to select exactly one, which they would like to try out (i.e., each participant selected three recipes overall). Furthermore, participants were asked for *each* displayed recipe to what extent they find it attractive, using a 7-point Likert scale from *very unattractive* to *very attractive.* Before moving to the next category, they were asked to provide a short free-text explanation of their choice and to give feedback on the perceived choice difficulty and their decision confidence using Likert-scale items.

Experiment Specifics

Study-1 was based on a within-subjects design. The application was identical for the treatment and control group, except that digital nudges were present for exactly one recipe per category in the treatment groups. Specifically, for each category (e.g., pasta, fish), one of the five different nudges that were considered in our work was applied. We tested the effectiveness of the following five nudges. The selection was done in a way to cover a diverse and popular set of nudges from the literature.

- *Setting Defaults:* The default nudge is a prime example for digital nudging in the literature, see, e.g., (Meske and Potthoff 2017; Weinmann et al. 2016). The assumption is that subjects will have a certain tendency to choose an option in case it is pre-selected. In our application, the radio button for selecting the chosen recipe was already set.

- *Highlighting:* This nudge consists of increasing the salience of one option (Caraban et al. 2019). It was also used as a means to direct user attention within news feeds in (Waldner and Vassileva 2014). In our study, one recipe was highlighted with a different background color.
- *Social Nudging:* Social nudges are based on different psychological phenomena, e.g., that people follow the crowd or obey social norms. In our application, we added the static text "90% of people liked this" to one of the recipes.
- *Hybrid (Social/Default)*: To assess if there is a cumulative effect of nudges, a hybrid nudge was implemented for one food category. The nudge consisted of both pre-selecting one option and the social nudge.
- *Warning*: Finally, we considered one "semantic" nudge, which used knowledge about the recipes themselves (nutrition information). This nudge also stands out from the others, as the goal is not to increase the chances that a desired option will be chosen, but to nudge participants to make a *different* choice. The nudge was applied in the category of desserts, which consisted of options that either had lots of calories or contained alcohol. Whenever a participant made their initial selection in the application, a warning was presented, either regarding the calories or the alcohol in this dish.

In terms of the particular options, we selected five popular recipe categories as found on *allrecipes.com*: vegetarian, pasta, fish, sandwiches and desserts. For each category, we selected six[1] of the most popular recipes from the same food website, ensuring that no two recipes are very similar. The order of the recipes in each category, the order of categories to choose from, and the combination of category and nudge were kept constant during the experiment. In each category, the nudge was always applied to the second recipe in the list. Keeping this factor static allowed us to rule out possible positional effects. After the participants made a selection in all three categories, they were forwarded to a post-task questionnaire, where they were asked, among other aspects, about their demographics, their interest and experience in cooking and their perception of the choice process. The overall flow of the experiment is sketched in Figure 1. A screen capture of a recipe choice page with the hybrid nudge is provided in Figure 2.

In *Study-2*, everything was the same as in *Study-1*, except that another set of participants was exposed to the most effective nudge of *Study-1*, which was the hybrid one, in all categories. Overall, with these two studies, we could avoid the need for a full factorial design (categories x nudges) within our research in progress, but could still examine if the most effective nudge in one category would be consistently effective across categories.

Experiment Execution

We recruited participants through the crowdsourcing platform Amazon Mechanical Turk. We only invited crowdworkers who had a track record of past successful tasks, evidenced through a "HIT approval rate" of at least 80%. To further increase the reliability of the obtained responses, we implemented an *attention check* in the post-task questionnaire, where participants were asked to select one specific answer option. Based on this check, we excluded the results of more than one third of the 353 crowdworkers as being potentially unreliable, leaving us with 225 participants. Of these, 139 were in the treatment group and 86 were in the control group. On average participants needed about 21 minutes to accomplish the task.

[1] In a pretest we experimented with 10 recipes per category, but saw indications that the choice effort for participants might be quite high with 10 options. Choice effort was not in the focus of our study.

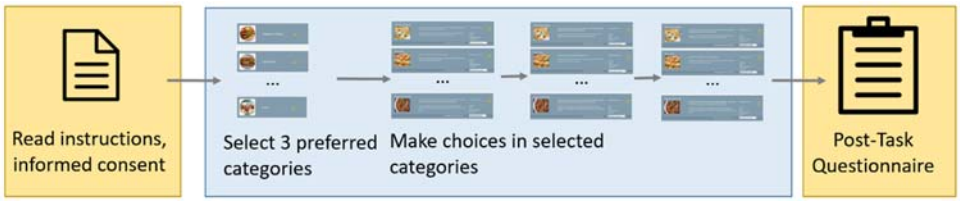

Figure 1. Overview of the Experiment Flow

From the 225 participants, 83 (37%) were female and 142 (63%) were male. The most frequent age group was "*between 26 and 35*". When asked for their cooking skills, the average response was 5.6 (on a scale from 1-7), indicating that participants, on average, should be able to make recipe choices with some confidence.

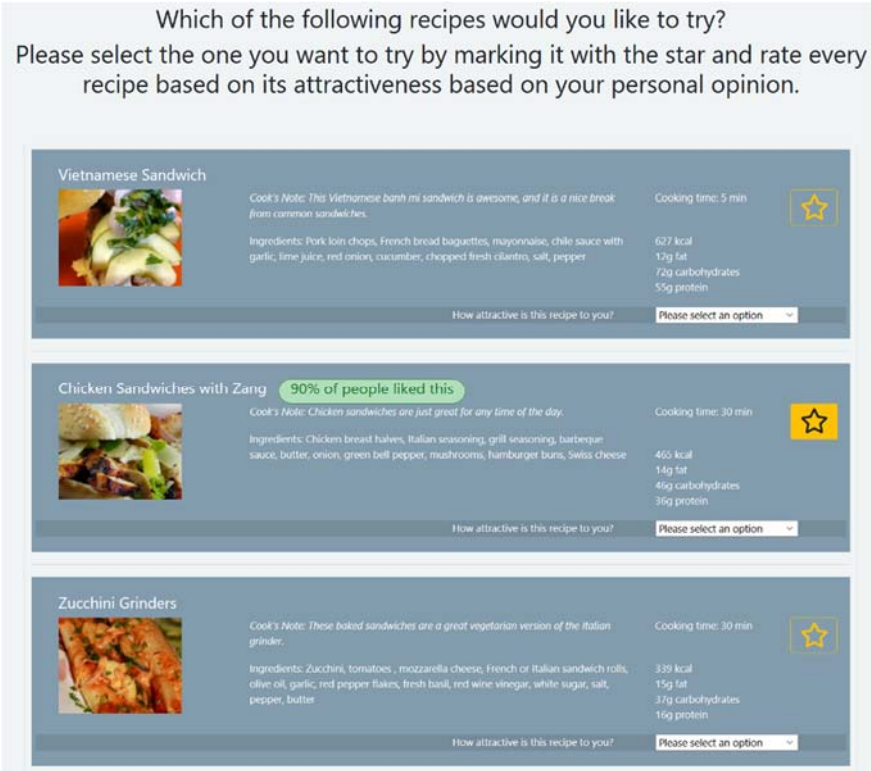

Figure 2. Recipe Selection Page with Hybrid Nudge (not all options shown)

Results

Table 1 shows the outcomes for the four different "positive" nudges, where we—based on the initial random assignment—used highlighting for the vegetarian dishes, the default nudge for the pasta recipes, the social nudge for the fish, and the hybrid, consisting of the default and the social nudge, for the sandwiches. Remember that we used the "negative" *warning* nudge for the desserts, which we discuss separately later.

Table 1 first shows how many decision situations (choices) there were for each category. Keep in mind that each participant made three choices and was allowed to select the categories by themselves (out of five). In the column "Nudged Item Selected", we show how often the nudged item was selected in the treatment group. 24.1% of the participants for example selected the nudged vegetarian dish. On the right-hand side, we report the decision behavior for the control group. In the column "Target Item Selected", we see how often the item that was nudged in the treatment group was chosen. Remember

that this was always the second item in the list, because the order of items was kept constant after initial randomization as described above.

			Treatment Group			Control Group			
	Category	Implemented Nudge	Decision Situations	Nudged Item Selected	Nudged Item Selected (%)	Decision Situations	Target Item Selected	Target Item Selected (%)	Chi-Squared Test (p<0.05)
Study 1: Different Nudges	Vegetarian	Highlighting	58	14	24,1%	50	9	18,0%	0,692
	Pasta	Default	51	18	35,3%	54	14	25,9%	0,576
	Fish Dishes	Social Nudge	47	11	23,4%	43	6	14,0%	0,495
	Sandwiches	Hybrid Nudge	66	36	**54,5%**	57	12	21,1%	**0,017**
Study 2: Hybrid Nudge	Vegetarian	Hybrid Nudge	28	15	**53,6%**	50	9	18,0%	**0,032**
	Pasta	Hybrid Nudge	29	19	**65,5%**	54	14	25,9%	**0,036**
	Fish Dishes	Hybrid Nudge	35	18	**51,4%**	43	6	14,0%	**0,011**
	Sandwiches	Hybrid Nudge	31	19	**61,3%**	57	12	21,1%	**0,019**

Table 1. Effectiveness of Different Nudges (*Study-1 and Study-2*)

We can see that in all categories the nudged item was more frequently chosen than in the control group. Across all four categories, the nudge item was chosen in around 36% of the cases. In the control group, around 20% selected the second item. This is slightly higher than the 16.7% that we would expect if each of the 6 items were chosen with equal probability. The observed value in the control group might be a random variation or due to a position bias.

Comparing the increases in the individual groups with a Chi-Squared test with $\alpha<0.05$, we find that the differences between treatment and control are statistically significant only for the hybrid nudge ($X^2(1)=5.6768$, $p=0.017$). Here, the probability that the nudged item was selected was more than twice as high as for the control group. To validate that this high effectiveness of the hybrid nudge is not tied to the sandwich category or the particular set of options in this category, we conducted *Study-2,* where we used the hybrid nudge for all categories. The results will be discussed below.

Looking at the results for the "negative" (warning) nudge, we had 45 decision situations in the treatment group. In these 45 cases, we found that in 20 of them (44.4%) the participants changed their decision after the warning was shown to them. In 75% of these cases, their final choice fell on a dish which either contained less calories or no alcohol, depending on the content of the nudge. Overall, we observed that the warning nudge can be an effective means to influence the decision behavior in the food domain. Note that we cannot compare the findings for the treatment group with the control group as done in Table 1, because we are not actively promoting one selected item, but are rather interested to see if users change their decisions after being nudged.

In *Study-2,* we applied the hybrid nudge in all food categories and we recruited additional crowdworkers (N=50 after excluding non-attentive workers). We report the decision behavior of this group in Table 1. The results show that the hybrid nudge was effective in all categories. On average, the nudged item was selected in about 58% of the cases, again given 6 options. Comparing the decision behavior with the control group---remember this is the same as in *Study-1*—as nothing was changed except the specific nudge, we found all differences to be statistically significant with $p<0.05$ according to a Chi-Squared test.

Looking at the negative nudge, which was also included in *Study-2* to have identical conditions, we found that around 37% of the participants changed their decision after being presented with a warning. This result is well aligned with the observations from *Study-1* above.

Contributions and Next Steps

Our ongoing research contributes to the growing knowledge in digital nudging, highlighting (a) that the choice of the nudge matters in the food domain and (b) that a combination of different mechanisms, in our case defaults and social information, can be key to the effectiveness of a nudge. In our current

explorations, we collected several types of additional data (e.g., regarding cooking experience, or choice difficulty), which we plan to explore in our immediate next steps.

For these analyses, we will systematically examine the conditions under which nudges are most effective to promote healthy food choices. Comparing our results to those by Lee et al. (2011), we see that our default nudge alone was not as effective as reported in their work. One reason for that might be that their implementation required from users more effort to choose non-nudged items. This can be specifically seen in their experimental setting, where the layout of the options was changed in the condition with the default (requiring users to press buttons to see all items), which might have affected their outcomes.

As another example, in *Study-2* we found that female participants were much more likely to choose the nudge item as male ones (77% vs. 51%). This effect was not very pronounced in *Study-1* (38% vs. 34%). The population of female participants in *Study-2* (N=50, with 12 women) is too low to make reliable conclusions. Still, the observations indicate that this question of gender differences might deserve more attention in our future work.

Regarding research limitations, note that we so far have mainly focused on nudges that were often explored in other domains. As such, the selection of nudges in our initial research was mainly based on what worked before and less on theoretical considerations that are specific to the food domain. Only the "warning" nudge in our experiments was based on nutrition information, as this seemed an important aspect in food-related previous works. Furthermore, remember that the specific nudge implementation in our present study may have affected the observed outcomes. It therefore has to be further investigated to what extent the results are specific to the used design and implementation. In our future work, we plan to select and design nudges for the specific problem at hand and therefore consider previous theoretical and practical insights regarding how people make choices that relate to their personal health. Moreover, we will apply and evaluate existing design frameworks for digital nudges in this ongoing process.

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