Do nudges work? Using personal normative message in mHealth intervention to dissuade from physical inactivity

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Abstract. Physical inactivity leads to a high risk of medical complications and triggering substantial health care expenses. The goal of the project within which the research is conducted is to explore the effect of the use of nudges to dissuade individuals from physical inactivity. This study is aimed to design and develop a zero/low-cost nudging mHealth intervention that allows users to check their time with normative messages when walking. This intervention is then utilised for individuals to investigate whether it stimulates physical activity. The design of the nudging intervention is followed by an iterative Design Thinking process. The result of the pilot study has shown us that participants highlighted personal normative message installed as a screensaver in a smartphone as a zero-cost solution to dissuade their physical inactivity. Our future effort is to access this intervention by experimental design studies with quantitative and qualitative surveys, which will be carried out with students to measure physical activity behavioural change.

Keywords: Nudge, Physical Activity, Design Thinking.

1 Introduction

The United Nations Sustainable Development Goals: goal 3 is intended to "ensure healthy lives and promote well-being for all at all ages", and it sets out to end the global non-communicable diseases by 2030 [1]. Lack of physical activity (PA) is a contributing cause to a non-communicable disease. Therefore, by 2025, the World Health Organization member states have set a level to reduce physical inactivity up to 10% [2]. Despite this, some citizens remain constantly physically inactive, thus leading to a high risk of medical complications and triggering substantial health care expenses [3][4].Thirteen years after the publication of the Nudge Theory [5], a concept which

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proposes positive reinforcement and indirect recommendations to influence the decision making and behaviour of individuals, there is now considerable research into Nudge Theory in many areas. For example, nudging has been applied to improve hand hygiene among health care employees to decrease the number of health-related infections [6]. The overall goal of the current project within which the research is conducted is to explore the effect of the use of nudges to dissuade individuals from physical inactivity. This study is aimed to design and develop a zero/low-cost nudging mobile health (mHealth) intervention. It includes a wearable touch interactive printed electrochromic displays (EC) based wrist band or a screen saver on smartphones which allows users to check their time with normative messages when walking to prolog the walk. This intervention will then be utilised for individuals to investigate whether it stimulates physical activity. It is aimed to adopt the elements of motivation (hope), elements of simplicity (time) trigger signals from the Fogg behavioural model (FBM) [7] with a combination of nudge (personal normative message) to propose a system model for the nudging intervention. Therefore, the following key research question will be investigated:

Is it possible to incorporate a personal normative message in designing nudging intervention to dissuading individuals from physical inactivity?

It is hypothesized that the nudging intervention system to be developed will affect individuals' subjective experience by motivating them intrinsically towards physical activity. To answer the research question, the design thinking iterative process will guide the design and development of nudging intervention that the user/individual can use to check the time and be motivated to perform physical activities. The intervention will be assessed by experimental design studies with quantitative and qualitative surveys. It can be expected that the results of the study will demonstrate a positive impact to decrease physical inactivity among the users.

2 Nudging

Many attempts at persuasive design fail as users do not understand what factors could lead to behavior change [7]. Theoretical frameworks are accessible, but these are often found to be unreachable by practitioners, precisely during design meetings, due to the fact of being lengthy, complex, and presented in a way that does not support the design process [8][9]. As a result, designers often fail to understand and take support of behavioral theory, as evidenced by reviews that have shown most of the behavior change mHealth solutions lack theoretical implementation [10].

Peoples' behaviour can be influenced by cues in the environment which are often processed outside of conscious awareness [11]. Thaler and Sunstein [5] introduced the concept of nudging to imply that we can influence our knowledge about cognitive biases to change behavior in a positive direction. Within the domain of human-computer interaction (HCI), researchers have enthusiastically implemented the idea of nudging to foster healthy behaviors [12]. Previous work of nudging interventions in an office environment showed that it helped to stimulate stair use by employees [13]. Nudges

can also be considered cost-effective interventions, which enable individuals to make decisions that they decide to be their own personal decisions or choices [14]. Normative messages as a way of nudging have been used to increase healthy behaviours [15], particularly towards positive anticipated emotion to influence physical activity [16]. Digital interventions such as mHealth is a possible solution to persuade individuals towards PA. It has shown to effectively increases PA levels in adults in the short term [17]. In prior work [18], researchers observed that knowledge on the how of nudging is incomplete and highlighted the limited understanding of the long-term effects of nudging in a technological context and suggested future studies on field trials of digital nudging interventions to investigate their effects over the long term and once nudges are removed. The present study has been adhered to the above recommendations for thorough field trials and long-term nudging effects with the mHealth solutions.

3 Methodology

An iterative design thinking process has been utilised to guide the design of the mHealth intervention. Design thinking is an iterative design process of an application in which users are involved in every design phase [19]. Design thinking comprises six steps: empathize, define, ideate, prototype, test, and implementation [20]. Empathizing indicates the sense of ability to share feelings thoughts towards solving problems and challenges. Define step implies making sense of information gathered from the empathize step and resulting in a problem statement known as point-of-view (POV). The ideate step focuses on making ideas and concepts that support designing prototypes, such as mind mapping, body storming, and sketching. The next step, prototyping, refers to an early stage of application delivery, for instance, prototyping a nudging mHealth intervention. This prototype can be of any type, i.e., low-fidelity, mid-fidelity, or high-fidelity prototype. For examples, a paper object, soft copy or electronic object, or an interactive display in technology-based solutions. Testing confirms that the prototype is refined, exploring the users' requirements, and clarifying the POV. The implementation step ensures that solution is materialized and touches the lives of the end users.

4 Iterative designs and pilot testing of nudging intervention

We performed an ethnographic study, i.e., observed and collected participants' views and then moved to the next Define step to draw the conclusions from the Empathize step and developed an actionable problem statement. The next Ideate step, by which various ideas was brought to forwarding into Prototyping, testing the prototype, and implementation of the real working system.

4.1 Empathize

We observed participants' behaviour, engaged them through interviewing, and watched and listened to them carefully. Face-to-face interviews were conducted with 13 students

at their preferred place (University campus and dormitory lounge). A majority (9/13; 69%) are pursuing their master's degree at the University of Oulu, Finland. The rest (4/13; 31%) are from different institutes in Finland studying Finnish language courses and other part-time courses. Participants were from four nationalities (Finnish, Irish, Indian, and Bangladeshi, and they are all residing in Oulu, Finland (population, ~200,000). An invitation email was sent out to them to take part in the study. Upon their consent, we agreed via email and WhatsApp communication with a date and place for the interview session. The interviews lasted for 15 minutes for each participant and were conducted between January 15th and January 30th, 2021.

The objective of the interview was to observe participants' understandings and viewpoints concerning their willingness to foster physical activity promotion by utilising the technology-enhanced solution. The participated students were asked to describe their experience and views of overcoming physical inactivity in their daily study life, for example, how they perform PA when sitting for a long-time and their inner thoughts about anything that could persuade them and any digital tools that might aid them to conduct the physical activity. All the participated students (13/13, 100%) reported physical inactivity in their daily life, and most students (12/13, 88%) suggested a technology-mediated solution to which they can do PA, particularly walking and weight control. They showed interest to use some sort of motivational message installed or somehow connected to a technology tool (which we call normative message), e.g., a wristband or a smartphone in which normative message will appear on the screen display. The normative message could be something to motivate them daily to prolog their walks, such as a wise proverb or a famous quotation. They wanted to see the normative message along with daily clock time in the same digital display, which can attract attention, such as a nudging way to boost up their physical activities. Most of them (12/13; 88%) recommended a zero/low cost and sustainable technology that might support them in preventing physical inactivity. Followed by these observations, we have moved to the Define step to culminate an actionable problem statement.

4.2 Define

The results of the interviews concluded with the following problem statement (POV):

Students sense a lack of being physically active in their daily life. A technology-mediated tool applying normative message can support them overcoming the state of their physical inactivity and can assist them to self-motivate towards PA such as walking, running, etc., to increase the net amount of daily movement.

The above POV has drawn our significance attention to how we might build a digital solution with the aid of the nudging technique. An example was applying the normative message to which end users can experience more enjoyment and influence in their physical activity encouragement.

4.3 Ideate

The POV from the define step has guided us to design the prototypes of the physical activity solution. The concept of designing the prototypes was to examine participants' responses and how they reacted using normative message in line with the nudge technique using Fogg's behavioural model (FBG). The prototypes were carefully designed by adding a normative message. We chose to use this solution because the empathize step has indicated participants' interest into applying a personal normative message with a clock display in it.

4.4 Prototype

The objective of building the prototype was to confirm whether the participants can run a nudging intervention with a personal normative message and how do they react in using them. EC are non-light emitting displays and ultra-low power. They have been the topic of extensive research due to their outstanding potential for application in novel paper-like display devices, commonly known as e-paper [21]. We chose to use this because it is a cost-effective solution that can be applied in many application domains, such as designing mHealth intervention. We designed a wearable touch interactive EC-based wristband paper prototype that allows users to check their time and a normative message appears in it (Fig 1).

Fig. 1. Mock-up UI (low-fidelity EC-based and mid-fidelity digital-screen display prototype)

On the other hand, a screen saver on the smartphone is a zero-cost sustainable solution installed on all mobile devices. It allows users to check their time with normative messages. Users can wear it in any part of the hand; when they touch a button on display, time with a normative message appears, such as a wise proverb, "The only push up you won't be able to do the one you never do". This normative message will appear every time the user presses the turning on the button to operate the smartphone (Fig 1). Out of these two interventions, one will be selected based on users' needs and feedback to conduct the pilot study.

4.5 Test

Nineteen students were invited via email/Facebook messenger. Out of those, ten students confirmed their availability to participate in the test study. Most of those (8) were pursuing their master's degree at the University of Oulu, Finland, and the rest (2) were from UCC, Ireland and WIT, Ireland. The test was conducted in February 2021. Two versions of the prototype (EC-based wrist band prototype and a digital display screensaver in a smartphone) were provided. The first version of the prototype (EC-based wrist band) was not interactive, i.e., participants used crafted paper to access the paper prototype. To test the prototypes, each participant had been allocated 10 minutes for a single session. They were asked to pretend to use the prototypes as if they were doing the physical activities in a real-life context (Fig 2).

Fig. 2. The participant is testing prototypes while walking.

All participants reported feeling beneficial after testing the digital display-based screen saver. They felt that the screensaver option in the smartphone was superior/better experience than the EC based wrist band. However, five participants highlighted more than one motivational message, and three other participants mentioned having one motivational message showing on the display of the intervention. Participants stated as

"Maybe two or three normative messages is enough; seeing one message is monotonous.",
"If there were random messages, more messages."
"Every time, different message. For example, 365 messages, every day new message."

The test result has informed us participants highlighted a zero-cost and sustainable technology and preferred the personal normative message as a digital display screensaver in a smartphone to dissuade their physical inactivity.

4.6 Implementation

This is the stage when finally nudging mHealth solution becomes real and is launched and tested on the real-life scenario. In this study, we have developed a prototype that users have tested. Once the real working version of the intervention is finalized, it will be implemented and used by the citizens in real life.

5 Discussions

This study has set up an example of a successful approach in designing a nudge mHealth intervention using personal normative messages to dissuade from physical inactivity. However, the study has some limitations, and further research needs to explore several things. Participants pretended that they used the prototypes, and it was only for 10 minutes. The actual use of the real working mHealth intervention might bring different users' experiences. Studies have shown that motivational signage increases physical activity on study premises [22]. Participants in our study highlighted motivational messages such as famous quotations or wise proverbs to be installed in the screensaver as a personal normative message. Researchers [23] demonstrated in a field experimental, observational study on free tire checks at a gas station that a moral appeal on a sign placed at a gas station ("Do you care for the environment? Get a free tire check") resulted in more coupon uptakes for free tire checks when personal pronouns related to the moral message were used. Hence, linking the moral messages to individuals' self-concept will activate an already existing personal norm in the direction of the pro-environmental behavior [23]. Studies have focused on examining the effect of different types of personal normative messages and analyzing to what extent several wordings in such messages may trigger one's personal norm [24]. Therefore, we could apply this strategy to activate one's personal norms, such as students' persuasion for physical activity.

This is a work-in-progress paper. Future studies will focus on a brief description of how the Fogg behavioural model (FBM) model [7] could be incorporated into the system and an additional iteration of the design thinking iterative process. Further ethical reflection about our research design should be done. In prior work [25] randomized controlled trial (RCT) based experimental design has been applied in the feasibility study of physical activity promotion. Once the real nudging intervention will be designed and developed, an RCT-based experimental design will be carried out. Participants will be randomly selected and divided into two groups (Group A: using a digital display-based screen saver installed in the smartphones; Group B: continuing their usual daily routine). The participants' key factors (consisting of intrinsic motivation, level of influence of the normative messages in the context of their PA behaviour) will be measured over eight weeks for each condition (experimental and control). These are subjective measures, and participants' responses (e.g., their daily usage of the interventions to do daily physical activities) will be gathered from participants' responses. On the quantitative side, psychological need satisfaction in exercise (PNSE) questionnaires (using the 7-point Likert scale) [26] will be used to measure intrinsic motivation and

the level of influence of the normative messages in the context of their PA behaviour. Face-to-face interviews will be conducted based on questionnaires (which will be formulated and tested based on participants' feedback and recommendation). Hence, semi-structured 10-minute interviews [27] will be conducted and audio recorded with participants who carry out the study. Thus, the analyses of the collected data will demonstrate empirically that the nudging intervention positively impacts students' physical inactivity. It can be expected that the study results will demonstrate a positive impact to decrease physical inactivity among the users.

6 Conclusion

Our study presents the nudging mHealth intervention to motivate individuals for physical activity promotion implemented in a paper prototype and mid-fidelity touch interactive prototype of an app. This study contributes to the HCI community to deepen understanding of how nudge theory can be integrated to design a zero-cost mHealth intervention. The study's secondary objective was to develop a prototype of a PA promotion mHealth intervention. We tested the mHealth intervention through a pilot followed by the design thinking iteration. Results have shown that participants felt that using a PA focused mHealth intervention could increase their PA related behaviours such as walking. The pilot study was small-scale, and due to the paper prototype-based study, participants could not really draw generalizable conclusions. The limitations of the study addressed us to examine the intervention empirically, i.e., long-term effects of it. Our results can guide us to develop a nudging mHealth intervention by adding extra features, e.g., personal normative message. This study also opens the gateway for further examination. Further research should concentrate on building actual mHealth intervention, evaluating in comparison with the existing system, i.e., experimental and control groups, and working out exactly where the personal normative message plays a meaningful role. Further research should also focus on users actually using the nudging mHealth intervention, its usability issues and a long-term study to examine the effect of the nudging intervention.

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