Improving Digital Nudging Using Attentive User Interfaces: Theory Development and Experiment Design

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Abstract. Digital nudging is building on the nudging concept established by behavioral economics. Although nudging and digital nudging have received increasing attention from academia and practitioners, there is evidence that it might be less effective than expected. This lacking effectiveness is in part due to not noticing and cognitively processing the digital nudge. Thus, more invasive methods are needed, and we suggest that using attentive user interfaces based on eye-tracking technology can further enhance the impact of digital nudges. These will be particularly effective when users would have missed out on certain digital nudges presented on the user interface. Hence, we propose a design science project with a focus on the evaluation phase which includes the theoretical underpinning as well as an experimental design of attentive user interfaces for digital nudges. Thereby, we build on an e-commerce context and suggest giving customers, that do not recognize a digital nudge, interactive real-time feedback. Our artifact can be used by practitioners to improve the usability of digital interfaces.

Keywords: Digital Nudging, Attention Awareness, UI, Design Science

1 Introduction

The concept of nudging [1] is receiving increasing attention from academia and practitioners. Numerous studies have implemented nudges in energy, environment, or health (e.g. [2, 3]) and even the 2017 Nobel prize in economics has been awarded to Richard Thaler for his work in behavioral economics. Digital nudging has been the latest development of the nudge theory [4]. It describes “the use of user-interface design elements to guide people’s behavior in digital choice environments” [4]. Nudging has also reached policy making by various “nudge units” in Western societies (e.g. [5]).

Yet, nudging is not always effective. From a systematic literature review, we identified at least twenty studies that report no or only mixed results (e.g. [6, 7]). For instance, Fellner et al. [6] aimed to increase law compliance, but only one out of three intervention was successful. We hypothesize that the missing effects might in part be due to not noticing and cognitively processing the nudge. To support this hypothesis, we report on findings from a recent eye-tracking study that included processing digital nudges. In the study, participants were asked to choose a sales channel to contract a student loan. A green box contained a digital nudge with additional information on the security features of the online channel. Thereby, we tried to nudge participants towards the online channel by showing such security-related features. While one participant (left side) noticed all available information, another one (right side) read the instructions but jumped directly to the channel choice without noticing the intervention. Such failure can be explained by inattentional blindness [8]. This type of blindness refers to the failure to notice fully visible content on the UI because the user's attention was engaged with another object.

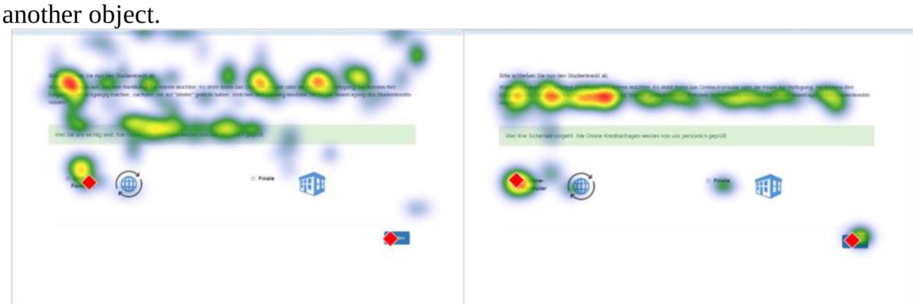

Fig. 1. Eye-tracking screenshots of participants noticing the digital nudge and not noticing it.

To improve the perception of digital nudges, the cognition of it has to be improved. To do so, several options are possible. Among such options, we suggest using attentive UIs [9–11], that recognize whether participants have noticed all available information. Eye-movement data are known as a source for studying visual attention and perception of the users [12]. Thereby, using eye-tracking devices and monitoring the visual behavior of the users in real-time can be used to detect inattentional blindness on UIs. This information is used as an input for attentive UIs and designing interactive elements to correct such failures. Such elements are in line with the definition of nudging as they do not forbid any options. Designing a feedback mechanism supports the users to improve their visual behavior, to recognize the nudge, and to gain trust in the system.

The constructs of trust and risk are major determinants of channel choices (e.g. [13, 14]), and companies often provide important security information, e.g. through seals, on the online channel. Similar to Kim et al. [13], we assume that these constructs are affected by such security information. Hence, the attentive user interfaces are especially helpful in a risk and trust context, and they will support the user in detecting such seals. We propose an experimental design to answer the following research question:

***RQ**: How to design feedback mechanisms in attentive user interfaces to enhance the perception of digital nudges, and to improve (reduce) the Internet trust (perceived risk) of the digital financial service?*

To answer the research question, we aim to conduct a laboratory experiment in a German university lab. Thereby, we follow the design science research (DSR) approach suggested by Kuechler and Vaishnavi [15]. We aim to design attentive user interfaces giving feedback to enhance the perception of digital nudges. To test whether the attentive user interface makes a difference, we measure the digital nudge perception and further constructs of the e-commerce website. For researchers, we contribute to an extension of the current digital nudging approach by going beyond the pure focus on user interface design elements. Practitioners can benefit from our approach by getting insights on how to design an attentive user interface in an e-commerce context and whether this technology is applicable for their context.

2 Theoretical Foundations

Nudging [1] has proven to be effective in a variety of online contexts (e.g. [7, 16]), Potentially for this reasons, IS researchers have developed an own theory on digital nudging [4, 17]. Currently, there is a growing stream of conceptual papers on digital nudging. These papers encompass literature reviews [18], research-in-progress papers, mainly on experimental designs or with preliminary results, or policy papers [19].

Studies on (digital) nudging have already been conducted in a risk and privacy context [20, 21]). This context is particularly applicable as it is one of the main inhibitors of digital channel usage and online shopping [14]. Therefore, it is promising to look deeper into the definitions and mechanisms of important constructs in this context, such as perceived risk and Internet trust. *Perceived risk* can be defined as “a function of uncertainty about the potential outcomes of a behavior and the possible unpleasantness of these outcomes” [22] and it has been studied by various researchers in the past (e.g. [22, 23]). On the other hand, *Internet trust* can be defined as “trust beliefs reflecting confidence that personal information submitted to Internet websites will be handled competently, reliably, and safely” [24]. Both items are established in the e-commerce and IS context (e.g. [13, 24]) and are thus a reliable instrument to measure the success of the feedback mechanism. For example, Kim et al. [13] use trust as one of the main predictors of the intention to purchase online.

Intelligent User Interfaces (IUIs) are known as UIs that utilize user’s relevant data to support the efficiency and effectiveness of them [25]. As we are moving towards a data economy, the importance of such systems increases, especially on the Internet [26]. Moreover, the attention of the users is known as the scarce resource and the importance of managing users’ attention in discussed as the theory of attention economy at the beginning of 2000 [27]. Attention-aware systems are known as a class of IUI in which they are sensitive to the attention allocation of the users [9, 10], and have the goal to support users avoiding attentional failures in digital environments [28]. Feedback mechanisms are a common nudge and researchers have used them, for instance, to raise awareness of the data collected by smartphone apps [20].

3 Method and Artifact

This project is structured based on design science research (DSR) methodology following Kuechler and Vaishnavi [15] by focusing on the first design cycle. As the first step is to get aware of the problem, we conducted a literature review in addition to the eye-tracking study (see above). The results from the conducted literature review supported us to get an overview of the topic as well as to identify research gaps. Additionally, the results from it show the existence of inattentional blindness with regard to the nudges on the UI. In the suggested phase of the first design cycle, we identified meta-requirements and, based on them, proposed theory-grounded design principles for designing attentive user interfaces. In this step, we classified the design principles based on the existing orientations suggested by Chandra et al. [29]. Next, we consider the development of this system by integrating eye-tracking devices and respective technologies.

Finally, we plan to evaluate the design of this system in a lab experiment. Currently, we are in the evaluation phase and this paper is focused on presenting the plan for conducting the lab experiment to evaluate the proposed design for attentive UIs.

As a first design principle (DP1), we consider designing an artifact that is sensitive to the attention of the user by utilizing eye-tracking technology. To reach this purpose, we use an existing eye-tracking technology, and collect the gaze position of the user in pre-defined area of interest. By utilizing this technology, the system provides the functionality for detecting the visual attention of the users in real-time. Therefore, it is considered as material-oriented DP. Furthermore, the artifact consists of a feedback mechanism that gives the users the hint that they might not have processed all relevant information and forces them to go back to the choice (DP2). As this DP describes both material properties (provide feedback) and objects (to make users aware of what they missed), it is considered as action- and material-oriented DP. Finally, the digital nudge will be highlighted as soon as the user returns and enable the user to notice the missed information (DP3). This is considered an action-oriented DP (see also Figure 2).

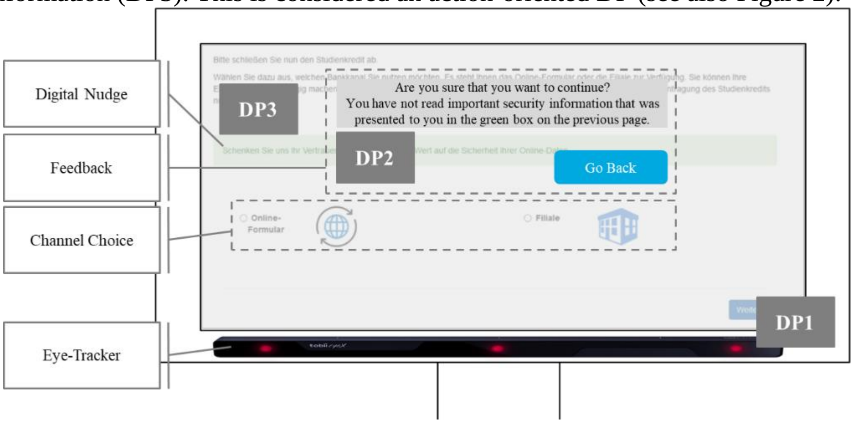

Fig. 2. Instantiation of an attentive user interface to improve digital nudging.

4 Evaluation and Experimental Design

To evaluate the design principles, we derived several hypotheses. The first hypothesis starts from the idea that the feedback mechanism increases the perception of the digital nudge. As the digital nudge provides additional security information, the increased perception will also impact the perceived risk and the Internet trust of the online channel. This is supported by earlier studies that experimented with feedback mechanisms to improve the object perception [30].

Hypothesis H1: *Participants that do* ***not notice*** *the digital nudge initially but received* ***feedback*** *will have a higher digital nudge perception compared with participants that do* ***not notice*** *the digital nudge and do* ***not*** *receive any* ***feedback****.*

Hypothesis 1 is based on the assumption that digital nudging makes a difference. Therefore, we also compare whether the digital nudge itself is working and claim that additional security information will benefit the properties of the online channel [31].

Hypothesis H2: *Participants that* ***notice*** *the digital nudge and receive* ***no feedback*** *will have lower perceived risk and a higher Internet trust compared with participants that do* ***not notice*** *the digital nudge and do* ***not*** *receive any* ***feedback****.*

The hypotheses are synthesized in a research model (see Figure 3).

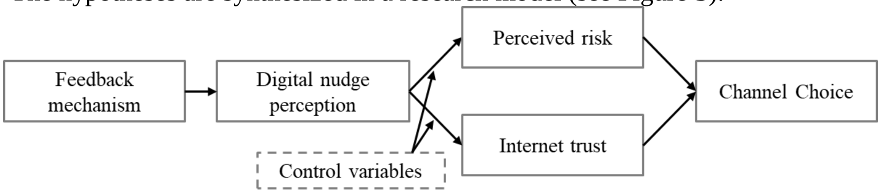

Fig. 3. Research model.

To test the hypotheses, we designed an experiment which will be conducted in a German university laboratory in 2018. The participants are part of the lab pool and they are invited by E-mail to take part in the experiment. The pool comprises mainly, but not exclusively, students of a large German university. To become a member of the pool, interested individuals can self-register themselves and they are given a compensation for their participation in the experiment.

Note that it is not possible to randomly assign the participants to the experimental groups based on their demographical characteristics. Instead, their group membership will depend on whether they notice the nudge (see Table 1). If they notice the digital nudge, they are assigned to group 1 as a feedback is not needed. If they do not notice it, the assignment to group 2 and 3 is random. Hence, we will have three groups in total.

We plan to invite 210 participants to participate in the experiment (70 participants per group). To calculate the group size, we utilized G*Power 3.1.9.2 [32], and conducted an a-priori test. Assuming a medium effect size ($f^2 = 0.25$) and a significance level of 0.05 for a sufficient statistical power (about 0.85) [33], a minimum total sample size of 197 participants is needed.

Table 1. Overview of experimental groups

Groups	**Receiving feedback**	**No feedback**
Notice digital nudge initially	n/a	Group 1
Not notice digital nudge initially	Group 2	Group 3

The experimental process is divided into four steps. Firstly, the participants are presented the general instructions about the experiment with information on context, timing and payout. Next, the participants browse a regular e-commerce website. In the buying stage, the participants have to purchase products and services. Thereby, they received a digital nudge and, depending on their experimental group, a feedback. Finally, the dependent variables and the control items are estimated with an online survey.

The channel choice will be measured using the binary choice between the online channel and the branch. Perceived risk based on Kim et al. [13] while Internet trust is based on Dinev and Hart [24]. We use the gaze duration to calculate whether the users noticed the nudge. A threshold value for this duration will be determined in a pre-test. Moreover, we use items of object perception [30] to determine the nudge perception.

Further, we estimate demographics and other control constructs such as focused attention [34], internet usage, online banking usage (both [35]), as well as perceived benefits and consumer disposition to trust (both [13]).

For the data analysis we use structured equation modelling (SEM). Generally, SEM can be divided into the covariance-based and the variance-based methodologies [36]. The first is usually theory driven and focuses of confirmatory research objectives while variance-based approaches are more predictive, data-driven and primarily exploratory [36]. Therefore, we will use a variance-based approach using SmartPLS 3.0.

5 Conclusion and Outlook

This study outlines the theoretical development and experimental design for an attentive user interface. It contributes to existing research by theoretically extending the concept of digital nudging to go beyond simple design changes in the user interface. In the taxonomy of Gregor and Hevner [37], our study is considered as an improvement as the solution maturity is low but the application domain maturity is high.

This study has some limitations. Foremost, we have not conducted the experiment yet and thus we cannot be certain, whether the attentive user interface makes any difference. In addition, our sample will not be representative for the German Internet population as it consists mainly of students. In addition, each laboratory experiment is operating in a controlled environment which limits the generalizability of the results.

Hence, future studies could replicate our approach in different contexts and using even more elaborate measures of user-interfaces. Moreover, it is promising to examine whether too much attention might trigger counter-effects in the user (e.g. defiance).

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