

# Effective Nudging in Digital Environments

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**Abstract.** This research investigates the user experience of receiving digital nudges. The nudges were designed as being either gain-framed or loss-framed, informing users of the benefits of exercise and were sent as push notifications in a fitness app. Qualitative data from semi-structured interviews were analysed using a thematic analysis. The overall results suggest that nudges via push notifications are well-accepted by users, particularly if trustworthy, short, easy to read and well-timed. Differences in opinion between gain-framed or loss-framed nudges were not strong. However, those who did express a dislike for loss-framed nudges tended to do so strongly. This paper is novel and useful to designers of digital nudges as our results can inform designers of best practices. To the best of our knowledge, there are a lack of studies that actually carry out the design, implementation and evaluation of digital nudging interventions (by its true forms), with the aim of understanding users' perception and experience of digital nudging. Further, as far as we have been able to ascertain, a systematic qualitative study of the user experience of digital nudges using push notifications has not been done until now.

**Keywords:** Digital nudges, Warning-type nudges, Evaluation, Qualitative interviews, Thematic analysis.

## 1 Introduction

Digital nudges are becoming common in digital interaction on mobile user interfaces and other user interfaces. Generally, we could suggest that 'Nudges are interventions that steer people in particular directions but that also allow them to go their own way [13]'. Further, 'to qualify as a nudge, an intervention must not impose significant material incentives (including disincentives) [13].'

More specifically digital nudges take place in a digital environment and involve features of the user interface that guide or influence users' behaviour in some way. This is particularly the case when choices are available to users in the digital environment [16].

Digital nudges come in different forms and with potentially different aims. Bergram et al [1] discuss in detail ten different kinds of main nudges that are used in digital environments. These are 'social, reinforce, disclosure, friction, feedback, default, warning, scarcity, deception, and commitment.' We refer the reader also to other related categorizations of nudges in [2], [7] and [14].

In this paper we will particularly concentrate on warning-type nudges. Warning nudges aim to capture a user's attention regarding some potential risk or consequence to something [1]. One example of a warning nudge can concern the use of social media. If a user posts on their public social media account that within certain dates they will be on holiday in another country and their home address is also public knowledge, this could present an easy target for thieves. A warning message or nudge could be used in this scenario to warn the user that posting that particular content could pose a security risk.

The research discussed in this paper will be in the context of keep-fit and active warning-type nudges, which were relayed to a group of participants via a real fitness centre app.

Our contributions to this research area are both novel and significant for two main reasons. The first is that to the best of our knowledge, there are a lack of studies that actually carry out the design, implementation and evaluation of digital nudging interventions (by its true forms), with the aim of understanding users' perception and experience of digital nudging.

Secondly, most studies in this area are not qualitative in nature and therefore our work contributes a qualitative dimension to the existing area of research.

Linked to the above, our main focus with the digital nudges concerned finding out about message framing effects on users, users' experience in receiving nudges via push notifications and users' experience of nudges giving health information.

In the coming sections of this paper, we will present some related background literature on this topic. Then our specific nudge design will be described, followed by a description of the qualitative data collection carried out and the results. The paper will then conclude with a discussion and conclusions.

## 2 Related Works

The predecessor to digital nudging involved nudging in the physical world, e.g. in using social-type aspects in a community or population telling people that most other people pay their bills on time can have a nudging effect on others to follow the same behaviour [14].

Nudges were then extended to include nudging in the digital world usually via some user interface. Schneider, et al [12] argue that all or most user interfaces involving a user needing to make some choice are effectively 'nudging' users in some way. Schneider et al [12] also show that deploying well-known principles of psychology regarding how humans tend to make decisions, can affect users' behaviour. For example, the 'decoy effect' [12] tends to have a choice that is attractive to users alongside an alternative choice that is much less attractive. Usually, users will select the more attractive option. The 'scarcity effect' [12] involves telling users that some item is limited in numbers. This tends to result in users finding the scarce item more desirable. The 'middle option bias' [12] involves presenting users with three or more choices which are ordered in sequence according to some characteristic, e.g. price. Generally, users will select the middle option in such a situation. Clearly, designers must take into consideration the context and possible side effects of using such nudges.

Digital nudges come in several main categories which are well-documented (See e.g. [1], [2], [7] and [14]).

Furthermore, how designers frame or phrase nudges can also have an influencing effect on users. Framing of nudges can be done to imply positive consequences (gains) of a certain action or negative consequences (losses) of a certain action [11].

Rothman and Salovey [11] suggest that humans engage in risky behaviour when faced with a loss of some kind, while they tend to avoid risk when faced with a gain of some kind. The authors have observed that this general behaviour within humans happens within health-related contexts. However, the authors acknowledge from other research that other factors can influence humans in their actions.

To better understand the effect of framing, aspects linked to psychology that relate to framing should be considered. Prospect theory makes statements about gain-frames and loss-frames, concerning which is better to use if one is faced with a quantity of risk, e.g. often denoted as small risk or large risk (smaller or bigger evil) [8]. In the context of our study looking at promoting physical activity, it can be translated to the large risk being the risk of contracting a health condition with the ultimate consequence of (early) death. The small risk can be interpreted as the time wasted at the gym should this information not be correct. Under such circumstances individuals are willing to accept the small risk (e.g. waste time in training) to avoid the big risk (early death) and that positive framing is favourable.

In the context of health-related behaviours, message framing has been shown to be effective. For example, nudging people to do self-examinations for skin and breast cancer (detection behaviour) have proven to be best when the framing of the message highlights the increased risk in the absence of it, and not the reduced risk if they actually do it, i.e. loss-framed [15]. In contrast, several studies conclude that in contexts of preventative health

behaviours (such as skin cancer screening, stopping to smoke, physical activity), gain-framed messages are measured to be most effective compared to loss-framed [4].

The literature indicates that ambiguity exists concerning what constitutes nudging and what is pure marketing. One of the nudge criteria is to safeguard the user's freedom to choose. By revisiting the categorization of nudges through the Hansen and Jespersen [5] framework, we see that nudges under the "automatic-non-transparent" category are said to manipulate behaviour. Such mechanisms of nudging (e.g. subliminal priming), optout policies, adding inferior alternatives, deceptive visualization and biasing the memory [2] are often unrecognized and may therefore deceive users. This raises the question of whether that category should actually be considered to be a nudge, as users' freedom to choose is not safeguarded. Examples of this are when nudging is used in commercial contexts, when the user is influenced to use money, make a choice that is not for the user's best interest, but rather benefits the organization or company behind the nudge. Such nudge implementations are unfavourable and a dubious way of implementing a nudge, due to their ethical implications. Transparency is important for helping to avoid manipulation [9].

In the next section, we will present our nudge design in the context of health and physical training, aiming to observe the attitudes different nudges might have on users.

### **3 Our Nudge Design**

In order to help investigate the issues raised above, we designed a series of nudges in the context of a real fitness centre app. Design and development of the nudges was informed by the Digital Nudge Design method of Mirsch et al. [10].

The digital nudge intervention was designed to provide health information related to physical activity. Since message framing was applied, it was natural to present positive health effects with physical activity and negative health effects with inactivity. The digital nudges were based on carefully selected information so as not to create commercial and controversial content that could overshadow the perception/experience. The topics chosen were muscle and skeleton, diabetes type 2, cancer, brain, life expectancy, endorphins and dopamine, mental health and cardiovascular disease.

Applying information about health effects matches with both the objectives of the training centre, as they aim to promote physical activity, and the definition of nudging, that should support good choices for individuals' best interests. It is generally accepted that physical activity is in the best interests of the individual as well as society. The presented knowledge is based on multiple reports from across the world and has been endorsed by international organizations like the World Health Organization [17] and Norwegian national organizations (the authors are based in Norway) like the Norwegian Institute of Public Health [3] and Norwegian Directorate of Health [6]. The latter, currently has the leading role of informing Norwegian residents about physical activity. Basing the nudges on such information also contributes to making the information more available, which can be an important step towards reducing inactivity.

The nudges were implemented in the training centre's content management system (CMS) that allowed for publishing content through their app. The CMS communicated with their service platform delivered by Microsoft Azure. Further, the service platform communicated with Google Firebase, which provided messaging through the cloud, and made it possible to send notifications to any operating system. Google Firebase connected with users'

Device ID (users' smartphones) and delivered notifications to the operating system on their devices. The nudges appeared as push notifications on users locked home screens, but were also presented as an in-app notification when opening the app.

The designed digital nudges were of two kinds. The first was gain-framed while the second type was loss-framed. Figure 1 shows all the nudges used in the study.

	<b>Gain-framed nudge</b>	<b>Loss-framed nudge</b>
<b>Muscle and skeleton</b>	Exercising strength two or more times a week, helps you maintain muscle strength and improves bone and joint health.	The risk of developing muscle and skeletal disease may increase if you do not exercise strength two or more times a week.
<b>Diabetes type 2</b>	Be aware that you reduce the risk of type 2 diabetes through physical activity.	Inactivity increases your risk of conditions such as type 2 diabetes.
<b>Cancer</b>	Remember that physical activity reduces the risk of various types of cancer, including colon cancer and breast cancer.	Be aware that the risk of various types of cancer, including colon cancer and breast cancer, increases if you are inactive.
<b>Brain</b>	Your brain benefits from staying physically active; it can improve both your memory and your stress management.	If you are physically inactive, your brain will not be stimulated to maintain good memory and stress management.
<b>Life expectancy</b>	No one lives forever, but remember that you can increase your life expectancy by being physically active.	You can miss several years of living if you are physically inactive.
<b>Endorphins and dopamine</b>	During physical activity, your brain will release endorphins and dopamine, which can give you a sense of well-being and you can become more at ease.	By physical inactivity, you will not stimulate the production of endorphins and dopamine to the same extent as when you are physically active.
<b>Mental health</b>	Physical activity can have a positive effect on your mood and mental health, while preventing mental disorders such as depression and anxiety.	Did you know that physical inactive people will be more prone to depression?
<b>Cardio-vascular disease</b>	Cardio exercise strengthens the heart's function and thus prevents cardiovascular disease.	If you do not perform cardio exercise, your heart and lung capacity may weaken, and you will be at higher risk for cardiovascular disease.

**Fig. 1.** Overview of health information that was broadcast in the digital nudge intervention.

#### 4 Qualitative Data Collection

To gain a deeper insight into participants' personal perceptions and experience of the digital nudges, a qualitative approach was chosen. Eight distinct nudges were broadcast to training centre members, via the training centre app, with the remainder shown to participants during the interview stage (see Figure 1). The transmission of the nudges was randomized over a period of two weeks across three daily time frames (08.00-10.00, 12.00-15.00 and 18.00-20.00).

After completion of the intervention period, the user experiences and perceived effect of the digital nudges were investigated through semi-structured interviews. The objective of this qualitative approach was to gain insight into how digital nudges for this user group and context should be designed and delivered.

The research was conducted ethically in-line with Norwegian requirements for research. Evaluation was carried out by The Norwegian Centre for Research Data (Now known as the Norwegian Agency for Shared Services in Education and Research). All participants gave informed consent before participating in the study.

## 4.1 Participants

To be able to investigate the participants' characteristics and their experience of the nudges, it was decided to categorise the users as detailed below:

- Age: In our participant sample, the age group of 20-30 years, contained 16 participants, whilst in the age group of 30+ years there were 6 participants.
- Type of motivation: These were intrinsic (motivated by internal reward such as joy) or extrinsic (motivated by external reward such as appearance).
- Prior level of physical activity: The participants were categorised into three different levels of average weekly physical activity. The three levels were: Engaging in 2 or less sessions of physical activity, 3-4 sessions of physical activity and 5+ sessions of physical activity.

## 4.2 Semi-Structured Interviews

Semi-structured interviews of 30-60 minutes duration were conducted, as they allowed new directions to occur during the sessions and thus provided a more open dialog between the interviewer and the interviewee. The interviews were completed by using different video conferencing tools, such as WhatsApp or FaceTime, dependent on interviewee preferences.

An interview started with a reminder of the purpose and procedures of the study. The participants were informed about their right to withdraw during the interview. Efforts were made to foster an open dialog and to make the interviewee comfortable during the session.

An interview guide covering predefined topics and questions was prepared and used during the interviews. Open-ended questions were asked aiming to get an honest, unbiased and comprehensive idea of the users' experience. Examples of open-ended questions were: what motivates you to stay physically active, how do you deal with push notifications, how do you perceive the message of the nudges, why do you use the training centre app and what do you use it for, what nudges do you remember, what effect did the nudge have on you? etc. Follow-up questions were asked when it was considered appropriate.

Some of the nudges intended for transmission had to be presented to the participants during the interview sessions to provide a meaningful opinion on the topic. Both WhatsApp and FaceTime facilitate the sending of text and thus mimicking push notifications. The interviews were documented by real-time transcriptions.

## 4.3 Results of Thematic Analysis of Interview Data

During the thematic analysis, several categories and subcategories of perceptions and opinions related to the digital nudging interventions were identified.

**Theme 1: Competitive Nudges.** Almost everyone is equipped with a smartphone and people are continuously bombarded with content. Digital nudging through push notifications could be expected to compete for the users' attention in this manner, and some of the user perceptions were related to the delivery method in the study.

*Attitudes Towards Nudging.* Several participants explained that they carefully consider which apps they allow push notifications from. This was mainly justified by their experience of interference and noise from their phones during the day. Further, general attitudes were that push notifications are easily overlooked in the larger flow of information. It was also

expressed that push notifications were considered an appropriate way of communicating content if the information received is perceived as useful.

Even though the addressed digital nudge intervention did not fall under this category based on their attitudes towards push notifications, most of the participants supported using push notifications for broadcasting such information as presented in this study.

The general attitude among the participants towards push notifications seemed to be that too frequent messages or irrelevant content are considered irritating and disruptive. Some associated push notifications with commercial content, advertising, and social media, and expressed prejudice towards such communications. Others expected it to be urgent and vital information and adjusted smartphone settings accordingly. Despite attitudes towards using push notifications to deliver information and regardless of the issue as to what is urgent or not, they were largely welcomed in this digital nudge intervention.

Timing and context were two factors that affected whether the nudges received attention immediately after they were received. For instance, during busy situations the nudges would have less probability of being noticed, and certain senders would be considered less important to prioritize: 'It feels less important that the training centre reminds me of something (Participant 9)'.

After a distributed message (nudge) was given attention and read, the timing and context still had influence. Some participants that experienced poor timing and context when receiving the nudge, were still reading it to the extent that it triggered a new decision process, i.e. deferred contemplation. 'It kind of disappears in the flow of information, you register it and it disappears (Participant 8)'.

*The Urgency Hierarchy.* Due to the special circumstances related to the Covid-19 pandemic and the societal lockdown, a particular opportunity emerged with regards to investigating another category of digital nudging concerning health information. Specifically, a text message (SMS) was broadcasted to all Norwegian citizens on the first day of lockdown by the Norwegian Directorate of Health. It contained behavioural advice to limit the spread of diseases, e.g., social distancing and recommendations on hand hygiene. All participants in this study could remember receiving this SMS from the Norwegian Directorate of Health. This nudge was perceived as more direct and important, and it was also expressed that an SMS was the right delivery method because of the urgency and abnormality of the situation.

*Readability and Memorability.* The nudges distributed in this study seemed to be read or partially read by all the participants. However, the timing for reading differed. The nudges were perceived as short and easy to read, and required little from the participants in terms of comprehension. Further, the participants seemed to perceive the nudges as non-intrusive ('It was such a short amount of information that I actually took the time to read it (Participant 8)'). Everyone claimed to have read the messages, and most participants recognized two distinct attributes. These were that the training centre was the sender, and there was some kind of health information involved.

Further, some participants mentioned remembering certain topics, i.e. specific conditions or health aspects that were addressed in the nudges. A few participants seemed to remember specific details about the different health topics presented.

**Theme 2: Overall Effects of the Nudges.** This theme involves the common experienced effects of the digital nudging intervention. The nudges appeal to the reflective processing which would be necessary for the nudge to have the desired effect. Most of the participants claimed that the digital nudges had some degree of persuasive effect.

*Limited but Positive Effect.* Participants themselves felt that the nudges had little or no effect on them, in terms of whether they would choose to be physically active after receiving the

nudge. Only one participant described how a nudge made him go for a longer hike and scheduled a workout the following day. Others mentioned how the nudges fostered a feeling that they ought to exercise but could not answer whether it had led to such an outcome.

In addition, several participants suggested that the thought of engaging in some sort of physical activity remained with them during the rest of the day. The extent to which this caused them to perform physical activity has not been possible to measure. For example, one participant said that in situations where the idea to workout was present, she would feel more committed to complete that workout after receiving a nudge. Further, some participants pointed out that they thought about having a training session (to what extent this was done is unknown), i.e. the incentive was introduced. Another participant said that a nudge convinced her to spend an extra hour exercising rather than being on the couch.

*Reminding Effect.* The main takeaway concerning the participants perception and experience of the digital nudges, is that it initiated a thought process more than actions and behaviours. In other words, few participants experienced an immediate effect, e.g., deciding about engaging in physical activity soon or planning a workout. However, the presented health information either aroused deliberate reflection (conscious) or remained at the back of their mind for the rest of the day (unconscious). Even though participants did not decide to go directly to the training centre or go for a run, it would stay with them as a consideration whether they should engage in some physical activity during the day. Another important effect of the nudges was that they were reminded of the health effects of physical activity. The information about the health effects was already known (to varying degrees) and was also some of the participants' justification for physical activity, although not always in their mind.

*Confirmatory and Minor Amounts of Motivation.* Another dominating opinion and experience with the digital nudges were that they had a positive effect, in the sense that participants got confirmation that their time and effort already spent in engaging in physical activity was worth it. It was a good reminder and support to make them want to continue what they were already doing. In a positive sense, the information was already known and accepted. This was used as argumentation to stay physically active. The findings indicate that the digital nudges served as a motivation which had the potential to give the extra push to carry out physical activity. 'They have served as a confirmation and an extra push that I should continue with what I do (Participant 15)'.

*Additional Information and Positive Influence/Persuasion.* The majority mentioned that most of the information that was presented was already known, at least to a certain degree. Some of the topics (e.g. cancer) and level of details (e.g. strength workouts should be performed two or more times a week) turned out to be new for several participants. A few participants stated that they had expanded their argumentation to stay physically active based on the presented information: 'I've added it to the reasoning to keep engaging in physical activity and training (Participant 9)' and 'It makes me think that I'm not only exercising for body and appearance but also for my health (Participant 3)'.

*Source Credibility.* Regarding credibility, the vast majority agreed that they could rely on the information that was conveyed. Some justified it because it was common knowledge that they already knew from before. Others pointed out that since the information came from

such a large well-known training centre, they trusted the content. 'I find the information very trustworthy since it comes from that training centre which I believe is the largest fitness centre in Norway... it never struck me that I should be critical of the information (Participant 12)' and 'I do not doubt the information even if it comes from a commercial operator, I trust the information that is sent (Participant 11)'.

**Theme 3: Influencing Factors on the Participants and User Experience.** Contrasting feelings were identified amongst the participants, both regarding the context and perception of content and framing. The findings incorporated a large variation of opinions throughout the interviews. A selection of the most prominent topics and variances across these, are presented below.

*Influence of Participants' Personal Circumstances.* Several participants described how the nudges could have been effective, or more effective, given a certain condition. This concerned both the nudging in general and specifically towards the message framing. Typical aspects that affected their perceptions were: current training routine, prior physical activities frequency, work situation, free time, priorities, timing and lack of motivation. Certain participants were affected by current training habits: 'If I had not trained normally and would be positively influenced to exercise, I think that is the kind of information I would like to be notified of (Participant 22)'. Some mentioned their job situation as an issue: 'The periods when I work a lot of overtime it is a little more demanding to get into training, if I had received one of the alerts in such a situation it might have influenced me to go training anyway (Participant 19)'. Others expressed that it may be more useful when motivation is lacking: 'If I had gotten them at the right time, e.g. the days I am struggling to get to workouts, they might have had a bigger impact on me (Participant 18)'. Another effect, was that some of the participants that expressed positive statements regarding the digital nudge intervention, also expressed that they thought it could have had an even greater effect if they were exposed to it over time.

*Nudge Content.* Time Related Factors: There was a strong tendency among the younger participants (under the age of 30) to accept that the information was important. However, they felt that the presented health effects were not applicable to them at this time, due to being younger in age. Typical topics that were considered to not be applicable at this time in their age group, were cardiovascular diseases, muscle and skeleton issues, cancer and life expectancy. 'I feel that cardiovascular disease and cancer are a bit far away from my concerns (Participant 11)'. 'The notifications appeal more to the long-term version of myself, and not the here and now version (Participant 12)'. 'When you are young and healthy, cardiovascular disease feels too far away for making it an argument for engaging in physical activity (Participant 14)'. Older participants did not seem to distinguish some topics as less relevant than others. Further, regardless of age, health effects that were easy to relate to and felt close, were perceived as more effective. (i.e. leading to greater potential effect). Such health effects concerned how physical activity currently affected the participants, e.g. the brain, stress management, endorphins, dopamine and mental health.

Novel vs. familiar Information: Participants over the age of 30 expressed that nudges presenting new information were more interesting as they could learn something from them. 'If I had been able to learn something from it, it would have been interesting (Participant 5)'. Other participants thought it was nice and most effective to be reminded of the health effects they had already acknowledged as arguments for participating in physical activity, as this was not constantly on their mind.

Training app expectations: Another perception regarding content was that participants experienced that the nudges did not encourage any concrete or specific actions, choices or behaviours. The fact that participants had to choose how to use this information, act or



respond to it, was experienced as both good and bad. Some participants experienced the nudges as not fostering commitment strongly enough, and wanted more concrete information such as challenges to join, exercises, type of training, etc. Others appreciated the fact that they had the ability to choose how to act on the information. Participants desired freedom of choice and ownership of the choice for engaging in physical activity.

**Perceived Usefulness of the Nudges:** A few participants brought up the issue that they had not requested this information to be delivered (other than signing up to participate in this research) and claimed that they could take the responsibility of acquiring such information themselves. However, other participants expressed that it was nice to be reminded and were happy that the information was provided to them without having to actively look it up.

*Gain-Framed vs. Loss-Framed Nudges.* When participants were asked open questions about what they noticed about the digital nudges they had received, the framing was not mentioned as a characteristic of the nudges. Due to only receiving 8 nudges, the perceptions, opinions, attitudes, and experiences regarding this were vague. Therefore, as an alternative to the intended broadcast schedule, the digital nudges were presented to them in the chat, during the interview. They identified nudges they thought were interesting and received both the gain-framed and loss-framed version of the same message. Without pinpointing the difference in framing, they were asked how they perceived the two versions, and which version would have the greatest effect on them.

Several participants experienced gain-framed nudges as the most effective, because they were perceived as positive, uplifting, rewarding and had a motivational effect. It was also pointed out that it was easier to relate to the positive health effects, especially topics such as mental health, endorphins and dopamine. 'It tells me what physical activity actually gives me, uplifting in style, feels like it rewards me for exercising (Participant 2)'.

No participants reported any negative reactions to the gain-framed nudges.

A few participants expressed that they considered loss-framed nudges to be more effective due to their serious tone. The perceived negative connotations seemed to make a deeper impact on them. 'It depends on whether I'm in a good or bad period of training. If I had been in a bad period then maybe the other (loss-framed) would have pushed me a little more (Participant 2)'.

Further, a few participants answered that they did not see the gain-framed or loss-framed nudges as more effective than the other, and argued that other factors, such as content and health topics were more important for their perceived effect.

These findings were identified through directly presenting participants with the different framings. However, the result was that the message framing itself was in fact not noticed by most of the participants, except those who had very negative opinions related to the loss-framed nudges. Participants were more opinionated about the varying health effect topics that were presented than the framing style.

As mentioned, the dominant overall perceived effect is that the nudges act affirmatively on current training and that they act as a push to continue, which shows desirable effects with the implementation. However, when looking deeper into the impact of message framing in particular, the complete opposite emerges for a few participants.

Firstly, several participants could identify the negative connotation in the loss-framed nudges when presented side by side. Some of them expressed that presenting the negative effects with not engaging in physical activity was not effective on them because it could lead

to a bad conscience, fear and a warning feeling. Thus, it felt like they were being given a penalty for not staying physically active. 'This one is a little more threatening, warning, talks about the penalty of not exercising (Participant 2)'. Another participant that had a strong negative reaction, said that the loss-framed nudge was experienced as patronizing and commanding, which resulted in demotivation. One participant had an extremely negative opinion. The participant expressed that the nudge(s) were perceived as patronizing, 'It feels like I'm being forced to train... Such messages do not motivate me to engage in physical activity or workout. To be honest, I am demotivated. The way in which the message is presented makes me tired. It feels like an order and that the push notification knows best (Participant 16)'.

It was revealed that those who were negative to loss-framed nudges were more committed and clearer on what they thought, than those who were positive towards gain-framed nudges. Some did not express any strong opinions but could still identify the negative framing, and among them, a smaller group of participants expressed rather strong opinions.

## 5 Discussion and Conclusions

As presented in the Introduction, our main focus for this digital nudge research concerned message framing effects on users, users' experience in receiving nudges via push notifications and users' experience of nudges giving health information. Overall, our results have revealed many useful indicators for using and implementing digital nudges.

Our first theme showed clearly that if push notifications are to work in terms of getting the appropriate user attention, there are some guidelines that need to be followed.

Our participant sample indicated that they were open to receiving digital nudges via push notifications. However, there are some negative and positive aspects that need to be considered.

Positively, nudges via push notifications are viewed as acceptable if they convey useful information. If they are short, easy to read and understand, our findings indicate that they are more acceptable to users in this kind of format. We felt from the participant comments that the content of the nudges had further been generally memorable.

However, designers of such nudges need to remember that push notifications for nudges can be easily overlooked by users and that users tend to vet more which push notifications they allow. Our participants also indicated that too frequent or irrelevant information can be irritating and can be sometimes viewed as 'junk' messages. Using push notifications is perhaps not the best option for information that needs immediate attention. Our findings indicate that time of day when a message is received and its context can have an effect on when they are given attention. Anecdotally, SMS may be better for a notification requiring immediate attention.

Our second theme looked at the effects of the nudges on users. This theme also reveals useful guidelines for using and developing nudges.

On the positive side, some participants felt that the nudges received gave them extra motivation to keep fit and work out etc. Most participants felt that the nudges led them to think more about working out. The nudges gave positive confirmation to participants regarding their current physical activities and they gave participants confirmation regarding their current knowledge about physical activity. Nudges providing participants new and already known information concerning working out encourages some more strongly to remain active. Further, trust in the information received is potentially higher when users recognize and accept that the sender is trustworthy (as it was in our study).

On the negative side, participants indicated that overall, the nudges received did not foster an instant effect on them to immediately go for a workout at the gym or elsewhere. There were not many effects on the participants in terms of immediacy. As indicated above the effects were more subtle in nature.

Our third and last theme looked more specifically at user experience aspects concerning nudges delivered via push notifications. Our findings show a rather complex and variable picture of factors that affect the user experience. The aspects we present now should always be taken into consideration when designing nudges.

Our results suggest strongly that nudge effectiveness is influenced by users' personal circumstances at the time of receipt. This factor is difficult to predict as it would require a detailed continual knowledge of a user's circumstances which could be unique when compared with other users.

We further observed differences according to age. Younger users gave less weight to information perceived as not affecting them at their age. Older users were less discriminating against the content they received and they felt that nudges presenting new information were more interesting. Other participants seemed to prefer information that acted as a reminder. Some systems/apps can have access to a user's age and therefore push notifications could be tailored according to age group. However, deciding which kind of nudge to send in the situation where a user's age group is not known or the user has refused to reveal it becomes much less clear.

All the nudges in our study were designed to deliver some health-related information and no more. It means that then the users were responsible for acting on the information or not. This approach was met with mixed responses. Some participants felt it was the correct approach, whilst others disagreed.

There was also disagreement amongst participants regarding the usefulness of the nudges sent. Some felt they were useful whilst others felt they were useless.

Our study also examined gain-framed and loss-framed nudge styles. Neither style was particularly perceived as being effective or ineffective. The content though was argued to be more important than the style (gain-framed/loss-framed). However, it is interesting to note that in our sample, the participants that disliked the loss-framed nudges, disliked them in a very strong manner. Some felt that the loss-framed style was negative and demotivating.

Therefore, as a starting point, we would suggest designers could implement nudges based on the positive findings discussed above, whilst avoiding the negative aspects we observed. However, we would also recommend continued evaluation by designers as even small changes to context and other aspects such as phrasing could cause differing effects to those we observed.

This work involved practical aspects and theoretical aspects and is not without limitations. The first limitation is that the study was done on a short-term basis and some other participant behaviours and opinions might have emerged if the study had been conducted over several months. The initial plan had been to conduct the study over a 30-day period. The second limitation concerns the participant sample. This could have been larger and included more participants in 'older' categories. Our analysis revealed different attitudes to the nudges and context in relation to age.

For future work we would suggest one or more follow-up larger studies that look in more detail at the differences in attitudes and preferences according to age. More detailed studies should also look into the effects of when (e.g. time of day) a nudge is sent to a user and how nudges can be designed to have different effects on participants, e.g. having an immediate effect or a purely motivational effect.

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