Université de Neuchâtel
Faculté des sciences économiques

DESIGN, DEVELOPMENT AND EVALUATION OF DIGITAL NUDGES FOR DIGITAL WELLBEING: AN EXPERIMENTAL APPROACH

PhD thesis submitted to the Faculty of Economics and Business

Institute Information Management Institute

University of Neuchâtel

For the PhD degree in Information Systems

by

Aditya Kumar PUROHIT

Approved by the dissertation committee:

Prof. Adrian Holzer, University of Neuchâtel, thesis director

Prof. Bruno Kocher, University of Neuchâtel, head of jury

Dr. Paul COTOFREI, University of Neuchâtel, expert

Adjunct Prof. Narendra M Agrawal, IIM Bangalore, India, external expert

Dr. Dennis Gillet, École Polytechnique Fédérale de Lausanne (EPFL), external expert

Defended on 03rd, February 2023

unine
Université de Neuchâtel
Faculté des sciences économiques

IMPRIMATUR POUR LA THÈSE

Design, Development and Evaluation of Digital Nudges for Digital wellbeing.
An Experimental Approach

Aditya Kumar PUROHIT

UNIVERSITÉ DE NEUCHÂTEL

FACULTÉ DES SCIENCES ÉCONOMIQUES

La Faculté des sciences économiques,
sur le rapport des membres du jury

Prof. Adrian Holzer (directeur de thèse, Université de Neuchâtel)
Prof. Bruno Kocher (président du jury, Université de Neuchâtel)
MER Dr. Paul Cotofrei (Université de Neuchâtel)
Adjunct Prof. Narendra M Agrawal (Indian Institute of Management Bangalore)
MER Dr. Denis Gillet (EPFL)

autorise l'impression de la présente thèse.

Neuchâtel, le 14 février 2023

Le doyen

Valéry Bezençon

Faculté des sciences économiques
Avenue du 1er-Mars 26
CH-2000 Neuchâtel
Email: secretariat.seco@unine.ch
Tel: +41 32 718 15 00
www.unine.ch/seco

Abstract

Aditya Kumar PUROHIT

Design, Development and Evaluation of Digital Nudges for Digital wellbeing: An Experimental Approach

The fact that tech companies continue to design experiences that maximize attention capture despite this growing interest in digital wellness suggests that this trend is not going away anytime soon. It is important to recognize that attention, i.e., a state in which an individual's cognitive resources are selectively directed to certain perceived stimuli from the environment, is one of the most valuable resources of our digital age. By transforming attention into a currency, businesses transform users' time into a form of currency. This behavior has adverse consequences on individuals such as anxiety, depression, irritability and distancing oneself from family and friends to name a few. Research suggests that digital nudging interventions can help combat social media addiction and improve digital wellbeing. However, it is still unclear how digital nudging interventions can be designed to promote digital wellbeing? and how effective are they?

This research explores the employment of digital nudges for digital wellbeing through six studies split into three parts. Part I, aims to provide an understanding of the framework to design digital nudges. The study outlines the nudging development process. More specifically, the framework elaborates on when and how digital nudges should be delivered. The Part II investigates the landscape of digital nudging and explores how digital nudges are employed in other health related prognosis. In particular, its application across the entire care continuum.

In Part III, digital nudges for digital wellbeing are developed, and their efficacy and usability are measured via four experimental studies. In study 1,

we look at and evaluate various types of digital nudges and the relationship between friction and usability in the context of digital nudging. Study 2 evaluates how successfully automation may be used for developing self-nudging interventions. Further, Study 3 investigates the process of co-creation of digital nudges for digital wellbeing on smartphones and Study 4 analyzes the impact of reducing newsfeed and the relation between compulsive use and intervention effectiveness.

The overall findings of this thesis suggest that digital nudges can contribute to maintaining or increasing digital well-being when developed ethically under the guidelines of the digital nudge development framework. Our work confirms that social media platforms are designed to be addictive and digital nudges can be used to mitigate the effects of these addictive designs. Digital nudges are more effective when delivered at the right time, and digital automation tools can be employed to build nudges through self-nudging and co-creation processes to reduce privacy concerns. These automation tools can be used to deliver digital nudges externally in a timely fashion (time spent notification delivered when a social media application closes and opens) and they can also be used to change the internal choice architecture of social media platforms (automatic unfollowing and reducing social media newsfeed content). This latter approach of changing internal choice architecture is challenging. In the future, researchers could study internal designs beyond the newsfeed that can be adjusted and tweaked to increase digital wellbeing as social media companies continuously alter their interfaces to keep users hooked.

Keywords: Digital Nudges ; Social media detox ; Digital wellbeing ; Automation ; Dark Patterns ; Attention Capture ; Digital Detox ; Instagram addiction ; Facebook ; Digital health ; Newsfeed ; Infinite newsfeed ; Self-nudging ; Co-creation

Résumé

Aditya Kumar PUROHIT

Design, Development and Evaluation of Digital Nudges for Digital wellbeing: An Experimental Approach

Le fait que les entreprises technologiques continuent de concevoir des expériences qui maximisent la capture de l'attention malgré l'intérêt croissant pour le bien-être numérique suggère que cette tendance n'est pas près de disparaître. Il est important de reconnaître que l'attention, c'est-à-dire l'état dans lequel les ressources cognitives d'un individu sont dirigées de manière sélective vers certains stimuli perçus dans l'environnement, est l'une des ressources les plus précieuses de notre ère numérique. En transformant l'attention en monnaie, les entreprises transforment le temps des utilisatrices et des utilisateurs en une forme de monnaie. Ceci a des conséquences néfastes sur les individus, telles que l'anxiété, la dépression, l'irritabilité et l'éloignement de la famille et des amis, pour n'en citer que quelques-unes. La recherche suggère que les interventions de "nudging" numérique peuvent aider à combattre l'addiction aux médias sociaux et à améliorer le bien-être numérique. Cependant, on ne sait toujours pas comment ces interventions peuvent être conçues pour promouvoir le bien-être numérique, ni quelle est leur efficacité.

Cette recherche explore l'utilisation des nudges numériques pour le bien-être numérique à travers six études divisées en trois parties. La première partie vise à faire comprendre le cadre de conception des nudges numériques. L'étude décrit le processus de développement des nudges. Plus précisément, le cadre précise quand et comment les nudges numériques doivent être mis en œuvre. La deuxième partie étudie le paysage des nudges numériques et explore la manière dont les nudges numériques sont utilisés dans d'autres

pronostics liés à la santé. En particulier, leur application dans l'ensemble du continuum de soins.

Dans la troisième partie, les nudges numériques pour le bien-être numérique sont développés, et leur efficacité et leur facilité d'utilisation sont mesurées par le biais de quatre études expérimentales. Dans l'étude 1, nous examinons et évaluons différents types de nudges numériques et la relation entre la friction et la facilité d'utilisation dans ce contexte. L'étude 2 évalue dans quelle mesure l'automatisation peut être utilisée avec succès pour développer des interventions d'auto-incitation. En outre, l'étude 3 examine le processus de co-création de nudges numériques pour le bien-être numérique sur les smartphones et l'étude 4 analyse l'impact de la réduction du fil d'actualité et la relation entre l'utilisation compulsive et l'efficacité de l'intervention.

Les conclusions générales de cette thèse suggèrent que les nudges numériques peuvent contribuer au maintien ou à l'augmentation du bien-être numérique lorsqu'ils sont développés de manière éthique selon les lignes directrices. Notre travail confirme que les plateformes de médias sociaux sont conçues pour créer une dépendance et que les nudges numériques peuvent être utilisés pour atténuer les effets de ces conceptions addictives. Les nudges numériques sont plus efficaces lorsqu'ils sont délivrés au bon moment, et les outils d'automatisation numérique peuvent être utilisés pour créer des nudges par le biais de processus d'auto-nudging et de co-création afin de réduire les préoccupations en matière de protection de la vie privée.

Ces outils d'automatisation peuvent être utilisés pour fournir des nudges numériques à l'extérieur en temps opportun (notification du temps passé lors de la fermeture et de l'ouverture d'une application de médias sociaux) et ils peuvent également être utilisés pour modifier l'architecture de choix interne

des plateformes de médias sociaux (désabonnement automatique et réduction du contenu du fil d'actualité des médias sociaux). Cette dernière approche, qui consiste à modifier l'architecture des choix internes, est difficile à mettre en œuvre. À l'avenir, les chercheuses et les chercheurs pourraient étudier les conceptions internes au-delà du fil d'actualité qui peuvent être ajustées et modifiées pour accroître le bien-être numérique, car les entreprises de médias sociaux modifient continuellement leurs interfaces pour garder les utilisatrices et les utilisateurs accros.

Mots-clés: Digital Nudges ; Social media detox ; Digital wellbeing ; Automation ; Dark Patterns ; Attention Capture ; Digital Detox ; Instagram addiction ; Facebook ; Digital health ; Newsfeed ; Infinite newsfeed ; Self-nudging ; Co-creation

Acknowledgements

A ‘guru’ is a Sanskrit term that refers to a person who is a "teacher, guide, or master." I would like to give this title to my ‘Guru’, my advisor, Prof. Dr. Adrian Holzer. He truly deserves this. This work would not have been possible without his incessant support and guidance. Besides enhancing my academic skills, his mentorship has inspired me to pursue further research and contribute meaningfully to my field. It is he who has encouraged and motivated me when I needed it most and guided me in executing my ideas. I have repeatedly asked him questions, and he has always responded patiently. His trust and belief in me remained steadfast when I doubted my work. Throughout this work, he has guided me at every step. Your role as my doctoral ‘father’ will never change.

I would also like to thank my wonderful and interesting colleagues, some of whom have become lifelong friends. My heartfelt appreciation to Kristoffer Bergram, Romain Claret, Eliane Maalouf, Martina Raggi, Pierluigi Giosi, Selena Baset, Alessio De Santo, Michael Fuchs, Abdessalam Ouaazki and Michael Palma Mendes for being an amazing company to have thought-provoking conversations and stimulating exchanges over lunch breaks.

My family has always been the greatest support and blessing of my life. I have always been fascinated by science because of my father who instilled curiosity in me from an early age. In second place, my loving mother, whose love has been the driving force behind my achievements and my little brother Satyam who cared for the affairs back home while I was away doing my PhD. To my grandparents, I owe everything in my life, a sense of blessing that has always filled my life. Furthermore, I would like to thank my sisters Bhavini and Anukriti, who provided me with support when the times got tough and have always been there for me. My sincere thanks goes out to all of them.

Contents

Dedicated to Oli

Chapter 1

Introduction

1.1 Motivation and Scope

In this age, the consequences of social media has touched almost every spectrum of our lives. For instance, consider the role that Twitter played in disseminating information to the wider network for informing individuals about the volcano eruption. However, there are also negative consequences when misinformation reaches a wider audience, such as when BBC reported that fake news led to lynching of at-least 25 people across India [1]. Not just misinformation and political polarisation but there are more individualistic issues such as bullying, anxiety, or social media addiction. This thesis aims at better understanding how to address one of these individual issues, namely social media addiction.

In order to understand why and how individuals become addicted to social media platforms, we must first examine their business model. We notice that several of Internet's biggest service providers are free from the perspective of the end-user. One of the reasons that they are free is because the user's behavior is currently the means of production for several of these data-driven companies. That is, companies sell user attention to advertisers. While this increases the reach of many convenient Internet services it also has its implications. During the last couple of years several scholars, industry professionals and journalists have started to contend that the infrastructure of the

attention economy has some adverse societal consequences [2–4].

While these consequences range from bots influencing democratic elections, increased political polarization, misinformation in the media to digital addiction, this thesis will precisely answer the following question : how to mitigate social media addiction. During the last decade researchers have further triangulated the phenomenon of behavioral addiction related to technology [5–10].

In this thesis, we define social media addiction in line with [8] as being overly concerned about social media networks, to be driven by a strong motivation to log on to or use social media, and to devote so much time and effort to these applications that it impairs other social activities, studies/job, interpersonal relationships, and/or psychological health and well-being. In fact, various researchers have already found excessive technology use to be the reason behind mental distraction [3, 11], mental health problems [12] and degraded social interaction [13]. Psychological research also highlights that there is an inverse correlation between age and social media addiction [7], making children more vulnerable.

1.2 Digital Nudges

Thaler and Sunstein [14] in their book, *Nudge* suggested that policymakers can design decision-making contexts to promote change in behavior among citizens. They defined nudge as"... any aspect of the architecture of choice that changes people's behavior in a way predictable without prohibiting all options or significantly changing their incentives" [14]. Choice architecture is the informational structure of the environment, influencing the process in which the choices are made [15]. According to the behavioral economics, the general state of things represent a choice architecture, even when not designed for the particular effect [16]. Another often used definition of nudges

is by Wedge et al., [17] "the purposeful modification of the choice architecture that can influence the behavior of the people, helping individuals to make choices automatically". The psychological explanation as to why nudges work is related to cognitive biases and heuristics in human decision-making [14]. A long tradition of psychological research has demonstrated how factors such as scarcity, loss aversion, framing, social proof or availability and representativeness heuristics can be used to alter people's choices and behaviours [18–22].

During the last decade, scholars and practitioners have worked to demonstrate the effectiveness of nudges to change people's behavior online [23]. When nudges are used with online technologies in the form of SMS, notifications, mobile applications, and gamification to encourage people to act in the desired way it is referred to as digital nudge [24]. In the context of HCI, a 'digital nudge' refers to the use of user-interface design elements that guide people's choices or behaviors in digital decision environments [25]. For example, adding a decoy option in reward-based crowdfunding can make another option more attractive [26]. Given the widespread problems of social media addiction, digital nudging principles may hold many theoretical and practical solutions that can be used as interventions at scale. Social media companies are themselves taking advantage of digital nudges i.e., deliberately using digital nudges to encourage users to spend more time on their platforms. For instance, in the pull-to-refresh interaction technique(*infinite scrolling*), users can swipe down on a mobile app to manually refresh the status and see if there is new content, such as a new post from a friend. At the same time, digital nudges can be used to balance social media usage i.e., to make people feel more in control [27]. While research at the intersection of digital nudging and social media use is limited, design guidelines for digital nudges in contexts such as health, energy, privacy, and finance [23, 28] has shown promise as a tool in mitigating social media overuse.

1.3 Problem statement

The general problem statement of this thesis might be summarized as follows: How can digital nudging interventions be designed for digital wellbeing? We break down this question into six sub-questions before delivering some answers:

Q1: What is an adequate framework for designing digital nudges in digital sphere?

Q2: What is the landscape of digital nudging in digital health?

Q3: What is the relationship between friction and usability in the context of digital nudging?

Q4: What is the scope of self-nudging in the area of digital wellbeing?

Q5: Can co-creation of digital nudges improve digital wellbeing?

Q6: Is there a difference in the effect of digital intervention based on the type of compulsive user (less/more)?

1.3.1 Framework for designing digital nudges in digital sphere

Digital nudging requires consideration of many different aspects during the design process. For example, it is imperative that nudges are transparent and visible to users, as critics may conclude that they are manipulative and threaten individual autonomy. In the previous literature we find Ly et al., [29] outlined the development process of nudging. However, when and how the digital nudge should be delivered seems to be missing from the nudge development framework. Furthermore, another design related challenge i.e., context in nudging also appears to be in its infancy and is missing from the framework along with recognition of an optimal moment for the delivery of

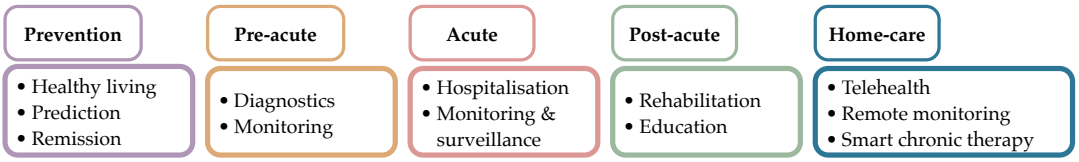
digital nudging interventions. In addition, previous researchers have emphasized that interventions should adapt to the changing internal and external state of individuals [30]. In a nutshell, we lack a comprehensive digital nudge design framework to guide and entail the process of overcoming the above challenges. Thus, greater knowledge of the design and practice of building digital nudges is urgently required raising the following question.

Q1: What is an adequate framework for designing digital nudges in digital sphere?

1.3.2 Digital nudges in Digital health: What works ? what does research say ? and what currently exists?

The use of nudges, i.e., design changes in the way choices are presented to steer users towards predetermined choices, has dramatically increased over the last few years. Online interventions in the form of digital nudges can now be found in many fields, including politics and healthcare.

FIGURE 1.1: *Continuum of care*



With the use of these mechanisms in healthcare growing exponentially in recent years, it is crucial that we understand both the opportunities and risks they present. We wonder about the characteristics of digital nudges and their application in the five general phases of the continuum of care in health as shown in the Fig - 1.1. This raises the following question:

Q2: What is the landscape of digital nudging in digital health?

1.3.3 Digital nudging in relation to friction and usability

Certainly the research on digital nudging has shown to hold promise to change a wide variety of behaviours [23]. Among the behaviors attracting researchers' attention is the time that people are spending on social media platforms. It is now widely recognized that social networking websites are addictive technologies filling social voids in people's lives and creating constant thrills [31]. A number of symptoms can indicate social networking website addiction, which can interfere with daily activities and normal functioning. The following symptoms could give a good indication 1) When the website is causing conflict with other tasks 2) Inability to access the website leads to rising negative emotions and 3) lack of ability to reduce the use of the website on a voluntary basis [31]. We wonder if digital nudging could be powerful catalysts to combat digital addiction. Yet it is unclear how digital nudges for digital addiction should be designed for addictive websites and which digital nudges actually work and how they could be improved. An important aspect is of usability when we arrive to the design making decisions. In short, the usability should remain intact and nudges should not degrade the apps/websites usability while making individuals mindful of their use of social media platforms. Therefore, this raises the following research question:

Q3: What is the relationship between friction and usability in the context of digital nudging?

1.3.4 Self-nudging and Co-creation of Digital nudges

The medium through which the social networking platform is accessed is also crucial. For instance, since mobile technologies have become ubiquitous, around 80% of social media use occurs on mobile devices and approximately

75% of Facebook users access the social media via their smartphones [6]. Two years ago, YouTube's CEO announced that the company had passed the threshold of 1.5 billion registered members and that these visitors (on average) were spending over an hour a day watching YouTube on mobile devices alone [32]. In 2016, Facebook's chief of marketing of North America reported that an average millennial checked their phone 157 times a day [33]. The above data points are promising from the perspective of mobile and social media marketing. It becomes more alarming when one realizes that, especially among young people, individuals barely have an average of six minutes of undivided attention [34].

To improve digital wellbeing on smartphones researchers have employed digital nudges such as vibration in the form of feedback nudge [35], limits [36]. However, in spite of the digital nudge's promise in the space of digital wellbeing, it has been criticized for being deceptive and privacy-invading. Privacy is an aspect of digital wellbeing that should not be overlooked [37]. Reijula et al., [38] suggested self-nudging as an alternative to nudging where an individual becomes his own choice architect. However, the application and research on self-nudging in the realm of digital wellbeing is sparse. This allows us to raise the following question:

Q4: What is the scope of self-nudging in the area of digital wellbeing?

Apart from self-nudging, one another alternative that we think that could reduce the privacy concerns and help individuals achieve digital wellbeing is the process of co-creation i.e, co-creation of digital nudges for digital wellbeing. Previously, prior research has shown that when individuals construct product themselves even when the product is mediocre users experience IKEA effect i.e., increased self-agency [39]. Similarly, the concept of co-creation has also been explored extensively in the context of consumer-company co-creation in which customers design products based

on pre-existing design tools provided by the company [40, 41]. Co-creation may increase an individuals awareness of being the creator of the product [42]. We assume the transparency of the intervention and sense of autonomy will lead do decreased sense of privacy risk and privacy concern. Hence, raising the following question:

Q5: Can co-creation of digital nudges improve digital wellbeing?

1.3.5 Effect of digital interventions based on the type of user

The research investigating various digital self-control artifact such as feedback to individuals about their usage delivered via notifications, dashboards, vibration and interventions such as limits hints that digital interventions seemed especially useful for users who experienced the most intense struggles for self-control or labeled themselves as addicted [43]. These struggles indicate how difficult it is to change strong (vs. weak) habits [44]. That is, stated intentions are at odds with actual behavior in the presence of strong habits, and this is especially salient when the environment is stable, because the cues triggering the habitual response typically come from the environment [45]. The previous literature certainly points to the general difficulty of changing strong habits with digital interventions as they tend to be less effective when habits are established. Thus, raising the following research question:

Q6: Is there a difference in the effect of digital intervention based on the type of compulsive user (less/more)?

1.4 Contributions

In this thesis the contributions of the above-stated questions are bundled together as a collection of studies. These studies include: (1) A novel theoretical

model that advances the process to design digital nudges i.e, inclusion of various stages related to identifying, inferring and delivery of digital nudges at an optimal moment (2) a systematic literature review of digital nudges and its application in digital health (3) a study that explores the relationship between friction and usability in digital nudging (4) An assessment of the scope of self-nudging and a mechanism for designing digital nudges to promote digital wellbeing. (5) A study examining the possibility to improve digital wellbeing through the co-creation of digital nudges and (6) evaluation and measurement of the effect of digital intervention on individuals who rate themselves as more compulsive users and those who don't. The following sections summarize the major contributions that have been made through the research conducted leading to this thesis.

1.4.1 Extending the process to design digital nudges

In this section, the first significant contribution is the extension and development of framework to design digital nudges for behavior change. The previous design frameworks omitted timing as a construct when several experiments have shown that "when" and "how" the digital nudges are delivered hold great importance. The re-design of the framework incorporated the following steps have been included: (1) Identifying the optimal digital nudge moment (2) Inferring this optimal moment and (3) Delivering the digital nudge at that moment.

1.4.2 Landscape of digital nudging in digital health

The second major contribution is the outcome of the review of existing empirical research on digital nudges in the digital healthcare. The results indicated that inclusion of digital nudging in digital health is increasing exponentially. The number of studies that include digital nudges have increased more than

160% since 2018. Among the 19 included studies, 30 nudges were used, as 7 studies employed two or more nudging techniques. The most common nudges used where feedback and reminders, their application lied on prevention and post-acute care. Surprisingly, none of the studies investigated default nudges.

Further, we identified privacy risks associated with digital nudging in digital health. More specifically, privacy, autonomy, and consent are ethical risks associated with digital nudging. The analysis indicated that only 1 study among the 19 studies included in the scoping review discussed the ethical and design implication of the digital nudges. There is definitely a scope to understanding the ethical boundaries of digital nudging that will allow practitioners in digital health to identify potential unintended nudges present on their digital support systems.

1.4.3 Development, measurement and deployment of digital nudges for digital wellbeing

In the third major contribution, we present a design evaluation of digital nudges and the sweet spot in which friction can be introduced while keeping usability intact, making Facebook users cognizant of their use of the app. The approach unveiled how different digital nudges such as feedback, hiding, pause-reminders, defaults, friction and hiding nudge should be designed for digital wellbeing. Our results show that interventions (1) helped users to become reflective of their social media usage, (2) possibly decreased their time spent, and (3) made the experience more pleasant.

The fourth major contribution is the introduction of a novel approach to self-nudging on smartphones. Not only do we introduce the methodology on how digital nudges can be self-designed by users but also evaluate a digital nudged namely "Misfeed" nudge that unhooks users from their mindless

scrolling. The results indicated the self-nudging can be effective to improve one's digital wellbeing and is a better alternative to pre-built intervention where users are not aware about the mechanics behind the digital nudges.

The fifth significant contribution is in regards to studying co-creation in design and development phase of the digital nudges and its impact on digital wellbeing. We employed the automation tool that was initially tested for self-nudging. The results indicated that the process of co-creation evoked a sense of IKEA effect while reducing privacy concerns and not impacting the usability of the target application. The users when co-create the digital nudges they experience inflated sense of agency and accomplishment and perceive the nudge to be useful for digital wellbeing.

Sixth and final contribution was in regards to the evaluation of a novel digital intervention that automatically reduced the newsfeed of Facebook to a minimum by employing real Facebook users (n = 138). We found that reducing the newsfeed is effective at cutting the time spent on Facebook's platform. Moreover, we also found that the effect of digital intervention did not change based on the type of compulsive user (less/more)

1.5 Form and structure

As opposed to a monograph, this thesis is arranged more as a series of essays. Having this structure has both advantages and disadvantages. On the plus side, each chapter of the thesis may be read as a stand-alone piece. It does, however, lead to redundancy and some differences in the descriptions that have developed during the process. I have divided my contribution into a number of scientific articles that have been published or that are being reviewed by international peer-reviewed journals or conferences in the area of computer science and information systems. This thesis presents a collection of essays in three sections. Each article is a chapter, arranged based on the

subject it discusses. Each chapter focuses on one of the problems specified in the problem statement.

Part I provides a better understanding of the framework to design and develop digital nudges. More specifically, Chapter 2 investigates how to design digital nudges for behavior change and expands the existing framework to include timing of digital nudges to be an important factor to determine the success of digital nudges to change behaviour (Q1).

- Aditya Kumar Purohit and Adrian Holzer. "Functional Digital Nudges: Identifying Optimal Timing for Effective Behavior Change". In: Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems. CHI EA '19. Glasgow, Scotland Uk: ACM, 2019.

In Part II, we determine how digital nudges are employed for various other health related prognosis. Precisely, the Chapter 3 investigates the landscape of digital nudging and its application at various phases of the digital health continuum (Q2).

- Aditya Kumar Purohit, Sofia Schöbel and Adrian Holzer. "Nudging to change, the role of digital health". In: Health Informatics. Digital Health: From Assumptions to Implementations, 2023.

In Part III, digital nudges for digital wellbeing are developed, and their efficacy and usability are measured. Chapter 4 looks at and evaluates various types of digital nudges and relationship between friction and usability in the context of digital nudging. Chapter 5 evaluates how successfully automation may be used as a tool for developing self-nudging interventions (Q4). Chapter 6 investigates the process of co-creation of digital nudges for digital wellbeing on smartphones (Q5). Chapter 7 analyzes the impact of reducing newsfeed and relation between compulsive use and effectiveness of the intervention (Q6). In total, it includes 4 four experimental studies

- Aditya Kumar Purohit, Louis Barclay, and Adrian Holzer. "Designing for Digital Detox: Making Social Media Less Addictive with Digital Nudges". In: Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems. CHI EA '20. Honolulu, HI, USA: Association for Computing Machinery, 2020, pp. 1–9.

- Aditya Kumar Purohit and Adrian Holzer. "Unhooked by Design: Scrolling Mindfully on Social Media by Automating Digital Nudges". In: Americas Conference on Information Systems (AMCIS 2021).

- Aditya Kumar Purohit, Torben Jan Barev, Sofia Schöbel, Andreas Janson and Adrian Holzer. "Designing for Digital Wellbeing on a Smartphone: Co-creation of Digital Nudges to Mitigate Instagram Overuse". In: Hawaii International Conference on System Sciences (HICSS 2023).

- Aditya Kumar Purohit, Kristoffer Bergram, Louis Barclay, Valéry Bezençon and Adrian Holzer. "Starving the Newsfeed for Social Media Detox: Effects of Strict and Self-regulated Facebook Newsfeed Diets". In: CHI Conference on Human Factors in Computing Systems (CHI'2023)

References

[1] Soutik Biswas. *On the frontline of India's Whatsapp Fake News War*. Aug. 2018. URL: https://www.bbc.com/news/world-asia-india-45140158.

[2] Robert Epstein and Ronald E Robertson. "The search engine manipulation effect (SEME) and its possible impact on the outcomes of elections". In: *Proceedings of the National Academy of Sciences* 112.33 (2015), E4512–E4521.

[3] Gloria Mark, Mary Czerwinski, and Shamsi T Iqbal. "Effects of Individual Differences in Blocking Workplace Distractions". In: *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. ACM. 2018, p. 92.

[4] Robert Epstein. "The Search Suggestion Effect (SSE): How Autocomplete Can Be Used to Impact Votes and Opinions". In: 2017.

[5] Daria J Kuss and Mark D Griffiths. "Online social networking and addiction—a review of the psychological literature". In: *International journal of environmental research and public health* 8.9 (2011), pp. 3528–3552.

[6] Daria J Kuss and Mark D Griffiths. "Social networking sites and addiction: Ten lessons learned". In: *International journal of environmental research and public health* 14.3 (2017), p. 311.

[7] Cecilie Schou Andreassen et al. "The relationship between addictive use of social media and video games and symptoms of psychiatric disorders: A large-scale cross-sectional study." In: *Psychology of Addictive Behaviors* 30.2 (2016), p. 252.

[8] Cecilie Schou Andreassen. "Online social network site addiction: A comprehensive review". In: *Current Addiction Reports* 2.2 (2015), pp. 175–184.

[9] Cecilie Schou Andreassen, Torbjørn Torsheim, and Ståle Pallesen. "Predictors of use of social network sites at work-a specific type of cyberloafing". In: *Journal of Computer-Mediated Communication* 19.4 (2014), pp. 906–921.

[10] Joël Billieux et al. "Problematic involvement in online games: A cluster analytic approach". In: *Computers in Human Behavior* 43 (2015), pp. 242–250.

[11] Morgan G. Ames. "Managing Mobile Multitasking: The Culture of iPhones on Stanford Campus". In: *Proceedings of the 2013 Conference on Computer Supported Cooperative Work*. CSCW '13. San Antonio, Texas, USA: ACM, 2013, pp. 1487–1498. ISBN: 978-1-4503-1331-5. DOI: 10.1145/2441776.2441945.

[12] Klodiana Lanaj, Russell E. Johnson, and Christopher M. Barnes. "Beginning the workday yet already depleted? Consequences of late-night smartphone use and sleep". In: *Organizational Behavior and Human Decision Processes* 124.1 (2014), pp. 11–23. ISSN: 0749-5978. DOI: https://doi.org/10.1016/j.obhdp.2014.01.001.

[13] Yu-Kang Lee et al. "The dark side of smartphone usage: Psychological traits, compulsive behavior and technostress". In: *Computers in Human Behavior* 31 (2014), pp. 373–383. ISSN: 0747-5632. DOI: https://doi.org/10.1016/j.chb.2013.10.047.

[14] Richard H Thaler and Cass R Sunstein. *Nudge: Improving decisions about health, wealth, and happiness*. Penguin, 2009.

[15] Eldar Shafir. *The behavioral foundations of public policy*. Princeton University Press, 2013.

[16] Matthias Lehner, Oksana Mont, and Eva Heiskanen. "Nudging–A promising tool for sustainable consumption behaviour?" In: *Journal of Cleaner Production* 134 (2016), pp. 166–177.

[17] Carey K Morewedge et al. "Debiasing decisions: Improved decision making with a single training intervention". In: *Policy Insights from the Behavioral and Brain Sciences* 2.1 (2015), pp. 129–140.

[18] Daniel Kahneman and Amos Tversky. "Prospect Theory: An Analysis of Decision under Risk". In: *Econometrica* 47.2 (1979), pp. 263–91.

[19] Amos Tversky and Daniel Kahneman. "The framing of decisions and the psychology of choice". In: *Science* 211.4481 (1981), pp. 453–458.

[20] Daniel Kahneman. "A perspective on judgment and choice: mapping bounded rationality." In: *American psychologist* 58.9 (2003), p. 697.

[21] Jerry M Burger and David F Caldwell. "The effects of monetary incentives and labeling on the foot-in-the-door effect: Evidence for a self-perception process". In: *Basic and applied social psychology* 25.3 (2003), pp. 235–241.

[22] Stephen Worchel, Jerry Lee, and Akanbi Adewole. "Effects of supply and demand on ratings of object value." In: *Journal of personality and social psychology* 32.5 (1975), p. 906.

[23] Ana Caraban et al. "23 Ways to Nudge: A Review of Technology-Mediated Nudging in Human-Computer Interaction". In: *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. ACM. 2019, p. 503.

[24] Aditya Kumar Purohit and Adrian Holzer. "Functional Digital Nudges: Identifying Optimal Timing for Effective Behavior Change". In: *Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems*. CHI EA '19. Glasgow, Scotland Uk: ACM, 2019. ISBN: 978-1-4503-5971-9. DOI: 10.1145/3290607.3312876.

[25] Markus Weinmann, Christoph Schneider, and Jan vom Brocke. "Digital nudging". In: *Business & Information Systems Engineering* 58.6 (2016), pp. 433–436.

[26] Christoph Schneider, Markus Weinmann, and Jan vom Brocke. "Digital Nudging: Guiding Online User Choices Through Interface Design". In: *Commun. ACM* 61.7 (June 2018), pp. 67–73. ISSN: 0001-0782. DOI: 10.1145/3213765.

[27] Aditya Kumar Purohit and Adrian Holzer. "Functional Digital Nudges: Identifying Optimal Timing for Effective Behavior Change". In: *Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems*. CHI EA '19. Glasgow, Scotland Uk: Association for Computing Machinery, 2019, pp. 1–6. DOI: 10.1145/3290607.3312876.

[28] Dennis Hummel and Alexander Maedche. "How effective is nudging? A quantitative review on the effect sizes and limits of empirical nudging studies". In: *Journal of Behavioral and Experimental Economics* 80 (2019), pp. 47–58.

[29] Kim Ly et al. "A practitioner's guide to nudging". In: *Rotman School of Management Working Paper* 2609347 (2013).

[30] Inbal Nahum-Shani et al. "Just-in-time adaptive interventions (JITAIs) in mobile health: key components and design principles for ongoing health behavior support". In: *Annals of Behavioral Medicine* 52.6 (2018), pp. 446–462.

[31] Ofir Turel and Alexander Serenko. "The benefits and dangers of enjoyment with social networking websites". In: *European Journal of Information Systems* 21.5 (2012), pp. 512–528.

[32] YouTube. *Updates from VidCon: more users, more products, more shows and much more.* Website. Available at: https://edu.nl/wmwxr. June 2017.

[33] Shoshana Zuboff. *The age of surveillance capitalism: The fight for a human future at the new frontier of power*. Profile Books, 2019.

[34] Larry D. Rosen, L. Mark Carrier, and Nancy A. Cheever. "Facebook and texting made me do it: Media-induced task-switching while studying". In: *Computers in Human Behavior* 29.3 (2013), pp. 948–958. ISSN: 0747-5632. DOI: https://doi.org/10.1016/j.chb.2012.12.001.

[35] Fabian Okeke et al. “Good vibrations: can a digital nudge reduce digital overload?” In: *Proceedings of the 20th international conference on human-computer interaction with mobile devices and services*. 2018, pp. 1–12.

[36] Jaejeung Kim et al. “Goalkeeper: Exploring interaction lockout mechanisms for regulating smartphone use”. In: *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 3.1 (2019), pp. 1–29.

[37] Kelly Widdicks. “When the Good Turns Ugly: Speculating Next Steps for Digital Wellbeing Tools”. In: *Proceedings of the 11th Nordic Conference on Human-Computer Interaction: Shaping Experiences, Shaping Society*. 2020, pp. 1–6.

[38] Samuli Reijula and Ralph Hertwig. “Self-nudging and the citizen choice architect”. In: *Behavioural Public Policy* 6.1 (2022), pp. 119–149.

[39] Michael I Norton, Daniel Mochon, and Dan Ariely. “The IKEA effect: When labor leads to love”. In: *Journal of consumer psychology* 22.3 (2012), pp. 453–460.

[40] Nikolaus Franke and Frank Piller. “Value creation by toolkits for user innovation and design: The case of the watch market”. In: *Journal of product innovation management* 21.6 (2004), pp. 401–415.

[41] C Page Moreau, Leff Bonney, and Kelly B Herd. “It’s the thought (and the effort) that counts: How customizing for others differs from customizing for oneself”. In: *Journal of Marketing* 75.5 (2011), pp. 120–133.

[42] Sigurd Villads Troye and Magne Supphellen. “Consumer participation in coproduction:“I made it myself” effects on consumers’ sensory perceptions and evaluations of outcome and input product”. In: *Journal of marketing* 76.2 (2012), pp. 33–46.

[43] Ulrik Lyngs et al. "The Goldilocks level of support: Using user reviews, ratings, and installation numbers to investigate digital self-control tools". In: *International journal of human-computer studies* 166 (2022), p. 102869.

[44] Wendy Wood and David T Neal. "The habitual consumer". In: *Journal of Consumer Psychology* 19.4 (2009), pp. 579–592.

[45] Unna N Danner, Henk Aarts, and Nanne K De Vries. "Habit vs. intention in the prediction of future behaviour: The role of frequency, context stability and mental accessibility of past behaviour". In: *British Journal of Social Psychology* 47.2 (2008), pp. 245–265.

Part I

Framework for Designing Digital Nudges

Chapter 2

Functional Digital Nudges: Identifying Optimal Timing for Effective Behavior Change

CHI'19 Extended Abstracts
ISBN: 978-1-4503-5971-9/19/05

Abstract – Digital nudges hold enormous potential to change behavior. Despite the appeal to consider timing as a critical factor responsible for the success of digital nudges, a comprehensive organizing framework to guide the design of digital nudges considering nudge moment is yet to be provided. In this paper, we advance the theoretical model to design digital nudges by incorporating three key components: (1) Identifying the optimal digital nudge moment (2) Inferring this optimal moment and (3) Delivering the digital nudge at that moment. We further discuss the existing work and open research avenues.

2.1 Introduction

Thaler and Sunstein [1] suggested that policymakers can design nudges to promote change in behavior among citizens. They defined a nudge as "any

aspect of the architecture of choice that changes people's behavior in a way predictable without prohibiting all options or significantly changing their incentives" [1]. Nudges assist in modifying the behavior by changing the way we see things and making a person more sensitive to one option [2]. Consumers accept nudges because they retain their freedom of choice [3]. Exhibiting the low-cost advantage with the potentiality to shape behavior [4], government organizations have successfully used nudges in public wellness campaigns [5], such as promoting smoking cessation [6], influencing food choices [7], or promoting pro-environmental consumption behavior [8].

The omnipresence of mobile devices with online communication has enabled the creation of *digital nudges* [9]. These digital nudges use online technologies such as SMS, notifications, mobile applications, and gamification to encourage people to act in the desired way. Research shows that digital nudges can have propelling effect on behavior and influence decisions of the individual [10]. An example of such a nudge is the gamification of physical activity by providing mobile application users with badges and points when they reach specific goals to increase physical activity [11].

However, the success of the receptivity of nudges has shown to be varying depending on their timing [12]. Deploying early nudges could lead to forgetfulness and provision of late nudges could shrink the time available for action [13]. Even though this issue has been raised, identifying the appropriate time to turn a potential digital nudge into what we call a *functional digital nudge*, that is a digital nudge that can effectively change behavior, is mainly an unresolved issue [14]. In this paper, we advocate for the investigation of this issue and propose open research avenues.

2.2 Designing Functional Digital Nudges

Schneider et al. [15] provided a general framework for designing digital nudges. The design process proposed to design digital nudges was similar to the systems development cycle (planning, analysis, design, implementation) - see Figure 2.1. Step 1 in the cycle was to define the goal - Investigating the organization's goal (e.g., increasing sales, increasing pledges). Step 2 was to understand and recognize user heuristic and biases (availability heuristic, representativeness heuristic). Step 3 was concerned about designing the nudges and Step 4 dealt with testing the nudges. Assessing the significance of the timing of digital nudges, we propose to extend this framework by including three additional components : (1) Step 2.1 identifying the optimal digital nudge moment (2) Step 2.2 inferring the optimal digital nudge moment (3) Step 3.1 delivering the digital nudge at the optimal moment.

2.3 Identifying the optimal digital nudge moment (2.1)

In health education research, McBride, Emmons, and Lipkus [16] introduced the notion of *teachable moments* to motivate individuals to change their behavior. A teachable moment has been described as "naturally occurring health events thought to motivate individuals to adopt risk-reducing health behaviors spontaneously." For example, an intervention for smoking cessation for women could be appropriate during the perinatal period [17]. Sunstein mentioned that timing matters for reminder type nudges [18]. For instance, in an offline setting, Sinning and Gillitzer [13] presented theoretical and empirical evidence on how different timings of nudges had an impact on tax payments. However, the specific payment behavior was investigated in a field experiment using a simple reminder letter and suggested to use early

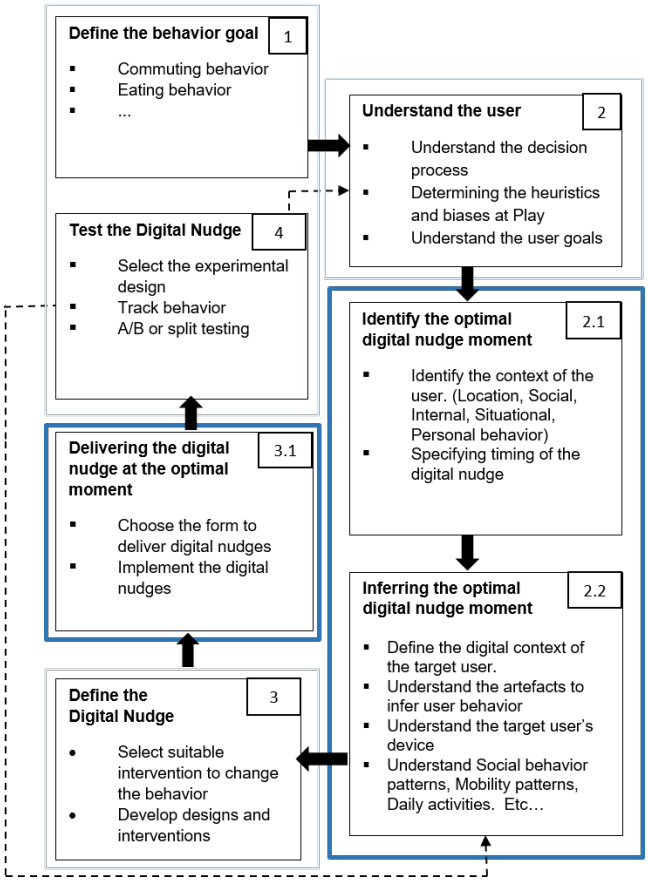


FIGURE 2.1: A theoretical model for designing digital nudges for behavior change. Components 1,2,3,4 - from the existing theoretical model by Schneider et al. [15]. Components 2.1, 2.2, 3.1 - added to advance the theoretical framework

reminders. Nevertheless, this study was confined to tax payment behavior and did not identify a specific nudging sweet spot. From the literature, we grasp the importance of timing to the success of digital nudges beyond reminders. Table 2.1 presents studies indicating how significant the timing is for various digital nudges.

The studies selected are from diverse disciplines like Information systems, Medical research, Policy Analysis, and Digital games. Besides the research by Intille et al. [19] that concentrated on "Just-in-Time" technology, other studies do not explicitly work on adapting digital nudges with timing. Nevertheless, we infer from studies the importance of timing digital nudges to achieve the goal. For instance, to motivate an incremental dietary behavior change, Intille et al. [19] proposed that the information should be provisioned

TABLE 2.1: Significance of Timing for various digital nudges

Type of digital nudge	Sig.	Delivery Medium
Provision of Information[19]	High	PDA$_{(1)}$
Feedback[20]	High	Mandometer$_{(2)}$
Reminder[21]	High	Mobile Phone$_{(3)}$
Default[22]	Low	Email$_{(4)}$
Game rewards[23]	High	Games$_{(5)}$

Associated goals :
(1) - Better dietary decision making
(2) - Normalize eating behavior
(3) - Increase payment of court fines
(4) - Increase web survey participation
(5) - Create sense of value and accomplishment

on a PDA (personal digital assistant) when the user was at the point of purchase (nudge moment). Another study investigated how to modify eating behavior for weight loss in obese adolescents [20]. The researchers provided participants with real-time feedback during meals (nudge moment) to slow down their eating speed.

Open research avenues In recent work, Meske and Potthoff [14] argued that the timing of nudge is an essential aspect of persuasion and present nudging tools are missing this crucial facet. Furthermore, it is still unclear to which behaviors timing of digital nudges is indispensable. Understanding optimal timing will lead to the identification of *nudge moments*. To simplify the understanding of the nudge moments, we have inferred various contexts from communication studies and classified them as potential dimensions of nudge moments in five categories (Figure 2.2). A nudge moment can include one or more of these dimensions. For each moment, the nudge could be timed before, during, or after it occurs. Digital nudge designers should implement validation techniques to validate the effectiveness of the digital nudges at different times.

Classification of nudge moments	
Categorization	**Dimensions**
Location context	Location, Address, Proximity with non-living things, mobility patterns
Social context	Proximity to living beings, social interactions, etc.
Internal context	Heart rate, moods, emotions, mental health, well-being, etc.
Situational context	Date, Weather, Time, Any event
Personal behavior	Smoking, eating, sleeping, waking up, running, etc.

FIGURE 2.2: Classification of nudge moments

Example scenario Imagine Tom, a 22-year-old design major. Tom agonizes with his increasing weight. His doctor has suggested maintaining a healthy diet by increasing protein intake and reducing carbohydrates. A nudge moments can be the moment right before Tom decides where to eat at lunch to nudge his restaurant choice to a better option. Another moment would then be right when he receives the menu in a restaurant to nudge his choice to a healthier option. This moment would have a combination of location context (a restaurant), situational context (lunchtime, after entering the restaurant), and behavioral context (sitting down, having received the menu).

2.4 Inferring the optimal digital nudge moment (2.2)

Inferring the timing for the digital nudge implies that designers understand the digital context of the target user concerning software and hardware. As digital devices have become an intrinsic part of our lives, mobile sensing technologies can be employed to interpret user behavior. The mobile phones equipped with sensors can record sociability and mobility behaviors [24]. In

a study by Mehl, Gosling and Pennebaker [25], an Electronically Activated Recorder (EAR) was used to infer users social interaction, daily activities, and mobility patterns. Similarly, Wang et al. [26], inferred the studying behavior of the students using combinations of mobile sensing technologies. For instance, a Microphone to determine if the environment was noisy or silent. An accelerometer can be used to ascertain if the phone is in activity by the user. GPS and WiFi data to ascertain if the student was in the library or study area. Inferring time of the day is trivial for any digital device. However, inferring past/current or future activity as well as context can be challenging. Sensors can help identify certain behaviors, such as sleeping or running, and particular contexts, such as location.

Open research avenues Using smartphone sensing, researchers have overcome the challenges of traditional methods of inferring behavior. However, it is still a challenge to monitor behavior patterns throughout a day across wide-ranging components of behavioral science. Another research avenue should further investigate how to combine different sensor technologies to operate as behavioral predictors and infer the behavior of user post-intervention. At the same time, the data required for predicting and inferring behaviors should be minimized as privacy is a significant concern.

Example scenario In the case of Tom, the location context (inside a restaurant) can be inferred with GPS, the situational context (lunchtime, after entering the restaurant) with a clock and a timer, and the behavioral context (sitting down) with a gyroscope and accelerometer. All these sensors are part of any smartphone. However inferring the exact moment when Tom is about to decide what to eat is not trivial (e.g., after receiving the menu). One could

Forms to deliver digital nudges	Requisite proximity with the device
Push notifications, SMS	At hand
Vibration, Ringtone	Within reach
In-App notifications	In use
Digital badges	In use
Ambient light/ LED Notifications'	Within reach

FIGURE 2.3: Proximity of device with user concerning various forms to deliver digital nudges

imagine that this could be inferred using an RFID chip in the menu which would be activated when Tom is nearby.

2.5 Delivering the digital nudge at the optimal moment (3.1)

After inferring the nudge moments, it is crucial to identify a suitable digital form for the delivery of digital nudges. Today various digital devices like smartphones [27] and fitness trackers [28] can leverage digital nudges to steer people in a particular direction using delivery methods such as sound and vibration notifications. Furthermore, user interfaces use banners, badges and other visible icons to draw user attention online. It should be noted that the delivery mode is not limited to personal devices and can include connected and ambient objects (e.g., lights, public displays, connected fridges).

Open research avenues Even though many delivery methods exist, the form in which digital nudge is most useful for a particular behavior needs

further investigation. For instance, in which form will the feedback nudge be most effective on various devices for commuting behavior, through push notification, vibration or text SMS? An understanding of the most effective form of delivery for various digital nudge types for target behaviors will assist in reducing the attempts of trial and error and save the time of nudge designers. In Figure 2.3, we identify that special attention is needed to be given to the device's proximity to the self when choosing different forms to deliver digital nudges. In particular, research should investigate unorthodox delivery methods through connected objects which are bound to become more and more present in our homes, cars, and cities.

Example Scenario In Tom's example, the digital nudge could be to gamify his food consumption by allowing him to track his food intake habits and set his goals. This nudge can be delivered directly through a push notification on his phone when he is about to order. The notification could direct him to his food tracking app. If the menu itself was a connected tablet, it could directly show how each option would affect Tom's score.

2.6 Conclusion

Digital technologies can harness the power of nudges by making them a useful tool for behavior change. It is important to identify favorable timing of digital nudges by taking advantage of mobile devices and online communication. In this paper, we attempted to provide a framework that could assist in designing timely functional digital nudges and a roadmap of open questions that still need to be addressed. It is relevant to note that the success of several digital nudges relies on their timely delivery. Future research can consider the open research avenues presented in this paper, imparting us with a temporal sweet spot for digital nudging.

References

[1] Cass R Sunstein and Richard H Thaler. *Nudge: Improving decisions about health, wealth, and happiness*. Yale University Press, 2008.

[2] Neil Levy. "Nudges in a post-truth world". In: *Journal of medical ethics* 43.8 (2017), pp. 495–500.

[3] Alain Samson. *The behavioral economics guide 2017 (with an introduction by Cass Sunstein)*. 2017.

[4] Matthias Lehner, Oksana Mont, and Eva Heiskanen. "Nudging–A promising tool for sustainable consumption behaviour?" In: *Journal of Cleaner Production* 134 (2016), pp. 166–177.

[5] Richard H Thaler and Shlomo Benartzi. "Save more tomorrow™: Using behavioral economics to increase employee saving". In: *Journal of political Economy* 112.S1 (2004), S164–S187.

[6] Xavier Giné, Dean Karlan, and Jonathan Zinman. "Put your money where your butt is: a commitment contract for smoking cessation". In: *American Economic Journal: Applied Economics* 2.4 (2010), pp. 213–35.

[7] Amy L. Wilson et al. "Nudging healthier food and beverage choices through salience and priming. Evidence from a systematic review". In: *Food Quality and Preference* 51 (2016), pp. 47–64. ISSN: 0950-3293. DOI: https://doi.org/10.1016/j.foodqual.2016.02.009. URL: http://www.sciencedirect.com/science/article/pii/S0950329316300210.

[8] Hunt Allcott. "Social norms and energy conservation". In: *Journal of public Economics* 95.9-10 (2011), pp. 1082–1095.

[9] Julia Dhar et al. "The Persuasive Power of the Digital Nudge". In: 2017.

[10] Linda Miesler et al. "Informational nudges as an effective approach in raising awareness among young adults about the risk of future disability". In: *Journal of Consumer Behaviour* 16.1 (2017), pp. 15–22.

[11] Tim Althoff, Ryen W White, and Eric Horvitz. "Influence of Pokémon Go on physical activity: study and implications". In: *Journal of medical Internet research* 18.12 (2016).

[12] Michael Hallsworth et al. *EAST Four simple ways to apply behavioural insights*. 2014.

[13] Mathias Sinning and Christian Gillitzer. "Nudging Businesses to Pay Their Taxes: Does Timing Matter?" In: (2018).

[14] Christian Meske and Tobias Potthoff. "THE DINU-MODEL – A PROCESS MODEL FOR THE DESIGN OF NUDGES". In: *Proceedings of the 25th European Conference on Information Systems (ECIS)*. 2017, pp. 2587–2597.

[15] Christoph Schneider, Markus Weinmann, and Jan vom Brocke. "Digital nudging: guiding online user choices through interface design". In: *Communications of the ACM* 61.7 (2018), pp. 67–73.

[16] Colleen M McBride, Karen M Emmons, and Isaac M Lipkus. "Understanding the potential of teachable moments: the case of smoking cessation". In: *Health education research* 18.2 (2003), pp. 156–170.

[17] Judith K Ockene et al. "Spontaneous cessation of smoking and alcohol use among low-income pregnant women". In: *American Journal of Preventive Medicine* 23.3 (2002), pp. 150–159.

[18] Cass R Sunstein. "Nudging: a very short guide". In: *Journal of Consumer Policy* 37.4 (2014), pp. 583–588.

[19] Stephen S Intille et al. "Just-in-time technology to encourage incremental, dietary behavior change". In: *AMIA Annual Symposium Proceedings*. Vol. 2003. American Medical Informatics Association. 2003, p. 874.

[20] Anna L Ford et al. "Treatment of childhood obesity by retraining eating behaviour: randomised controlled trial". In: *Bmj* 340 (2010), b5388.

[21] Laura C Haynes et al. “Collection of delinquent fines: An adaptive randomized trial to assess the effectiveness of alternative text messages”. In: *Journal of Policy Analysis and Management* 32.4 (2013), pp. 718–730.

[22] Liyin Jin. “Improving response rates in web surveys with default setting: The effects of default on web survey participation and permission”. In: *International Journal of Market Research* 53.1 (2011), pp. 75–94.

[23] Hao Wang and Chuen-Tsai Sun. “Game reward systems: Gaming experiences and social meanings.” In: *DiGRA Conference*. 2011.

[24] Gabriella M Harari et al. “Using smartphones to collect behavioral data in psychological science: opportunities, practical considerations, and challenges”. In: *Perspectives on Psychological Science* 11.6 (2016), pp. 838–854.

[25] Matthias R Mehl, Samuel D Gosling, and James W Pennebaker. “Personality in its natural habitat: Manifestations and implicit folk theories of personality in daily life.” In: *Journal of personality and social psychology* 90.5 (2006), p. 862.

[26] Rui Wang et al. “SmartGPA: how smartphones can assess and predict academic performance of college students”. In: *Proceedings of the 2015 ACM international joint conference on pervasive and ubiquitous computing*. ACM. 2015, pp. 295–306.

[27] Neal Lathia et al. “Smartphones for large-scale behavior change interventions”. In: *IEEE Pervasive Computing* 3 (2013), pp. 66–73.

[28] Alycia N Sullivan and Margie E Lachman. “Behavior change with fitness technology in sedentary adults: a review of the evidence for increasing physical activity”. In: *Frontiers in public health* 4 (2017), p. 289.

Part II

Evolution of Digital Nudges in Digital health

Chapter 3

Nudging to change, the role of digital health

Digital Health: From Assumptions to Implementations, 2023.

ISBN: 978-3-031-17665-4

Abstract – The use of nudges, i.e., design changes in the way choices are presented to steer users towards predetermined choices, has dramatically increased over the last few years. These interventions have moved online to become digital and are present across many fields from politics to healthcare. As the use of these mechanisms in healthcare has grown exponentially recently, it is crucial to understand the opportunities they offer and the risks they pose. However, at this stage, such an analysis is lacking. This chapter specifically addresses this issue by (1) analyzing how digital nudges can be applied in the continuum of care and (2) mapping the current empirical research landscape on the topic. To do so, this chapter presents a scoping review of the literature by searching relevant research in the electronic database of JMIR (Journal of Medical Internet Research). The search yielded 150 unique articles, of which 19 articles satisfied the criteria for inclusion in this study. The results indicate that feedback and reminders are the most commonly used digital nudges for behavior change in digital health. Moreover, the results show that most digital nudges research focuses on

prevention and the post-acute phase of the continuum of care, with none of the studies investigating nudges for the acute phase. Finally, the results indicate that current empirical research on digital nudging in healthcare only rarely discusses ethical considerations.

Keywords Digital health, Digital nudging, Nudging, Continuum of care, Ethics of nudging, Scoping review

3.1 Introduction

Most diseases can be prevented by assisting people to change their habitual risky behaviors [1]. A variety of risky behaviors are negatively associated with health, including being sedentary [2], smoking [3], eating unhealthy foods [4], and binge-drinking [5]. If people change their health risk behavior, they can reduce their risk of developing diseases that cause premature sickness and death, like cancer and heart disease [1]. A case in point would be that millions of premature deaths are preventable if individuals stop smoking cigarettes, which not only cause lung cancer [6] but also increase the risk of pulmonary and cardiovascular diseases [7].

Historically, interventions to change risky health behaviors were offered in service settings or within communities, but today, this is no longer the only way to do so. Through the IT infrastructure that has been developed with data from patients and service providers [8], research and practice in digital health have become more relevant to clinical needs. Through continuous, real-time, and objective measurements of physiological parameters and motion activity, it has become possible to change risky behaviors through digital interventions. However, this is a challenging task as it requires combining evidence-based approaches with trust in technology while respecting patient autonomy and consent.

A potential behavioral theory that could be leveraged to address this issue is nudge theory [9]. Behavioral economists have proposed the idea of nudging, which uses human cognitive processes to direct people towards the desired behavior without restricting user choice [9]. This theory is gaining traction in the digital health context as researchers have started to apply it to different contexts such as mental health [10], smoking cessation [11], weight management [12], medicine adherence [13], and digital well-being [14] to name a few. Despite these examples, there is currently no unified picture of how digital nudges are used in healthcare and where the state of research stands. In this chapter, we address this issue by mapping the landscape of digital nudging for healthcare. In particular, the chapter will summarize which specific health behaviors are targeted, which nudging techniques have been employed for behavior change and how these strategies have been delivered, and their ethical implications. In an examination of the nudging landscape in digital health, two main research questions will be addressed:

- RQ1: What kind of digital nudge strategies can be leveraged to improve health?
- RQ2: How can digital nudge strategies be used to support behaviour change on the continuum of care?

The remainder of this chapter is structured as follows. First, the background provides a definition of "nudging" and "digital nudging" in the context of behavior change. Second, existing digital nudging strategies are detailed and their employment in continuum of care are illustrated. Third, the current state of the literature is discussed through a scoping review of the JMIR electronic database. Finally, the chapter wraps up with a conclusion.

3.2 Background

Originally, Thaler and Sunstein [9] suggested that policymakers can design nudges to promote change in behavior among citizens. They defined a nudge as "any aspect of the architecture of choice that changes people's behavior in a way predictable without prohibiting all options or significantly changing their incentives" [9]. To modify behavior, nudges change how we see things and make people more receptive to one option [15]. A typical example is the way products are displayed in cafeteria, the more prominent, the greater the chance a customer will select them [9]. Meanwhile, researchers and practitioners have taken the nudging concept online, resulting in so-called digital nudges. The term digital nudges refer to nudges that are provided through digital technology and employ user-interface design elements to influence people's decisions and behaviors [16], again without restricting choice [17]. For instance, intuitively reminding individuals by giving them feedback about their Instagram use while they are mindlessly scrolling through their Instagram news feed can help them reduce their consumption [14]. Especially, digital nudges delivered via mobile devices are becoming increasingly common. As a result of recent technological advancements, mobile phones have acquired new and distinctive characteristics that make them a compelling behaviour change support system. These characteristics include (1) their ability to gather contextual and bio-metric data from users, such as location, movement, or heart rate, (2) their ability to be reached by users at anytime as they carry their phones around almost 24/7, and (3) their ability to potentially reach their users through at any time through notifications.

These characteristics imply that delivery of digital nudges can be much

more fine tuned than traditional nudges to fit optimal timing [18]. More precisely, through adequate identification of user context, nudges can take advantage of so-called *teachable moments* [18] i.e., "naturally occurring health events thought to motivate individuals to adopt risk-reducing health behaviours spontaneously." For example, a woman might benefit from a smoking cessation intervention during the perinatal period [19]. In an attempt to motivate incremental dietary behaviour change, Intille et al. [20] suggested that information should be provided on a PDA (personal digital assistant) at the time of purchase (the nudge moment). Another study examined how weight loss could be achieved by altering eating behavior in obese adolescents [21]. The study indicated that real-time feedback was given to the participants during meals (the nudge moment) to help them eat more slowly. It should be noted that despite these examples, of "just-in-time" technology, most other studies do not address digital nudges explicitly with timing.

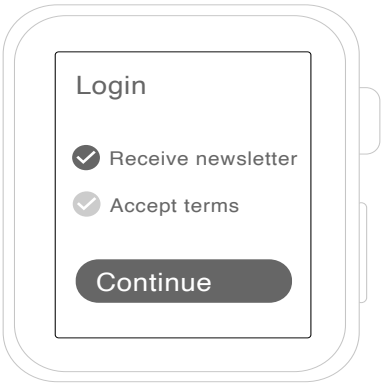
3.3 Digital nudging strategies

This section outlines different strategies of digital nudging used to influence human behavior exemplified in the context of digital health. The digital nudges outlined here have been adopted from Caraban et al. [22], they are: defaults, reminders, feedback, social, framing, suggesting alternatives, and positioning. Several nudges such as hiding, scarcity, and deceptive visualisations and many others are not included as they do not fall within the scope of healthcare. In addition to different digital nudging strategies and examples from healthcare research, we also present scenarios that illustrate how clinicians and designers might apply digital nudges in healthcare. Consider James. He is overweight and sedentary. Through the app store, James has downloaded an application called *Fitness* to his smartwatch that will help him increase physical activity and manage his weight.

3.3.1 Default nudge

A default nudge occurs whenever there is a predefined option chosen by a system designer. A prime example of default is the initial organ donation status of a person in a country, i.e., their default status. In some countries, people are organ donors by default and they have to actively opt out, whereas in other countries, people are not organ donors by default and they have to actively opt in. The status quo bias of human psychology is such that people will tend not to change default settings. As a result, the number of people on the organ donor list increased by 60% in countries where it is the default option compared to the national average of 38% [23] in countries where it is not. On top of the status quo bias, defaults produce such large effects because individuals do not have explicit preferences for every possible good or service offered [24]. For instance, If individuals are assigned permanent appointments by default, assuming they have consented beforehand, they are more likely to have a flu vaccine appointment, thus increasing the possibility of being vaccinated [25]. Figure 3.1 illustrates a default nudge.

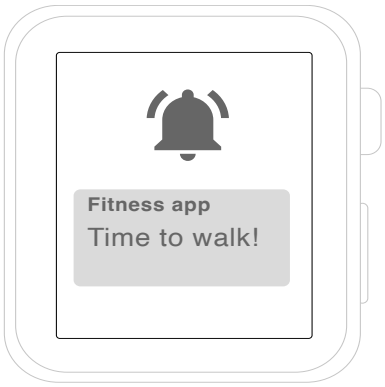
FIGURE 3.1: Default nudge on the Fitness app. The app's log in page requires users to agree with the terms and conditions, but they are free to choose to subscribe to the newsletter or not. However, by default, as James logs into the application, the subscription option is ticked by default in order to steer his behaviour towards simply leaving it as is and subscribing to the newsletter.



3.3.2 Reminder nudge

An reminder nudge is a nudge that brings a choice to the user's attention. With the ubiquity of mobile phones, this nudge can typically be delivered through a visual, sound, or haptic cue to the user (e.g., a push notification). Most of the time, people have a lot on their minds, and they may forget to start an activity [26], become preoccupied, or simply put it off. A reminder can act as a helpful digital nudge to help them follow through with a certain behavior. For instance, text messages sent by the clinician to remind or alert patients to read relevant health resources or to perform an activity. Figure 3.2 illustrates a reminder nudge.

FIGURE 3.2: Reminder nudge on the Fitness app. The sensors in the watch recognize that James is sitting idle for some time. While James sits on the couch watching TV, a notification is sent to his watch to make it vibrate and displays a message to steer him towards doing some physical activity



3.3.3 Feedback nudge

Feedback nudges aim to inform users about their performance on some task in order to raise their awareness and potentially rectify a misconception the user has about their problematic behavior by presenting evidence that their behavior is inconsistent with what is actually deemed acceptable [27]. For instance, to motivate an individual a feedback nudge can be utilized to provide feedback on goals achieved by the end of the day, or the total number

of steps taken during a certain period. Moreover, a feedback nudge can be tailored/personalized to an individual to solve the problem of heterogeneity, i.e., individuals' behavior differ despite being nudged in the same way. Figure 3.3 illustrates a feedback nudge.

FIGURE 3.3: Feedback nudge on the Fitness app. The sensors in the watch record James' physical activity using the accelerometer and GPS. James' steps are recorded whenever he moves. To further motivate James, the health application provides James with feedback on his weekly move goal. The presentation of the feedback makes it easier for James to track his performance.

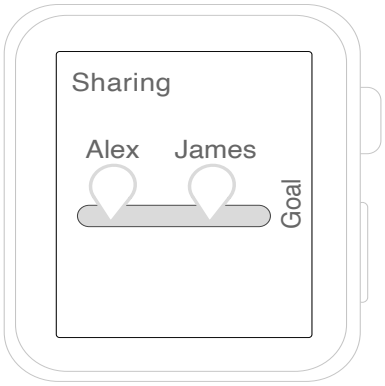
3.3.4 Social nudge

A social nudge is a nudge that informs individuals about what other people are doing. This is also known as a peer comparison nudge. Nudges of this type aim to establish social norms that users will be motivated to follow. [28]. For instance, a user could receive the following message on their app "Approximately half of your co-workers walk at least 10000 steps per day. And you?" Figure 3.4 illustrates a social nudge.

3.3.5 Framing nudge

The way information is presented affects the way people make decisions [29], and framing is the deliberate phrasing to encourage the target behaviour. A good example is the fact that people respond differently to information presented as a loss or a gain. Consider the following framing example: "If skin

FIGURE 3.4: Social nudge on the Fitness app. The app provides a peer comparison feature. James can invite his friends and compete against them. Whenever James exercises, the watch records the activity via its sensors. It then informs him about how well or bad he is doing in comparison to his friend Alex to motivate him to follow through on his exercise goals.



cancer is detected early, it can be treated before it becomes life-threatening" stresses more on benefits while "if skin cancer is not detected early, it cannot be possibly treated before it becomes life-threatening" stresses more on costs. Figure 3.5 illustrates a framing nudge.

FIGURE 3.5: Framing nudge on the Fitness app. The app features a Q&A section that answers question related to health. When James visits the Q&A section within the app, he is presented with various questions and related answers that are framed as loss or gain. To encourage James to increase his physical activity the answer to why walking is important is framed positively.

3.3.6 Suggesting alternatives nudge

This nudging strategy aims at providing individuals, about to make a decision, with alternatives that they might not have considered at this point [30]. For instance, to reduce the antibiotic over prescription, patients/clinicians could be suggested alternatives to antibiotics medication at the time decision is to be taken. Likewise, an individual who is mindlessly switching between social media apps could be given alternative tasks to complete: Take a walk. Figure 3.6 illustrates a suggesting alternatives nudge.

FIGURE 3.6: Suggesting alternatives nudge on the Fitness app. As a means to motivate James and support him in his decision-making, the health app offers James a variety of activities to improve his health each morning that he may not have thought of before. Moreover, the options have been ordered to favor the first three options visible on the screen (example of a positioning nudge).

3.3.7 Positioning nudge

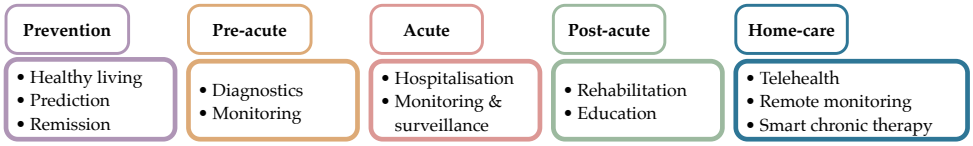
Positioning nudges tap into the status-quo bias by changing the way the options are presented visually [22]. Intuitively, options that are more salient, will be chosen more often than options that are less salient. In the extreme, system designer can hide certain options to make users less likely to select them. For instance, re-positioning the food choices to make nutritious food more prominent in a physical setting can increase their sale both [31]. In the digital context, Wyse et al. positioned nutritious food at the top of the list

on the food ordering web-platform, resulting in an increased selection of nutritious food [32]. Figure 3.6 illustrates how positioning can assist James in being more active.

3.4 Digital nudges in the continuum of care

In medicine, continuum of care is the provision of health care over time. The term refers to all the phases of a patient's illness, from before the diagnosis to the end of life. The continuum of care can be split in five general phases: prevention, pre-acute, acute, post-acute and chronic home-care [33, 34]. Below, readers are provided with an overview of what it means for digital nudges to be used in digital health and how they can be leveraged to address each aspect of the health care continuum.

FIGURE 3.7: *Continuum of care*



3.4.1 Prevention

In the prevention phase the goal is to employ digital nudge interventions before the onset of a disorder and discourage risky health behaviours and prevent individual risk factors for a certain medical condition. The following study presents a case in point, Milkman et al. employed text-based nudges delivered on a phone that used a framing nudge to boost vaccine adoption, i.e., to prevent influenza [35]. The application of framing led to increase in influenza vaccination rates by 5% when individuals were reminded twice to get their flu shot and also were also informed that their vaccination appointment was already booked. Within the prevention phase of patient care,

digital nudges are generally used to target individuals toward increasing behavior such as physical activity, food intake.

3.4.2 Pre-acute care

The pre-acute phase encompasses the time when a patient starts to experience a deteriorating health condition and starts self-monitoring. Patients with a progressing health condition following the prevention phase receive pre-acute care that often includes services such as health screening, lifestyle behavioural modification (healthy living) and disease risk reduction. One among many case in point for pre-acute care are digital interventions such as feedback and reminders to improve dietary intake and physical activity behaviour. To illustrate, Xu et al. employed feedback nudges to improve dietary behaviour and increase physical activity for the patients who were at high risk for type 2 diabetes [36].

3.4.3 Acute care

The acute phase starts with medical diagnostic by medical professional and treatment. Following the prevention phase, patients with potentially unstable health condition then receive acute care that often includes services such as the provision of urgent, targeted, primary care or hospital-based care. An example of the area where acute care and chronic care is crucial for recovery is motor training for individuals affected by stroke [37]. The game-based digital therapy supports user motivation. The goal of gamification is to use game mechanics such as competition, awards, and timely feedback to motivate and reward players. These elements of the game such as feedback, rewards and social comparison are in fact digital nudges integrated into the game mechanics. For instance, Perez-Marcos et al. employed gamification-based games for functional training of upper limb after brain damage [38].

Also, it has been proposed that immersive VR therapy based on gamification can be beneficial in treating balance problems associated with chronic ischemic stroke [39]. Moreover, digital nudges are also employed for clinicians in acute phase. One classical example is by Boillat et al. to prevent the human error-related complications in operating rooms, they proposed smart glasses to overcome the challenge that surgeons in an operating room have to rely on a poster or paper to complete a time-out checklist that takes place before the surgery [40]. There was a 100% completion rate with an 18% decrease in the average checklist duration, demonstrating the efficacy of reminders digital nudge in reducing patient complications from surgery.

3.4.4 Post-acute care

Patients with stabilized conditions following acute hospitalization receiving later care often receive services such as nursing care, monitoring, drug administration, rehabilitation, health education and residential care [41]. The employment of various digital nudges in post-acute care phase has shown some promise. For instance, elderly patients who recently suffered a heart attack were significantly motivated to become more physically active with loss-framed incentives and personalized goals using a wearable device [42]. In context of residential care, medicine adherence is one of many self-management behaviors in which digital nudges are being employed. In a recent clinical study, Benjamin et al. identified the medicine adherence barriers using proprietary recursive machine learning algorithms [43]. Based on augmented intelligence, digital nudges were formulated on the content, frequency, timing, delivery method, and feedback metric. These digital nudges were distributed via computer-generated emails, SMS messages, and interactive voice response phone calls. A 12-month randomized controlled trial indicated that the participants in the nudge group adhered to

their medicine significantly more than the participants in the control group.

3.4.5 Ethical considerations

As illustrated above, digital nudging in the health context seem to have promising applications, as they could potentially steer behaviour in a very cost-effective fashion. However, one important aspect to note is that most digital nudges such as feedback, social comparison, or reminders require a multitude of data. Therefore, it is important to put some attention on the ethics of digital nudging and how existing studies are taking care of it. As to ethics, Thaler proposed a set of design guidelines that should be used to design what he called nudges for good [44]. Nudges should be (1) transparent, (2) easy to opt-out, and (3) designed with the wellbeing of the user in mind [9, 45]. Transparency can be understood both as the goal of the nudge, which should not be deceitful or obfuscated, but also as the mechanism of the nudge by which it operates [14]. This second aspect involves transparency about data usage and privacy. Opting out easily means that users should have the autonomy to follow the nudge or to decide not to follow it. However, individuals being nudged are often unaware of the nudge or the psychological mechanisms employed by the choice architect [46, 47]. Lastly, the well-being of users should be the central focus for nudging and not the well-being of the designer [14]; however, even with the noblest intentions, who is to decide what is in the user's best interest. An ethical analysis of nudges is particularly important to mitigate potentially undesirable or harmful consequences through design changes.

3.5 Landscape of digital nudging in digital health

To better understand the current landscape of existing empirical research on digital nudges in the digital healthcare field we performed a scoping review.

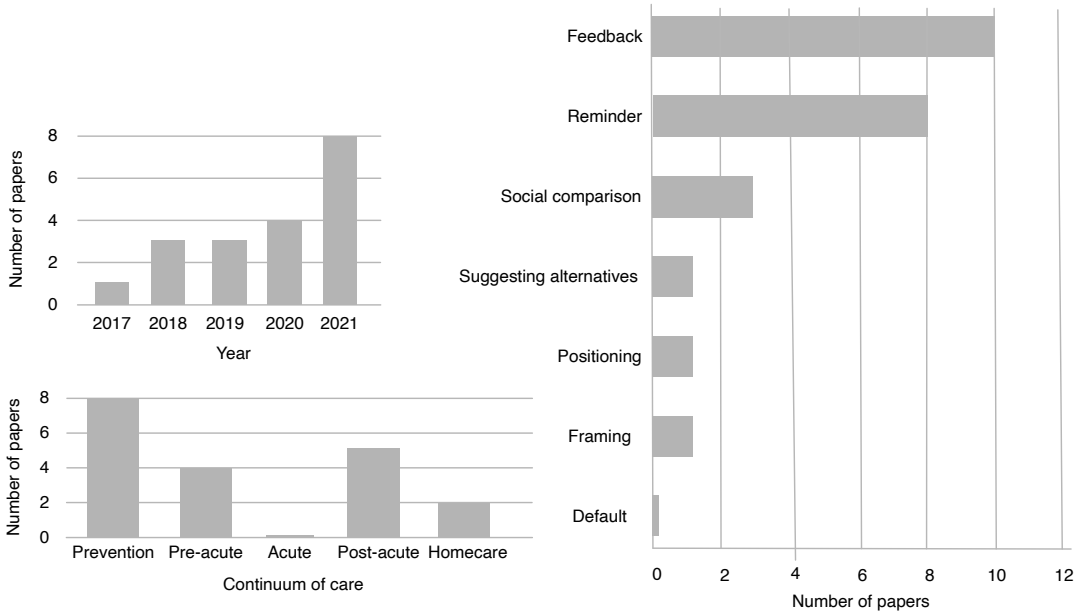
The review also attempts to answer RQ1 and RQ2. This analysis is based on the three main grids of analysis presented above: digital nudging strategies, continuum of care and ethics of nudging. The inclusion criteria consisted of three main points: (1) the focus of the research had to be a digital intervention for behaviour change, (2) the intervention had to be evaluated empirically, and (3) the intervention had to target patients or healthcare professionals. A search for articles was conducted on the electronic database of JMIR (Journal of Medical Internet Research), which is the leading peer-reviewed journal for digital health and medicine. We searched for the term "nudging", "nudges" or "nudge" or "digital nudges" or "digital nudging" or "digital nudge" in the content of the articles.

The database search yielded a total of 150 articles, 131 articles were excluded based on not fulfilling inclusion criteria, resulting in 19 full-text articles for inclusion. The results in Figure 3.8 seem to indicate that inclusion of digital nudging in digital health is increasing exponentially. For instance, the number of studies that include digital nudges have increased more than 160% since 2018. Among the 19 included studies, 30 nudges were used, as 7 studies employed two or more nudging techniques. In most of these 7 studies, nudging strategies were used in combination. The most common nudges used where feedback and reminders their application lied on prevention and post-acute care. Surprisingly, none of the studies investigated default nudges. Figure 3.9 provides a full overview of the analysis.

3.5.1 Increasing desired behaviour

The results of this review suggest that digital nudging can be applied to for a wide variety of health objectives, i.e, from increasing the uptake of contraceptives in Africa to increasing treatment adherence to HIV treatment.

FIGURE 3.8: *Results of the scoping review*



It should be noted that most papers focus on increasing a desired behaviour (e.g., increase in vaccination rate, increase physical activity). Sometimes increasing a desired behaviour is coupled with a decrease in an unwanted behaviour, such as increasing activity is implicitly coupled with decreasing sedentary behaviour. Nevertheless, in the reviewed studies, nudges are not used to solely reduce an unwanted behaviour. This presents a potential opportunity for further investigation. There are several challenges in nudging patients away from undesired behaviour, a first linked to the identification of such a behaviour (e.g., inferring when a smoker lights up a cigarette), and a second linked to providing adequate feedback on a negative behaviour (e.g., "you have not smoked today").

3.5.2 Personalized mobile feedback

In terms of nudging strategies, most research has focused on feedback nudges and reminders. Social comparison has also been investigated a few times, but the other strategies are only marginally studied (once in the reviewed papers). The rise of feedback nudges is not surprising given

the wide adoption of smart devices such as wearable and smartphones, which allow tracking motion, steps, heart rate and other physiological metrics. Furthermore, these devices allow to easily reach users at any time (potentially an identified teachable moment) through push notifications, sounds or vibrations, which make them ideal delivery channels for reminder nudges. Moreover, this ubiquitous nature of devices has led to the use of digital nudges in the different phases of the continuum of care. For instance, from averting illness by encouraging individuals to vaccinate in the prevention phase to using feedback nudging strategies to rehabilitate stroke patients in the post-acute phase. However there were no studies focused on acute care in the reviewed articles. This might not be surprising as this stage of the continuum of care is the most challenging to study empirically. Furthermore, in the acute phase, patients are potentially more passive than in other phases, and as such, nudges might have to focus on medical practitioners rather than patients. Future research could further investigate this phase, since nudge can present undeniable opportunities, as exemplified by the reminder nudge to improve checklist compliance during surgery presented above [40].

3.5.3 Ethical nudging boundaries

There is no denying that the omnipresence of connected devices can present opportunities for innovative and effective digital nudges along the continuum of care. However, there are ethical risks associated to these technologies in terms of privacy, autonomy, and consent. Understanding the amplitude of these risks requires in-depth analyses of the intervention design in their specific contexts, but the reviewed literature only rarely discuss these issues. Indeed, only 1 out of 19 studies conferred about ethical considerations while designing the intervention and others paid little or no attention

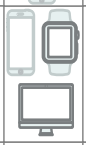
to even explaining the mechanism and working of the nudge. The criteria of transparency work well with certain digital nudges such as feedback and reminders. For instance, provision of feedback to increase physical activity is pretty transparent in its objective like in the study by Xu et al. [36]. However, digital nudges such as framing, default and social comparison are inherently not transparent, as individuals are often unaware about the objective of the nudge until revealed before deployment. For instance, Suzuki et al. [48] employed framing in a brief web-based educational intervention to increase vaccination rates.

The participants were blind to the mechanism employed to change their mindset. The criteria of ease of opting out is also met in certain cases. For instance, in a study by Purohit et al. [14] participants could opt out of the feedback nudge by just turning off the feedback automation themselves. The process to opt-out would become challenging for nudges like default, framing [48], positioning [49] are used. Finally, surprisingly, as shown in Figure 3.9, the ethical analysis reveals that out of 19 studies only one study that of Neto et al. [50] explicitly discusses the nudge designs and ethical implications. Future researchers should further investigate this issue. It should also be noted that understanding the ethical boundaries of digital nudging will also allow practitioners to identify potential unintended nudges present on their digital support systems. This can typically happen as nudges such as positioning or defaults are unavoidable when a system is designed. The challenge is to make sure these design decisions are aligned with the welfare of the patient and are not so called dark patterns, manipulating them.

3.5.4 Limitations

It should be noted that this chapter is not without limitations. Despite carefully following the guidelines for scoping reviews, the results are confined

FIGURE 3.9: *Characteristics of the articles included in the review. Abbreviation of nudging strategies: F (Feedback), R (Reminders), SC (Social comparison), SA (Suggesting alternatives), PO (Positioning)*

Authors	Evaluation	Objective	Nudging strategy	Medium	Continuum of care	Transparent	Easy to opt-put	Wellbeing	Ethics discussed
André et al., (2021) [30]	RCT	Increase physical activity	SC		Prevention	✓	✓	✓	-
Azulay et al., (2019) [5]	RCT	Increase colonoscopy followup	R		Pre-acute	✓	X	✓	-
Belli et al., (2021) [7]	RCT	Improve Diabetes management	SC, SA		Post-acute	X	✓	✓	-
Bredbenner et al., (2017) [9]	RCT	Promote child growth	R		Prevention	X	✓	✓	-
Coorey et al., (2021) [13]	RCT	Improve cardiovascular disease management	F, R		Pre-acute	✓	✓	✓	-
Elnaggar et al., (2021) [15]	RCT	Motivating patients to sustain physical activity	F		Homecare	✓	✓	✓	-
Green et al., (2018) [21]	RCT	Increasing uptake of contraceptives	R		Prevention	✓	✓	✓	-
Manne et al., (2020) [31]	RCT	Improve sun protection behavior	F, SC		Prevention	✓	✓	✓	-
Neto et al., (2021) [36]	Longitudinal study	Promote optimal child growth	R		Prevention	✓	✓	✓	Yes
Nsagha et al., (2020) [37]	RCT	Increase treatment adherence to HIV treatment	R		Homecare	✓	X	✓	-
Orme et al., (2018) [40]	RCT	Reduction of sedentary behavior	F		Post-acute	✓	X	✓	-
Sankaran et al., (2019) [45]	Cross-over study	Motivate to achieve rehabilitation targets	P, R		Post-acute	✓	X	✓	-
Summers et al., (2021) [51]	Pre-post	Improving glycemic control and enabling weight loss	F		Homecare	✓	✓	✓	-
Suzuki et al., (2021) [53]	RCT	Increasing the willingness to take vaccine	FR		Prevention	X	X	✓	-
Signal et al., (2020) [58]	Cross-over study	Increase upper limb movement	F		Post-acute	✓	X	✓	-
Vandelanotte et al.., (2018) [60]	RCT	Increase physical activity	F		Prevention	X	X	✓	-
Whelan et al., (2019) [64]	RCT	Improve diabetes self-management	F		Pre-acute	✓	X	✓	-
Wyse et al., (2021) [66]	RCT	Increase intake of healthy food	PO, R, F		Prevention	✓	✓	✓	-
Xu et al., (2020) [67]	RCT	Improving dietary and physical behaviour	F		Pre-acute	✓	✓	✓	-

to the initial search, as is inherent to their nature. For instance, the nursing field may have applied a type of digital nudge like feedback without calling it that. Moreover, our search for the scoping review was limited to JMIR database and mainly focused on digital nudging for patients. Future research could include other digital health databases and review digital nudging for clinicians to provide a full-fledged systematic review of the topic.

3.6 Conclusion

This chapter mapped the landscape of a growing topic, namely digital nudging in healthcare. This chapter allows practitioners and healthcare system designers to get a better understanding of possible applications of digital nudges to increase the effectiveness of health applications along the continuum of care. It first gave an overview of the potential opportunities offered by digital nudges through the continuum of care. It then discussed the current state of the empirical literature on digital nudging in healthcare through a scoping literature review. The review highlighted the fact that current research efforts mainly focus on feedback and reminder nudges applied to increasing desired behaviour for prevention and post-acute care. At the current stage, several otherwise effective nudging strategies such as defaults are absent from the reviewed literature and none of the interventions was applied to acute care. Furthermore, the review revealed that only one paper out of 19 discussed ethical aspects of nudging. As such it appears that the development and promotion of an ethical analysis grid that will guide practitioners and researchers in designing not only low cost and effective, but also *ethical* nudges is crucial to unleash the full power of nudging to improve digital health.

References

[1] Jeffrey A Kelly. "Behavior changes & disease prevention: MCW research shows effectiveness of HIV/AIDS risk reduction interventions. Medical College of Wisconsin." In: *WMJ: Official Publication of the State Medical Society of Wisconsin* 99.1 (2000), pp. 41–3.

[2] Esmee A Bakker et al. "Sedentary behaviour in cardiovascular disease patients: Risk group identification and the impact of cardiac rehabilitation". In: *International journal of cardiology* 326 (2021), pp. 194–201.

[3] Zhuo Wang et al. "Premature deaths caused by smoking in Sichuan, Southwest China, 2015–2030". In: *Scientific reports* 11.1 (2021), pp. 1–8.

[4] Simonetta Marucci et al. "Eating Disorders and Type 1 Diabetes: a perspective." In: *Endocrine, Metabolic & Immune Disorders Drug Targets* (2021).

[5] Fredrik Åberg et al. "Binge drinking and the risk of liver events: a population-based cohort study". In: *Liver International* 37.9 (2017), pp. 1373–1381.

[6] AJ Sasco, MB Secretan, and K Straif. "Tobacco smoking and cancer: a brief review of recent epidemiological evidence". In: *Lung cancer* 45 (2004), S3–S9.

[7] Reuel A Stallones. "The association between tobacco smoking and coronary heart disease". In: *International journal of epidemiology* 44.3 (2015), pp. 735–743.

[8] Neil Shah and Srinath Adusumalli. *Nudges and the meaningful adoption of digital health*. 2020.

[9] Cass R Sunstein and Richard H Thaler. *Nudge: Improving decisions about health, wealth, and happiness*. Yale University Press, 2008.

[10] Fabian Okeke, Michael Sobolev, and Deborah Estrin. “Towards a framework for Mobile behavior change research”. In: *Proceedings of the Technology, Mind, and Society*. 2018, pp. 1–6.

[11] Caroline Free et al. “Smoking cessation support delivered via mobile phone text messaging (txt2stop): a single-blind, randomised trial”. In: *The Lancet* 378.9785 (2011), pp. 49–55.

[12] Carmina G Valle, Brooke T Nezami, and Deborah F Tate. “Designing in-app messages to nudge behavior change: Lessons learned from a weight management app for young adults”. In: *Organizational Behavior and Human Decision Processes* 161 (2020), pp. 95–101.

[13] Edith Angellotti et al. “Combining wireless technology and behavioral economics to engage patients (WiBEEP) with cardiometabolic disease: a pilot study”. In: *Pilot and feasibility studies* 5.1 (2019), pp. 1–6.

[14] Aditya Kumar Purohit and Adrian Holzer. “Unhooked by Design: Scrolling Mindfully on Social Media by Automating Digital Nudges”. In: (2021).

[15] Neil Levy. “Nudges in a post-truth world”. In: *Journal of medical ethics* 43.8 (2017), pp. 495–500.

[16] Markus Weinmann, Christoph Schneider, and Jan vom Brocke. “Digital nudging”. In: *Business & Information Systems Engineering* 58.6 (2016), pp. 433–436.

[17] Mathias Jesse and Dietmar Jannach. “Digital nudging with recommender systems: Survey and future directions”. In: *Computers in Human Behavior Reports* 3 (2021), p. 100052.

[18] Aditya Kumar Purohit and Adrian Holzer. “Functional digital nudges: Identifying optimal timing for effective behavior change”. In: *Extended*

Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems. 2019, pp. 1–6.

[19] Judith K Ockene et al. "Spontaneous cessation of smoking and alcohol use among low-income pregnant women". In: *American Journal of Preventive Medicine* 23.3 (2002), pp. 150–159.

[20] Stephen S Intille et al. "Just-in-time technology to encourage incremental, dietary behavior change". In: *AMIA Annual Symposium Proceedings*. Vol. 2003. American Medical Informatics Association. 2003, p. 874.

[21] Anna L Ford et al. "Treatment of childhood obesity by retraining eating behaviour: randomised controlled trial". In: *Bmj* 340 (2010), b5388.

[22] Ana Caraban et al. "23 Ways to Nudge: A Review of Technology-Mediated Nudging in Human-Computer Interaction". In: *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. ACM. 2019, p. 503.

[23] Richard H Thaler, Cass R Sunstein, and John P Balz. "Choice architecture". In: *The behavioral foundations of public policy* (2014).

[24] Hendrik P Van Dalen and Kène Henkens. "Comparing the effects of defaults in organ donation systems". In: *Social science & medicine* 106 (2014), pp. 137–142.

[25] Birthe A Lehmann et al. "Changing the default to promote influenza vaccination among health care workers". In: *Vaccine* 34.11 (2016), pp. 1389–1392.

[26] Randi Karlsen and Anders Andersen. "Recommendations with a nudge". In: *Technologies* 7.2 (2019), p. 45.

[27] Clayton Neighbors et al. “Efficacy of personalized normative feedback as a brief intervention for college student gambling: a randomized controlled trial.” In: *Journal of Consulting and Clinical Psychology* 83.3 (2015), p. 500.

[28] Danielle Arigo and Jerry M Suls. “Smartphone apps providing social comparison for health behavior change: a need for better tailoring to person and context”. In: *Mhealth* 4 (2018).

[29] Amos Tversky and Daniel Kahneman. “The framing of decisions and the psychology of choice”. In: *Behavioral decision making*. Springer, 1985, pp. 25–41.

[30] Suzanna E Forwood et al. “Offering within-category food swaps to reduce energy density of food purchases: a study using an experimental online supermarket”. In: *International Journal of Behavioral Nutrition and Physical Activity* 12.1 (2015), pp. 1–10.

[31] Hannah Ensaff et al. “Food choice architecture: An intervention in a secondary school and its impact on students’ plant-based food choices”. In: *Nutrients* 7.6 (2015), pp. 4426–4437.

[32] Rebecca Wyse et al. “Long-term Effectiveness of a Multistrategy Behavioral Intervention to Increase the Nutritional Quality of Primary School Students’ Online Lunch Orders: 18-Month Follow-up of the Click & Crunch Cluster Randomized Controlled Trial”. In: *Journal of medical Internet research* 23.11 (2021), e31734.

[33] Adam B Cohen et al. “A digital health industry cohort across the health continuum”. In: *NPJ digital medicine* 3.1 (2020), pp. 1–10.

[34] Kathleen Spring et al. “A model for a life-long personalised Continuum of Integrated Care revolutionising healthcare delivery: Description of technological impact.” In: ().

[35] Katherine L Milkman et al. "A megastudy of text-based nudges encouraging patients to get vaccinated at an upcoming doctor's appointment". In: *Proceedings of the National Academy of Sciences* 118.20 (2021).

[36] Zidu Xu et al. "A mobile-based intervention for dietary behavior and physical activity change in individuals at high risk for type 2 diabetes mellitus: Randomized controlled trial". In: *JMIR mHealth and uHealth* 8.11 (2020), e19869.

[37] John W Krakauer and Juan Camilo Cortés. "A non-task-oriented approach based on high-dose playful movement exploration for rehabilitation of the upper limb early after stroke: a proposal". In: *NeuroRehabilitation* 43.1 (2018), pp. 31–40.

[38] Daniel Perez-Marcos et al. "Increasing upper limb training intensity in chronic stroke using embodied virtual reality: a pilot study". In: *Journal of neuroengineering and rehabilitation* 14.1 (2017), pp. 1–14.

[39] Irene Cortés-Pérez, Francisco Antonio Nieto-Escamez, and Esteban Obrero-Gaitán. "Immersive virtual reality in stroke patients as a new approach for reducing postural disabilities and falls risk: a case series". In: *Brain sciences* 10.5 (2020), p. 296.

[40] Thomas Boillat, Peter Grantcharov, and Homero Rivas. "Increasing completion rate and benefits of checklists: prospective evaluation of surgical safety checklists with smart glasses". In: *JMIR mHealth and uHealth* 7.4 (2019), e13447.

[41] Yu-Chun Wang et al. "Post-acute care as a key component in a healthcare system for older adults". In: *Annals of geriatric medicine and research* 23.2 (2019), p. 54.

[42] Neel P Chokshi et al. "Loss-framed financial incentives and personalized goal-setting to increase physical activity among ischemic heart

disease patients using wearable devices: the ACTIVE REWARD randomized trial". In: *Journal of the American Heart Association* 7.12 (2018), e009173.

[43] Benjamin D Horne et al. "Behavioral nudges as patient decision support for medication adherence: the ENCOURAGE randomized controlled trial". In: *American heart journal* 244 (2022), pp. 125–134.

[44] Richard H Thaler. *Nudge, not sludge*. 2018.

[45] Natalie Gold et al. "'Better off, as judged by themselves': do people support nudges as a method to change their own behavior?" In: *Behavioural Public Policy* (2020), pp. 1–30.

[46] STUART MILLS. "Nudge/sludge symmetry: on the relationship between nudge and sludge and the resulting ontological, normative and transparency implications". In: *Behavioural Public Policy* (2020), pp. 1–24.

[47] Samuli Reijula and Ralph Hertwig. "Self-nudging and the citizen choice architect". In: *Behavioural Public Policy* 6.1 (2022), pp. 119–149.

[48] Yukio Suzuki et al. "Effect of a Brief Web-Based Educational Intervention on Willingness to Consider Human Papillomavirus Vaccination for Children in Japan: Randomized Controlled Trial". In: *Journal of Medical Internet Research* 23.9 (2021), e28355.

[49] Rebecca Wyse et al. "Effectiveness of a Multistrategy Behavioral Intervention to Increase the Nutritional Quality of Primary School Students' Web-Based Canteen Lunch Orders (Click & Crunch): Cluster Randomized Controlled Trial". In: *Journal of medical Internet research* 23.9 (2021), e26054.

[50] Onicio Leal Neto et al. “Combining wearable devices and mobile surveys to study child and youth development in Malawi: implementation study of a multimodal approach”. In: *JMIR Public Health and Surveillance* 7.3 (2021), e23154.

Part III

Design & Evaluation of Digital Nudges

Chapter 4

Designing for Digital Detox: Making Social Media Less Addictive with Digital Nudges

CHI '20 Extended Abstracts
ISBN: 978-1-4503-6819-3/20/04

Abstract – Social media addiction concerns have increased steadily over the past decade. Digital nudges have previously been shown to hold enormous potential to change behavior. However, it is not clear how they might be designed to combat social media addiction. In this late-breaking work, we aim at clarifying this issue by investigating how digital nudges can reduce the addictive features of social media and other addictive sites. More precisely, we present the design of NUDGE, a novel browser extension that aims to make social media less addictive by delivering digital nudges founded on behavioral science. We conducted a preliminary evaluation of NUDGE with 67 actual users and 14 university students. Our results show that NUDGE (1) helped users to become reflective of their social media usage, (2) possibly decreased their time spent, and (3) made the experience more pleasant.

4.1 Introduction

Our dependence on technology is on the rise, and as a consequence, an estimated 210 million people are suffering from social media addiction worldwide [1]. This condition makes individuals overly concerned about, and increasingly dependent on, online social networks (OSN) [2]. Social media were designed as web-based technologies built to facilitate messaging and sharing of content between people [3]. At the same time, many social media companies, including Facebook, Twitter, and YouTube, rely on the continued attention of users for their revenue generation [4], in what is sometimes called the attention economy [5]. As a result, these technologies are now designed to be intrinsically persuasive [6] to attract people's attention [7]. This has consequences such as impairing interpersonal relationships [8], and/or psychological health and well-being [9].

In this paper, we argue that the same design principles that create addiction could be leveraged to mitigate it. More specifically, digital nudges, i.e. design features that steer people's decisions without banishing freedom of choice, can be used in welfare-promoting directions [10]. We present specific digital nudges that can be used by designers to mitigate the addictive features of social media. Further, we present the implementation of these nudges in a novel Chrome extension called NUDGE. Finally, we present a preliminary evaluation of NUDGE with 67 actual users and 14 students who assessed its usability and effectiveness.

4.2 Methodology

This research project follows the steps of the design science research methodology (DSRM) [12]. The paper first identifies the problem (Introduction). Second, it presents the objectives of a solution by describing the addictive model

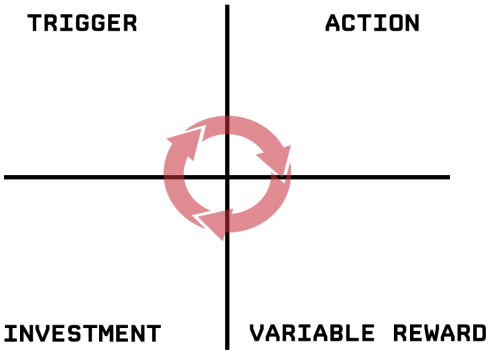


FIGURE 4.1: Hook model adapted from Eyal [11]

used in social media (Hooked on Social Media). Third, it presents the design of a solution and a real word demonstrator (i.e., NUDGE) before providing a preliminary evaluation. Finally, it concludes and presents future work.

4.3 Hooked on Social Media

The design of social media platforms is intentionally engineered to be addictive and exploit vulnerabilities in human psychology [6]. This intentional design results in undesirable platform usage that can lead to addictive usage patterns [13]. One model that many companies adopt for the development of habit-forming social media products is the Hook model [11]. This model draws on behaviorist principles to build habits [14]. It describes a four-phase iterative process for software design that encourages habit formation. The process starts with (1) a trigger that leads to (2) an action, which produces (3) a reward and ultimately creates (4) an investment. Successfully utilizing these four phases produces an addictive feedback loop where the more users receive rewards and invest, the more they will be incentivized to respond to triggers and perform actions, which in turn will produce more rewards and investments and so on (see Figure 4.1).

4.3.1 Trigger

A trigger operates as a foundation on which habits are formed. Internal triggers hinge on thoughts and emotions like boredom, pre-existing routines, and loneliness, prompting the user to take mindless actions. External triggers could be, for instance, notifications indicating the arrival of a new message in the user's environment. A trigger prompts an individual to take action by supplying cues.

4.3.2 Action

The action phase is based on the Fogg behavior model [15]. When sufficient ability and motivation exist with a trigger, an action occurs. Actions in social media are typically browsing, posting, commenting, or reacting. Social media platforms increase the ability of users to take actions by making actions more accessible. For instance, YouTube presents personalized recommendations on the right side of its website, reducing the burden to search for similar videos. The motivation to seek pleasure, social acceptance, and to avoid pain and social rejection increase the chance that the user will take action.

4.3.3 Reward

Giving users rewards after they have taken action brings them to social media platforms over and over again. Rewards can be of three types [11]: the 'tribe', the 'hunt', and the 'self'. The rewards of the tribe are social rewards such as comments and likes. The rewards of the hunt are the consumption of new content, for instance, on the endless News Feed on Facebook. The rewards of the self are intrinsic rewards of mastery, competence, and completion, for instance, on platforms like LinkedIn completion of profile increases visibility to recruiters.

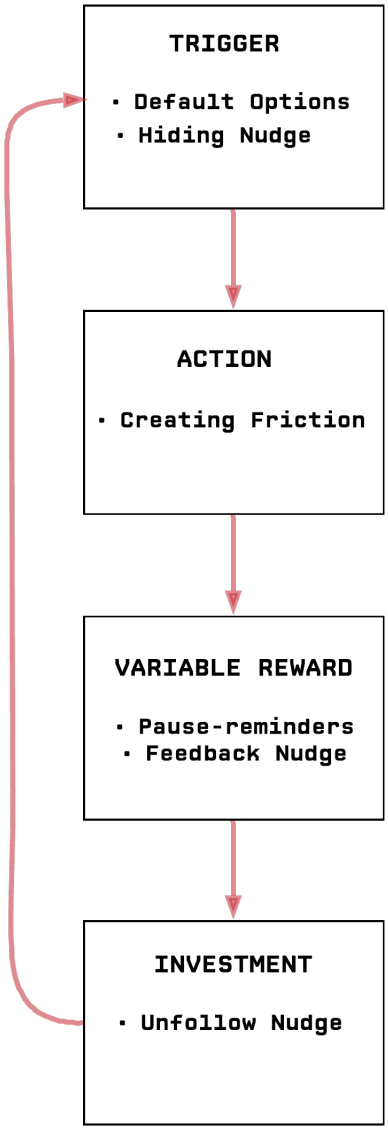


FIGURE 4.2: Potential digital nudges to combat the design context of the Hook Model

4.3.4 Investment

Investment increases the likelihood of users returning to social media platforms as they have invested value in the form of content, data, followers, and reputation [11]. The investment on the platform increases the possibility of users responding to the next trigger to start the cycle once again.

The objectives of a solution to address the social media addiction problem should address these four phases in order to break users free from the vicious cycle.

4.4 Designing for Digital Detox

Hereafter, we illustrate, with scenarios, how designers could leverage digital nudges to counteract the various phases of the Hook model. Figure 4.2 provides an overview of the different digital detox nudges.

4.4.1 Dismissing Triggers

Imagine a user called Thomas. Like many other mobile phone users, he receives around 100 notifications from social media per day (external triggers), indicating a new message is received. Also, every so often, Thomas visits his favorite social media platform almost unconsciously out of boredom (internal triggers). The following two nudges could work on dismissing these triggers and thus preventing users from accessing social media in the first place:

- Hiding Nudge: Hiding nudge operates by obscuring a trigger so that it becomes harder to respond to [16]. After Thomas enters the social media platform, notifications within the platform can be hidden so that they fail to trigger an action.

- Default Nudge: Default options are very powerful, as it takes effort to deviate from the default environment set by some intervention [17–19]. Typical examples are opt-out rather than opt-in approaches. In our context, social media platforms could be turned off by default, i.e., Thomas is not taken directly to Facebook, but to another page by default where he is asked if he is sure he would like to visit Facebook, in which case he has to switch Facebook on mindfully.

4.4.2 Limiting User Action

After Thomas enters the social media platform, algorithms supply personalized content. The tailored content increases the opportunity of action on the platform; thus, Thomas ends up looking at linked content that he was not interested in the first place, but was conveniently accessible. The following nudge could limit his action on social media:

- Creating Friction: In the course of interaction with technology, frictions hinder people from painlessly achieving their goals [20]. Usually, systems are designed to lower friction. However, in our context, friction creates an opportunity for the user to interact mindfully. Frictions could be introduced by asking if Thomas wants to see video or post recommendations in the sidebar of social media; thus, making it harder for Thomas to click on other content mindlessly.

4.4.3 Reducing Reward

Once Thomas is online, the infinite scrolling offered by websites as well as the likes of his posts produce rewards to make him stay longer on the site. In addition to hiding nudge that can also be used to reduce the impact of likes and comments from others, the two following nudges can reduce the rewards of staying on the site:

- Pause-reminders: Pause-reminders break users free from addictive continuous scrolling [21] by creating an interface that reduces hunt rewards. In this case, the pause-reminder makes Thomas aware of his mindless scrolling.

- Feedback nudge: Feedback about time spent on an app combined with negative reinforcement could reduce the rewards of users from staying on social media [22]. Given the scenario, Thomas could be presented with a timer that shows how much time he has already spent on social media.

4.4.4 Reduce Investment

Thomas has invested in his favorite social media in the form of following various pages and friends which keeps bringing him back on the social media platform. The following nudge could reduce that investment:

- Unfollow nudge: According to the Fogg behavior model [15], with increased ability, sufficient motivation, and a trigger, an action occurs. Presently on social media platforms, unfollowing friends, groups, and pages is a strenuous task. Alternatively, Thomas could be presented with a prompt that makes unfollowing friends, groups, and pages automized.

4.5 Demonstration

In this section, we present a demonstration of the nudges described above in a tool for digital detox called NUDGE. Technically NUDGE is a Chrome extension written in JavaScript that provides an overlay on certain predefined websites. It uses custom JavaScript code and CSS with injected HTML to create this overlay. NUDGE currently has 1,200 weekly active users.

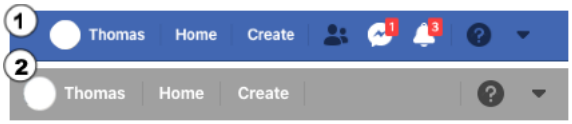


FIGURE 4.3: (1) Notifications on Facebook (2) Hiding nudge hides notifications on Facebook

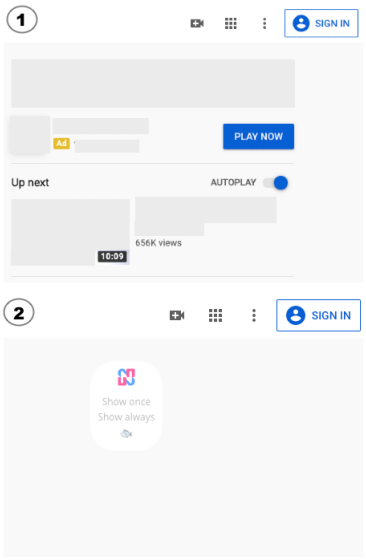


FIGURE 4.4: (1) Sidebar on YouTube with personalized content (2) Sidebar on YouTube with Friction nudge to confirm actions

The hiding nudge in NUDGE hides notifications to counter triggers (See Figure 4.3). NUDGE creates friction by concealing certain sections of websites that keep the users sucked in longer than they want. For instance, sections such as sidebars displaying personalized recommendations on YouTube, and sponsored ads and links on Facebook. If the user desires to see these sections, they have to hover over the NUDGE logo and decide to choose either "Show once" or "Show always." (See Figure 4.4).

The default nudge intervention in NUDGE switches off social media websites, which means that when users enter the URL of Facebook, for instance, they are not taken directly to Facebook, but to another page that requires them to drag a slider across the screen in order to proceed to Facebook. The slider gets stickier to drag with every visit. In other words, increasing your visits to a particular website will make the slider harder to drag, thus also adding a friction component to the default nudge (See Figure 4.5).

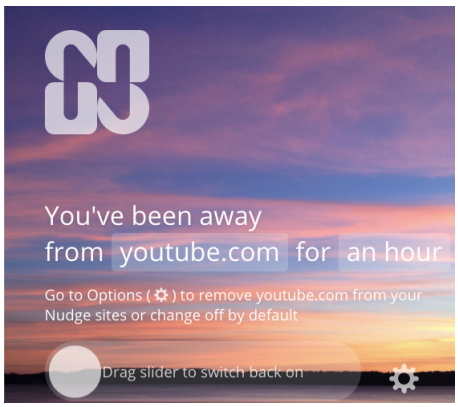


FIGURE 4.5: Default nudge in NUDGE switching off YouTube.com

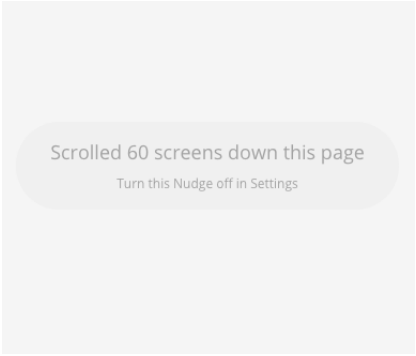


FIGURE 4.6: Pause-reminder Nudge

The pause-reminder nudge disrupts mindless infinite scrolling to keep users away from rewards of the hunt on social media (See Figure 4.6). NUDGE reduces the reward further by presenting a feedback nudge that overlays on the user interface. The feedback nudge grows on the screen every five minutes a user spends on a social media site. It does not stop a user from taking action, but keeps the user more aware of the time they are spending (See Figure 4.7).

Finally, to undermine investment, an unfollow nudge is available. It allows a user to unfollow 100% of their friends, pages, and groups, and permanently get rid of their cluttered News Feed. Once a user has enabled the feature, with the assistance of the 'auto-unfollow' feature, unfollowing happens automatically (See Figure 4.8).

FIGURE 4.7: (1) Feedback nudge in NUDGE (2) Feedback nudge growing on screen every five minutes a user spends on Facebook

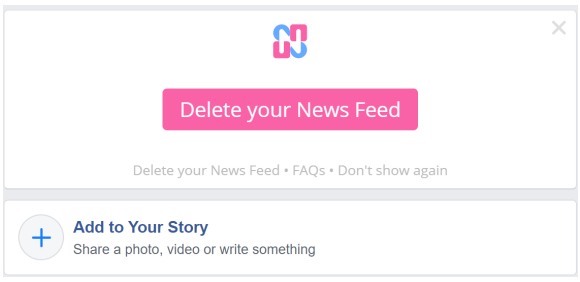


FIGURE 4.8: Unfollow Nudge

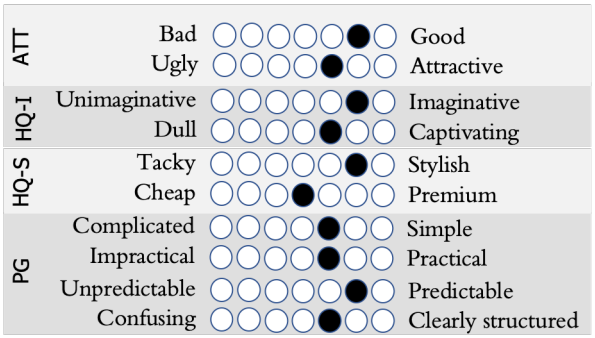


FIGURE 4.9: AttrakDiff 2 results highlighting median values. N = 14

4.6 Evaluation

We conducted a preliminary evaluation of NUDGE with university students and with actual users. A survey was pushed on the Facebook platform for actual users to provide their feedback. In two weeks, we received 67 responses, which is a 24.8% response rate out of 270 active users of Facebook out of the 1,200 NUDGE active users. For the students, we introduced NUDGE to first-year business students (about 51 students) at the University of Neuchâtel, Switzerland. 14 students agreed to be a part of the evaluation.

The students were instructed to install NUDGE on the Chrome browser and given two days to test it. Then the students were asked to fill out the SUS [23] and AttrakDiff 2 [24] questionnaire to assess usability. The ability to generate reliable results even with small sample sizes makes SUS valuable [25]. The goal of the survey with students and actual users was to make a preliminary assessment of (1) usability (2) effectiveness and (3) design.

4.6.1 Is NUDGE usable and effective?

On the SUS scale for general usability, NUDGE achieved a mean score of 79.8, which indicates between Good and Excellent usability [23]. We used the short version of the AttrakDiff 2 survey to evaluate the hedonic and pragmatic qualities of NUDGE. The results are presented in Figure 4.9. The results

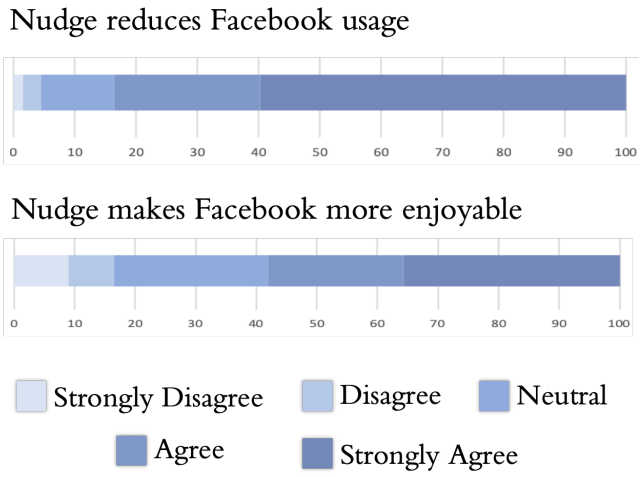


FIGURE 4.10: Survey results N = 67.

show mostly positive attractive (ATT), hedonic (HQ), and pragmatic (PG) measures. The extension is viewed as neither cheap nor premium.

To assess if users believed NUDGE reduced their Facebook usage and at the same time made Facebook more enjoyable, we have assessed two items (1) "NUDGE reduces time spent on Facebook" and (2) "NUDGE makes Facebook more enjoyable" on a Likert scale from 'Strongly disagree' to 'Strongly agree' from actual users. 67 actual users responded to the items. We applied a one-sample Wilcoxon signed-rank test to both the items that indicated the median for the first item was significantly different from 3, $Z = 6.35$, $p < .001$, with a strong effect size (r = .78). It can be seen in Figure 4.10 that 59.7% of the users think NUDGE reduces their Facebook usage. The median for the second item was significantly different from 3, $Z = 3.48$, $p < 0.01$, with a moderate effect size (r = .43). We can observe in Figure 4.10 that 22.4% users agree and 35.8% strongly agree that NUDGE makes Facebook more enjoyable.

We were also interested in collecting diverse perspectives about the efficacy and experiences of NUDGE. The actual users were presented with two open questions: 1) What is the best thing about NUDGE? And 2) What is the worst thing about NUDGE? 65 actual users provided open-ended comments. The analysis was completed using grounded theory [26]. By coding the data

through line-by-line, we articulated emergent themes. Here we discuss the major themes.

4.6.2 Automaticity

One theme that emerged was the various ways in which users relished NUDGE. Automatic unclutter, automates, and auto-unfollow were recurring codes from the users. As an example, the following comment was coded as automates: *"Simple one-click automatization that really completes the task of deleting my facebook feed."* Another comment that was coded as auto-unfollow: *"I didn't have to select one by one all the friends or pages I didn't want to follow anymore."* While users reported how much they valued the automatic unfollow feature, for some users automatic unfollow evoked a sense of loss. For example, *"Deleting my feed was a drastic choice, but it's cut my time there like tenfold."*

4.6.3 Mindfulness

Another interesting theme was whether digital nudge interventions of NUDGE made users mindful of their actions. One user saw the interventions as an incentive to remain mindful. For example, *" It acts as an incentive to be mindful of my web use."* A code that kept occurring was rationalizing; a user reported: *"The notification that shows how many pages you've scrolled. It is really excellent and works every time to make me stop mindlessly scrolling."* Another user commented: *"having to slide the bar across. It creates an opportunity for mindfulness that I didn't have before. It's a pain when I have to be on social media a lot in one day for work, but the tradeoff is worth it because every time I have to decide: Do I need to be here?."*

4.6.4 Privacy Threat

One common area of concern for the users was that of privacy. In particular, some users found themselves to be feeling as if they are losing control of their data. For instance, one user reported, *"I felt as if I took a risk in relation to my FB-data, by giving over some control to Nudge."* In some cases, users developed skepticism *" I did feel skeptical about letting a relative alien add-on interfere with my facebook."* One user stated, *" Not sure about the privacy thing."*

4.6.5 Customization

Several users asked for greater possibility of customization. Codes like customizing, personalizing, and customizability were recurrent. For instance, one user reported, *" I wish there could be some kind of middle ground. Like a feed with only my best friends and favorite pages? And no sponsored content?"*. Another user reported on customizing rainbow timer, *"Maybe there should be an option for how much time it takes to add each ring to make it faster? Or an option to slightly adjust the color of the rings?"*.

4.7 Conclusion and Future Work

In this paper, we introduced and evaluated NUDGE, a Chrome extension designed to counter the cycle of addictive design contexts employed by social media platforms. These preliminary results show how system designers can design and channel digital nudges to combat social media addiction. It is relevant to note that NUDGE utilizes a counter-intuitive design approach to decrease the usability of social media platforms. Users appreciated NUDGE and believed that NUDGE reduced their Facebook usage and, at the same

time, made Facebook more enjoyable. Future research could build on previous work on unorthodox usability (e.g., [27–30]) and investigate how reducing social media usability could improve the user experience. The design evaluation of NUDGE and its shortcomings presented in this paper will allow designers to build effective, likable, and practical digital detox apps. In the future, we aim to grasp a more in-depth understanding of the described nudges individually by conducting RCTs with a combination of usage log data and survey results. Furthermore, we will deeply investigate the concerns of privacy, sadness following a loss of investment, and bringing the ability to customize digital nudges.

References

[1] Phil Longstreet and Stoney Brooks. "Life satisfaction: A key to managing internet & social media addiction". In: *Technology in Society* 50 (2017), pp. 73–77.

[2] Cecilie Schou Andreassen. "Online social network site addiction: A comprehensive review". In: *Current Addiction Reports* 2.2 (2015), pp. 175–184.

[3] Jaclyn Cabral. "Is generation Y addicted to social media". In: *Future of children* 18 (2008), p. 125.

[4] Logan Kugler. "Getting Hooked on Tech". In: *Commun. ACM* 61.6 (May 2018), pp. 18–19. ISSN: 0001-0782. DOI: 10.1145/3204447.

[5] Thomas H Davenport and John C Beck. *The attention economy: Understanding the new currency of business*. Harvard Business Press, 2001.

[6] A. Alutaybi et al. "How Can Social Networks Design Trigger Fear of Missing Out?" In: *2019 IEEE International Conference on Systems, Man and Cybernetics (SMC)*. Oct. 2019, pp. 3758–3765.

[7] Marta E. Cecchinato et al. "Designing for Digital Wellbeing: A Research & Practice Agenda". In: *Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems*. CHI EA '19. Glasgow, Scotland Uk: ACM, 2019, W17:1–W17:8. ISBN: 978-1-4503-5971-9. DOI: 10.1145/3290607.3298998.

[8] Eduardo Guedes et al. "Social networking, a new online addiction: a review of Facebook and other addiction disorders". en. In: *MedicalExpress* 3 (Feb. 2016). ISSN: 2358-0429.

[9] Patti M Valkenburg, Jochen Peter, and Alexander P Schouten. "Friend networking sites and their relationship to adolescents' well-being and social self-esteem". In: *CyberPsychology & Behavior* 9.5 (2006), pp. 584–590.

[10] Aditya Kumar Purohit and Adrian Holzer. "Functional Digital Nudges: Identifying Optimal Timing for Effective Behavior Change". In: *Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems*. CHI EA '19. Glasgow, Scotland Uk: ACM, 2019. ISBN: 978-1-4503-5971-9. DOI: 10.1145/3290607.3312876.

[11] Nir Eyal. *Hooked: How to build habit-forming products*. Penguin UK, 2014.

[12] Ken Peffers et al. "A design science research methodology for information systems research". In: *Journal of management information systems* 24.3 (2007), pp. 45–77.

[13] Christian Montag et al. "Internet Communication Disorder and the structure of the human brain: initial insights on WeChat addiction". In: *Scientific Reports* 8.1 (2018), p. 2155. ISSN: 2045-2322. DOI: 10.1038/s41598-018-19904-y.

[14] Nick Seaver. "Captivating algorithms: Recommender systems as traps". In: *Journal of Material Culture* (2018), p. 1359183518820366.

[15] Brian J Fogg. "A behavior model for persuasive design". In: *Proceedings of the 4th international Conference on Persuasive Technology*. ACM. 2009, p. 40.

[16] Ana Caraban et al. "23 Ways to Nudge: A Review of Technology-Mediated Nudging in Human-Computer Interaction". In: *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. ACM. 2019, p. 503.

[17] Richard H Thaler and Cass R Sunstein. *Nudge: Improving decisions about health, wealth, and happiness*. Penguin, 2009.

[18] Claus Ghesla, Manuel Grieder, and Jan Schmitz. "Nudge for Good? Choice Defaults and Spillover Effects". In: *Frontiers in Psychology* 10 (2019), p. 178. ISSN: 1664-1078. DOI: 10.3389/fpsyg.2019.00178.

[19] Isaac Dinner et al. "Partitioning default effects: Why people choose not to choose". In: *Journal of Experimental Psychology: Applied* 17.4 (Dec. 2011), pp. 332–341. ISSN: 1076898X. DOI: 10.1037/a0024354.

[20] Thomas Mejtoft, Sarah Hale, and Ulrik Söderström. "Design Friction". In: *Proceedings of the 31st European Conference on Cognitive Ergonomics*. ECCE 2019. BELFAST, United Kingdom: Association for Computing Machinery, 2019, pp. 41–44. ISBN: 9781450371667. DOI: 10.1145/3335082.3335106. URL: https://doi.org/10.1145/3335082.3335106.

[21] Emelie Andersson. "Pause-reminders in mobile applications". In: *CONFERENCE IN INTERACTION TECHNOLOGY AND DESIGN*. 2019, p. 67.

[22] Fabian Okeke et al. "Good Vibrations: Can a Digital Nudge Reduce Digital Overload?" In: *Proceedings of the 20th International Conference on Human-Computer Interaction with Mobile Devices and Services*. MobileHCI '18. Barcelona, Spain: ACM, 2018, 4:1–4:12. ISBN: 978-1-4503-5898-9. DOI: 10.1145/3229434.3229463.

[23] Aaron Bangor, Philip T. Kortum, and James T. Miller. "An Empirical Evaluation of the System Usability Scale". In: *International Journal of Human–Computer Interaction* 24.6 (2008), pp. 574–594. DOI: 10.1080/10447310802205776.

[24] Marc Hassenzahl, Michael Burmester, and Franz Koller. "AttrakDiff: Ein Fragebogen zur Messung wahrgenommener hedonischer und pragmatischer Qualität". In: *Mensch & Computer 2003: Interaktion in Bewegung*. Ed. by Gerd Szwillus and Jürgen Ziegler. Wiesbaden: Vieweg Teubner Verlag, 2003, pp. 187–196. ISBN: 978-3-322-80058-9.

[25] Thomas S Tullis and Jacqueline N Stetson. "A comparison of questionnaires for assessing website usability". In: *Usability professional association conference*. Vol. 1. Minneapolis, USA. 2004.

[26] Anselm Strauss and Juliet Corbin. "Grounded theory methodology". In: *Handbook of qualitative research* 17 (1994), pp. 273–85.

[27] William W Gaver, Jacob Beaver, and Steve Benford. "Ambiguity as a resource for design". In: *ACM CHI'03*. 2003, pp. 233–240.

[28] Paul M. Aoki and Allison Woodruff. "Making Space for Stories: Ambiguity in the Design of Personal Communication Systems". In: *CHI'05*. 2005, pp. 181–190.

[29] Dimitris Grammenos. "Abba-dabba-ooga-booga-hoojee-goojee-yabba-dabba-doo: stupidity, ignorance & nonsense as tools for nurturing creative thinking". In: *CHI'14 EA*. 2014.

[30] Adrian Holzer et al. "Uncomfortable Yet Fun Messaging with Chachachat". In: *Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play*. CHI PLAY '15. London, United Kingdom: ACM, 2015, pp. 547–552. ISBN: 978-1-4503-3466-2. DOI: 10.1145/2793107.2810296.

Chapter 5

Unhooked by Design: Scrolling Mindfully on Social Media by Automating Digital Nudges

- Americas Conference on Information Systems
AMCIS 2021 Proceedings.

Abstract – In 2020, over a billion people spent at least three hours a day on social media, primarily engaging in what is described as mindlessly scrolling through their newsfeed. This illustrates the growing societal concern of digital wellbeing and social media addiction. Reducing the time spent on these platforms is challenging since they are designed to be addictive. This paper presents the design and evaluation of a digital nudging intervention that unhooks users from their mindless social media use by making them more mindful. We evaluated the intervention through a two-week single case experimental design (N =20). The findings show that weekly digital consumption was significantly reduced by over 20.58%.

5.1 Introduction

A wide distribution of smartphones has changed the relationship we have with technology, and it is not always a healthy one. The same device that helps us get productive, i.e., sending emails, browsing the web, and improving communication, can also have a negative impact on our mental health [1]. In just two years, the American consumer has, on average, increased the time spent on their smartphones by 63% [2]. The applications inside our smartphones that seem to capture most of our attention are related to social media [3]. In fact, in some countries, the self-reported averages of social media usage surpass 4 hours a day [4]. This hyperconnectivity can lead to potential dysfunctional behaviour [5], ranging from mental distraction [6] to mental health problems, such as Obsessive-Compulsive Disorder (OCD), depression [7, 8] and degraded social interaction [9]. In cases where social media usage impairs social activities, interpersonal relationships, or psychological health and well-being, researchers label it as a form of social media addiction [10]. More distressingly, other negative states such as the feeling of envy [11], loneliness [12], and anxiety are also correlated with social media usage [13].

Such hyperconnectivity is not surprising since it is precisely what social media platforms designers aim for [14, 15]. Eyal [16] introduced the Hook Model, a useful framework to think about addictive social media design features. The model presents a circular 4-phase feedback loop that increases engagement: First, *a trigger* (e.g., a push notification) brings a user to the platform. Second, once on the platform, users are nudged to perform *actions* (e.g., liking, posting, creating a friend list). Third, these actions become *investments* in the platform, which makes it harder to leave ("It took time to create my friend list"), they also act as triggers for other users ("somebody liked your post"), and they are used to populate the endless newsfeed of users. The

newsfeed is one of the central design features in the fourth and last phase of the model, the *variable reward phase* where users are rewarded continuously with new content to view, comment, share, or like [17]. It leads to many users mindlessly scrolling through their newsfeeds [18]. Many of these design features can be described as digital nudges, i.e., indirect incentives that drive user choices.

To reduce social media overuse, mobile phone providers and third-party developers have started to provide solutions, many of those using digital nudging design principles (e.g., default, feedback, friction). Sometimes these interventions are referred to as digital detox apps. For instance, Apple provides weekly usage feedback reports and app limits. Nudge.io offers a solution to unfollow friends or hide some parts of the news feed [15]. Unfortunately, at this stage, there is still only sparse research about the efficacy of such interventions. Furthermore, researchers have pointed out privacy and ethics threats pertaining to digital detox that could make adoption more difficult [19]. For instance, in a digital detox app study by Monge Roffarello and De Russis [20] a participant mentioned "Just another data-stealing greedy app!! Hate greedy data-stealing apps, Robbery! Deleted". In another study by Purohit, Barclay, and Holzer [15] a participant mentioned, "I felt as if I took a risk in relation to my FB-data giving over some control to [the digital detox app]". Indeed, whereas digital nudging mechanisms are promising candidates to change user behavior, it is vital that they do not feel being even more manipulated. To tackle these issues, this paper presents the design and evaluation of a privacy-sensitive digital nudging intervention that unhooks users from their mindless digital behavior by increasing their mindfulness.

5.2 Methodology

This paper follows and is structured according to the design science research methodology (DSRM) [21]. In the Introduction, the paper first identified the problem, the first step of the DSRM. The Related Work section defines the objectives of the solutions, the second step of the DSRM. The third steps of the DSRM, namely the design and development of the solution, are presented in the Intervention Design, while the fourth step, Demonstration, is detailed in the section with the same name. The fifth step of the DSRM, the solution's evaluation, is detailed in the Evaluation Setup and Evaluation Results sections. Finally, the Discussion and Conclusion section can be seen as the last step of the DSRM, i.e., communication of the findings.

5.3 Related Work

In this section, we discuss the research efforts closest to our problem and define the objectives of the solution. Thaler and Sunstein [22] defined nudging as "... any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives." During the last decade, scholars and practitioners have demonstrated the effectiveness of digital nudges to change people's behavior [23]. For example, making indviduals mindful of online privacy policy by changing digital choice environment [24]. By definition, *digital nudges* refer to nudges that are provided via digital technology and employ user-interface design elements that guide people's choices or behaviors in digital decision environments [25]. Whereas these digital nudging principles are used to increase time spent online, they can also help users reduce their social media consumption through digital detox apps.

Researchers at Cornell Tech leveraged the concepts of nudging and negative reinforcement with their vibration intervention [26]. This intervention nudged users whenever they exceeded the daily usage limit of Facebook. The intervention design decreased Facebook usage, but most participants felt irritated and annoyed by the digital nudge and returned to their old habits when the intervention was removed. Similarly, researchers have used notifications to mitigate social media use by delivering the reminder after the users hit the daily goal limit [27]. However, 92% of the participants ignored and continued using social media. The intervention gave a chance for self-reflection, but it was frequently ignored [27]. The existing research on employing digital nudges to mitigate social media consumption is commendable. They also point to potential issues when the nudge is too forceful, leading to friction and less usability. The above findings convey that digital nudging interventions are potentially effective but can show a usability risk that could lead to them being less effective.

One of the aspects that can lead to better or worse usability and effectiveness of digital nudges is timing [28]. Indeed, one of the particularities of digital nudges compared to physical ones is that they can be timed and personalized more precisely, based on user interaction, location, or other contexts. Nudges delivered at the wrong time can lead to decreased satisfaction, negative emotions, hyperactivity, and distraction [29–31]. Researchers have identified the opportune moments to deliver digital nudges in the form of notifications that can be non-interruptive [32–35]. These findings indicate that identifying an adequate nudging moment is an essential aspect of the digital nudge design.

Two additional challenges when designing digital detox apps have to do with privacy and ethics. Digital detox apps are positively motivated and designed for digital wellbeing, i.e., digital overuse and addiction [36]. Nevertheless, recent experiments have been instrumental in revealing the primary

reason for users' reluctance towards digital wellbeing / digital detox apps: privacy [15, 37]. Digital detox solutions negatively impact creating a possible tradeoff between privacy and "fit" of the intervention [19] compromising users' data privacy [19, 38, 39], when privacy in itself is an important aspect of digital wellbeing [40]. Adopting a privacy-by-design approach could solve this issue, but the topic is rarely addressed in digital nudging research. A further issue is related to the fact that nudging users can be perceived as a deception. Indeed, much of the designs used by social media designers are at odds with the ethical guidelines to design ethical nudges. These guidelines suggest that nudges be (1) transparent, (2) easily avoidable, and (3) designed with the wellbeing of the user in mind [41, 42]. One approach to ensure that the end users' wellbeing is taken into account is to provide self-nudging tools. That is, instead of relying on third-party applications, people can design and structure their environments in ways that make it easy for them to make the right choice [43].

5.4 Intervention Design

The problem statement pointed out that social media users tend to spend too much time on social media mindlessly, which they might not find useful. The solution's main objective is not to prevent users from scrolling through their newsfeed but to reduce it by making it more mindful. The related work pointed to several promising design choices. The solution can leverage digital nudging interventions to break free users from the latches of variable rewards like mindless scrolling. However, these interventions need to balance being strong enough to allow users to change behavior and soft enough to avoid backfiring, which may eventually lead to users forsaking the intervention altogether. Furthermore, the intervention should be designed with privacy and ethical concerns in mind.

To find an adequate position on the design space to provide an effective yet soft nudge, we can play with two variables: the intervention type (e.g., temporary visual notification, lasting haptic vibration) and the intervention moment (i.e., before, during, or after mindlessly scrolling). We choose to design a soft nudge type (temporary visual feedback) combined with a potent nudge moment (during scrolling). The idea is to provide feedback to users about their current social media consumption through a temporary visual banner (in the style of a push notification). We refer to the feedback notification as MISFEED Nudge (Mindful Scrolling Feedback Nudge). Research has shown that push notifications are non-interruptive when they are well-timed and are perceived as a reminder even when delivered at a greater frequency multiplying the exposure of the notification content [44].

Previous research findings indicate that if an intervention is delivered at the beginning of the target behavior, it might break the desire or urge to conduct the behavior [45, 46] in our case, the behavior is mindless scrolling. Along this line, we chose to deliver MISFEED Nudge to users after a certain time of using the app (1 minute) and repeat the feedback every minute after that.

To design an ethical nudge, the intervention should be (1) transparent; it should be (2) easy to opt-out, and (3) the user wellbeing should be taken into account. It is possible to meet the first requirement by merely advertising the nudge for what it is: a feedback mechanism that aims at reducing a user's time spent on a social media platform. As the MISFEED Nudge is soft (it displays a temporary banner), it can easily be ignored and thus meeting the second requirement. To meet the third requirement, we take the approach to let users nudge themselves, i.e., not only allow them to opt-out of the nudge but allow them not to be nudged in the first place.

To design a solution with privacy in mind, a privacy-by-design approach should be adopted. As such, critical data should be identified, and systems

should avoid collecting them as much as possible from the start. To time the feedback nudges, it needs access to basic social media usage data, i.e., when a user opens the app. However, it does not need to access any other sensitive user data.

5.5 Demonstration

We built the intervention design using the shortcuts automation app, which comes pre-installed on Apple iOS 13 onwards. Shortcuts provide a powerful way to implement a well-timed feedback nudge while ensuring privacy and ethics. Shortcuts provide a visual way to build a set of instructions that can be triggered by various events, such as when an app is opened. With this tool, simple nudges can be designed without installing and trusting third-party applications. Furthermore, as the code is visible to users, it is free for inspection.

The MISFEED Nudge's implementation in the shortcut app and the resulting notification banner is shown in Figure-5.1. In the first step, we created timer actions from 1 minute to 10 minutes named timer collection; subsequently, the reset timer was created and named terminate timer. After, we ran both the shortcuts within automation based on two conditions. 1) When a user opened Instagram, automation executed timer collection shortcut, and the timers would start running 2) When a user closed Instagram, automation would execute terminate timer shortcut, which would reset the timers to zero in the timer collection.

5.6 Evaluation Setup

To evaluate the intervention's impact, we experimented with 20 students recruited from the pool of graduate students at our university and evaluated

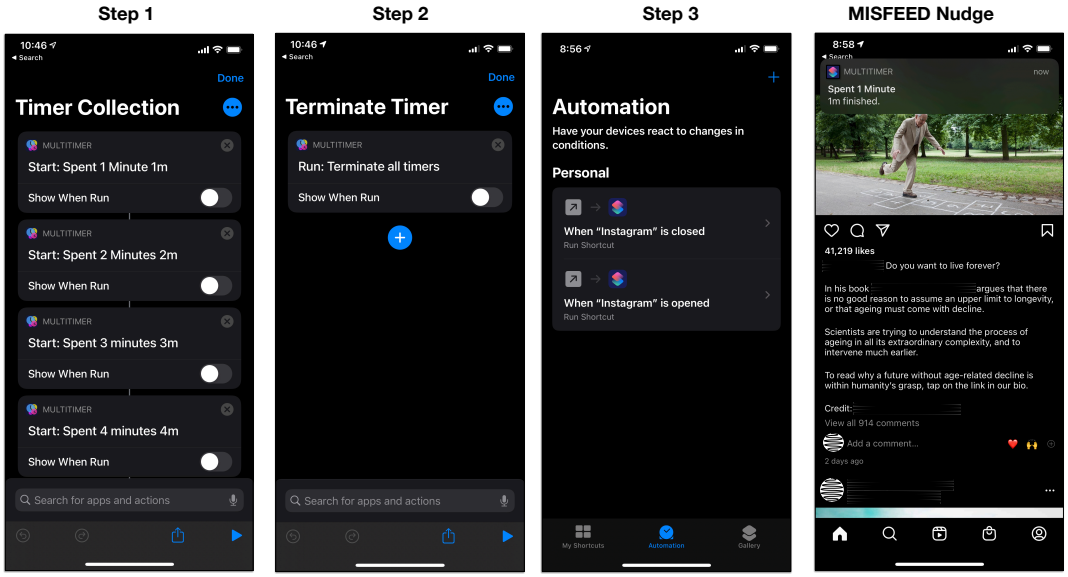


FIGURE 5.1: Step 1: Create a shortcut of timers. Step 2: Create a shortcut to terminate timers. Step 3: The shortcuts are run in automation. When the Instagram is opened, timers created in Step 1 is run and when Instagram is closed shortcut created in Step 2 is run.

the MISFEED Nudge on the Instagram social media application. We choose Instagram as the target application for two reasons: 1) The participants' self-rated time spent on Instagram was three times higher than Facebook. 2) In comparison, Facebook and Twitter have received more attention from scholars. Considering the immense popularity of Instagram, there have been limited studies on Instagram Addiction [12, 47]. We ran a single-case experimental design (N = 20) where participants were exposed to the intervention on Instagram. Our experiment ran for two weeks: a one-week baseline period, a one-week intervention period. This allowed participants to act as their own controls by comparing baseline (i.e. before the intervention) and intervention performance. The use of a single-case experimental design allows for high-quality research to be conducted with a small sample size [48]. During the intervention period, participants received the feedback nudge described in the previous section with notifications every minute they spent on Instagram. All the participants were given similar instructions.

A pre-survey was conducted with 55 students. The pre-survey included

questions on (i) self-rated time spent on various social networking platforms, (ii) demographic information, (iii) questions from the BSMAS social media addiction scale [49], and (iv) willingness to participate in a future study to reduce their addiction on social media. To participate in the study, students had to be active Instagram users (at least ten minutes of usage per day) on iOS. We filtered students on their Instagram using habits on their iOS and their willingness to reduce the time spent on Instagram. All selected participants had to have their iPhones already installed with the Instagram mobile app. After invited students consented to the study, a link to text and video-based tutorials on creating the nudge intervention using Shortcuts App on iOS was delivered to them.

To track Instagram usage behavior, the instructions on the shortcut app also included logging timestamps when the app opened and closed onto a local CSV file on the participants' phones.

During the first week, i.e., the baseline period, only the timestamps of opening and closing the Instagram was recorded in the CSV file. No intervention was provided during that period. The second week of the study was the treatment period in which participants turned on the feedback nudge intervention. At the end of the second week, participants completed an exit survey and received instruction on deleting the shortcut automation. The participants then sent over their CSV files and a screenshot of the native screen-time app to enable researchers to double-check the accuracy of the data collected.

5.7 Evaluation Results

This paper's main objective was to design a 1) usable nudge, which is 2) effective at reducing the time spent scrolling through social media feed by 2) making individuals more mindful.

5.7.1 The Misfeed Nudge showed Good to Excellent Usability

A condition for the intervention's success is that users find value in it and are willing to use it. They should find it useful, easy to use, and usable. In particular, we aimed for an intervention that was not perceived as annoying or irritating. To evaluate the intervention's usability, we used the IUS scale(Intervention usability scale) [50]. This scale is adapted from the SUS scale [51] that can generate reliable results even with small sample sizes [52]. The Misfeed nudge scored a mean of 77.3 points out of 100, indicating Good to Excellent usability.

5.7.2 The Misfeed Nudge Significantly Reduced the Time Spent on Instagram

We analyzed the Misfeed nudge's impact on the total amount of time that each participant spent on Instagram for a week. We performed paired sample t-test. Our sample size was N < 25; hence it required that we met the normality assumption, i.e., the difference in scores must be normally distributed in the population. In Table 5.1 we can observe that the mean difference between baseline and treatment is statistically significant at $p < 0.001$ with very large effect size $d = 0.98$. We evaluated the Shapiro-Wilk test to assess the normality of our data and found that it was not statistically significant, i.e., not violating the normality assumption required by our t-test (Table 5.2).

Measure 1	Measure 2	t	df	p	Cohen's d
Baseline	Treatment	4.403	19	<.001	0.984

TABLE 5.1: Average time spent on Instagram

The findings reveal that the intervention significantly reduced the time participants spent using Instagram. Figure 5.2 illustrates the variations in the

Conditions		W	p
Baseline	Treatment	0.976	0.881

TABLE 5.2: Test of Normality (Shapiro-Wilk)

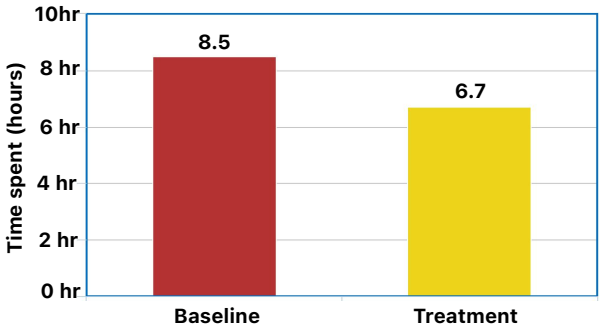


FIGURE 5.2: Time spent on Instagram across the baseline week and treatment week.

total amount of time spent by participants over the baseline and treatment periods using Instagram. The amount of time spent on Instagram per week during the treatment period decreased by over 20.58%, i.e., 1.75 hours. These findings suggest that the Misfeed nudge successfully and effectively reduces the time spent on the target application. In addition to measuring the total amount of time participants reduced on Instagram using the intervention, we were also interested to know if the intervention was able to reduce how many times participants opened Instagram. In Table 5.3 we observe that the mean difference between baseline and treatment was not statistically significant. Therefore, MISFEED Nudge did not reduce or increase the number of times participants opened Instagram.

Measure 1	Measure 2	t	df	p
Baseline	Treatment	0.161	19	0.437

TABLE 5.3: Average number of times Instagram opened

5.7.3 The Misfeed Nudge made Scrolling more Mindful

To assess if the intervention was effective and made participants mindful when using the app, they were asked to answer the items in Table 5.4 measured on a Likert scale from 'Strongly disagree' to 'Strongly agree'. To analyze the items, we applied a One-sample Wilcoxon signed-rank test that measured if the median is significantly different from 3. The effect size is calculated using Rosenthal correlation coefficient [53]. The result indicates that the intervention encouraged participants to become (1) mindful of their digital behavior on Instagram, (2) encouraged them to reduce their Instagram usage, and (3) assisted them in self-monitoring their Instagram usage.

Item	*Z*	*p*	*Effect size (r)*
The Feedback intervention that you experienced allowed you to easily self-monitor your Instagram usage?	3.739	.000	.83 (very strong)
The Feedback intervention that you experienced provided you encouragement to reduce your Instagram usage?	3.448	0.01	.77 (strong)
The Feedback intervention made you more mindful while using Instagram	2.723	0.006	.60 (strong)
The Feedback intervention encouraged you towards positive habit formation	2.401	0.05	.45 (moderate)

TABLE 5.4: Items for measuring the effectiveness of intervention and mindfulness

Further, we were also interested in understanding diverse perspectives about the intervention. Participants responded to the open question, "What is the best thing about the Intervention ?" All 20 participants reported that timely intervention made them more mindful and aware of their behavior on Instagram. All the answers to the open question pointed towards the theme of mindfulness. Here we report few comments from many; one participant reported that "Being informed of the time spent on Instagram by notifications made me leave the application." Another user commented, "When I'm on Instagram without really being interested in what I see, the reminders just

push me to quit the app because the way I'm occupying myself is useless." Another interesting comment stated by the user "The intervention made me realize how much time I spend on an app and the fact that it has been 10 minutes that I am on it but felt like I just opened the app 2 minutes ago." Taken together, these findings suggest that the Misfeed nudge was useful for participants, and it increased their awareness of digital behavior on-the target application. The intervention instilled self-awareness which is an aspect of mindfullness [54]. More precisely, a state of awareness that promotes digital well-being.

To assess if intervention changed the way participants used Instagram, we asked the following item "Did the Feedback intervention change the way you use Instagram?". Furthermore, if participants reported "yes," then they were asked an open question "Please describe how did it affect or change the way you use Instagram ?". 65% of the participants reported that intervention had changed the way they use Instagram. For instance, a participant wrote "When I went to Instagram, I only looked at the story and my timeline. I very rarely watched publications randomly. I got lost less in Instagram." Another participant reported, "I used to close the app and open it again a few minutes after (habit) and the fact that the timer starts again, it makes you realize that you spend too much time on it." Some participants thought the intervention increased the number of times they open Instagram while reducing their overall Instagram usage "This experience mostly impacted my time spent on the application every time I opened it. When I received a notification, it made me leave the application, and I find this positive. Even though maybe we open the application more often, we don't stay there as long. I think it's a good initiative to reduce our screen time on this application."

5.8 Discussion and Conclusion

We investigated how a usable, privacy-sensitive, and ethical digital nudging intervention could be designed to effectively make social media users more mindful when they scroll through their newsfeed and reduce their time on the platform. We designed the MISFEED nudge intervention as a feedback notification displayed while a user is on the social media platform. Our results supported the fact that such soft and transparent digital nudges can be designed and remain effective in curbing digital consumption. Participants indicated that the nudge made them more mindful of their social media consumption and our findings show that weekly digital consumption was significantly reduced by over 20.58%. Furthermore, the intervention exhibited Good to Excellent usability, which conveys the fact that increased mindfulness did not come at the cost of adding excessive friction to the user experience, which could potentially lead to users abandonning the nudge.

Our research makes the following contributions to the existing literature for reducing social media overuse. First our research contributes to existing literature by showing that the design of a feedback nudge timed during social media usage can significantly reduce the time on a social media platform, by increasing user mindfulness. This complements existing research which focused more on using commitment nudges, e.g., setting limits with potentially strong nudges, i.e., continous vibration, or firm limits. Whereas timing has been identified as an important factor in the design of digital nudges, few studies have explicitly investigated it. Our results show that feedback received right at the time of the behaviour can indeed provide a soft cue that can help users to get out of a mindless scrolling behavor if they wish. It should be noted that our findings show a decrease in time on the social media platform, but not a reduced number of times the social media app is opened. This results seem to indicate that the effect of the nudge, which specifically

targetted the reward phase of the Hook model, did not spill over to address the trigger phase. Future work could further investigate how nudges can be designed for the different phases of the model. Second, our research not only focused on nudge effectiveness, but also on privacy and ehtical considerations in the problem definition and then discussed design principles to uphold these constraints. Third, our research led to the design and implementation of a novel artefact, namely the MISFEED nudge. This nudge was implemented using Apple's built-in Shortcut app. With this app, MISFEED could not only deliver the nudge in a timely fashion, but could also meet the privacy and ethical requirements by preventing any thirrd party intervention and providing transparency to users with regards to the algorithm. Future research could investigate if the fact users co-create the nudge to such a do-it-yourself app, adds to the effectiveness of the app, similarly to the IKEA effect [55]. Furthermore, it is still not clear how much more trustful users are when they have the opportunity to see the high-level algorithm behind the intervention and how much they can be empowered through such interventions.

Our research also makes several contribution for practice. First, whereas phone manufacturers provide built-in mecanisms for reducing digital consumption, they mainly focus on either limiting the time spent on apps (very strict intervention) or giving weekly usage feedback (very soft intervention). The results from our study could pave the way for them to develop new soft feedback mecanisms delivered while on an app. Second, social media designers could themselves could integrate soft feedback to potentially improve the user experience of some of their users that want to reduce their consumption without entirely leaving the platform. Third, the use of the Shortcut app, or other automation apps, as nudge factories is still in its infancy. Nevertheless, the results from our study could encourage others to develop their own interventions to encourage digital wellbeing. These nudges could

be delivered through different artefacts, from haptics, to visual dashboards and could potentially also include other contextual information as triggers, such as time or location.

This research is not without limitations. As is inherent to any design choice, we had to limit our investigation to a particular location on an infinate design space. That is, we focused on a specific time frame, i.e., nudge users every minute when interacting within the target application and a specific digital nudge, i.e., feedback. Future work could further explore the design space both in terms of specific timing and nudge types in order to increase efficiency and reduce friction. Furthermore, our sample size was relatevely limited, in part due to COVID-19 restrictions, which made recruitment more difficult and partly because of the mobile device requirement to participate in the experiment (iOS devices only). Future work could replicate these findings with a broader sample over a longer period of time. However, despite these limitations, our research allowed us to observed a strong and significant effect of the intervention, which is encouraging for future towards towards better userexperience on social media.

References

[1] Chi-Ying Chen. "Smartphone addiction: psychological and social factors predict the use and abuse of a social mobile application". In: *Information, Communication & Society* 23.3 (2020), pp. 454–467. DOI: 10.1080/1369118X.2018.1518469. eprint: https://doi.org/10.1080/1369118X.2018.1518469. URL: https://doi.org/10.1080/1369118X.2018.1518469.

[2] Neilsen. *So Many Apps, So Much More Time for Entertainment*. Website. Available at: https://cutt.ly/Aolf5uj. June 2015.

[3] Peng Sha et al. “Linking Internet Communication and Smartphone Use Disorder by taking a closer look at the Facebook and WhatsApp applications”. In: *Addictive Behaviors Reports* 9 (2019), p. 100148. ISSN: 2352-8532. DOI: https://doi.org/10.1016/j.abrep.2018.100148. URL: https://www.sciencedirect.com/science/article/pii/S2352853218301561.

[4] GlobalWebIndex. *Flagship Report 2019*. Report. Global Web Index, 2019.

[5] Anne-Françoise Rutkowski and Carol Saunders. *Emotional and Cognitive Overload: The Dark Side of Information Technology*. Routledge, 2018.

[6] Gloria Mark, Mary Czerwinski, and Shamsi T Iqbal. “Effects of Individual Differences in Blocking Workplace Distractions”. In: *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. ACM. 2018, p. 92.

[7] Helmut Appel, Alexander L Gerlach, and Jan Crusius. “The interplay between Facebook use, social comparison, envy, and depression”. In: *Current Opinion in Psychology* 9 (2016), pp. 44–49.

[8] Maartje Boer et al. “Social media use intensity, social media use problems, and mental health among adolescents: Investigating directionality and mediating processes”. In: *Computers in Human Behavior* 116 (2021), p. 106645. ISSN: 0747-5632. DOI: https://doi.org/10.1016/j.chb.2020.106645. URL: https://www.sciencedirect.com/science/article/pii/S0747563220303927.

[9] Yu-Kang Lee et al. “The dark side of smartphone usage: Psychological traits, compulsive behavior and technostress”. In: *Computers in Human Behavior* 31 (2014), pp. 373–383. ISSN: 0747-5632. DOI: https://doi.org/10.1016/j.chb.2013.10.047.

[10] Cecilie Schou Andreassen. "Online social network site addiction: A comprehensive review". In: *Current Addiction Reports* 2.2 (2015), pp. 175–184.

[11] Hanna Krasnova et al. "Research note—why following friends can hurt you: an exploratory investigation of the effects of envy on social networking sites among college-age users". In: *Information systems research* 26.3 (2015), pp. 585–605.

[12] Saranya Ponnusamy et al. "Drivers and outcomes of Instagram Addiction: Psychological well-being as moderator". In: *Computers in Human Behavior* 107 (2020), p. 106294. ISSN: 0747-5632. DOI: https://doi.org/10.1016/j.chb.2020.106294. URL: https://www.sciencedirect.com/science/article/pii/S0747563220300492.

[13] Daria J Kuss and Mark D Griffiths. "Social networking sites and addiction: Ten lessons learned". In: *International journal of environmental research and public health* 14.3 (2017), p. 311.

[14] Santiago Giraldo-Luque, Pedro Nicolás Aldana Afanador, and Cristina Fernández-Rovira. "The Struggle for Human Attention: Between the Abuse of Social Media and Digital Wellbeing". In: *Healthcare*. Vol. 8. 4. Multidisciplinary Digital Publishing Institute. 2020, p. 497.

[15] Aditya Kumar Purohit, Louis Barclay, and Adrian Holzer. "Designing for Digital Detox: Making Social Media Less Addictive with Digital Nudges". In: *Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems*. CHI EA '20. Honolulu, HI, USA: Association for Computing Machinery, 2020, pp. 1–9. ISBN: 9781450368193. DOI: 10.1145/3334480.3382810.

[16] Nir Eyal. *Hooked: How to build habit-forming products*. Penguin UK, 2014.

[17] Nancy K Baym, Kelly B Wagman, and Christopher J Persaud. “Mindfully scrolling: Rethinking Facebook after time deactivated”. In: *Social Media+ Society* 6.2 (2020), p. 2056305120919105.

[18] Jennifer Rauch. *Slow media: Why slow is satisfying, sustainable, and smart*. Oxford University Press, 2018.

[19] Kelly Widdicks. “When the Good Turns Ugly: Speculating Next Steps for Digital Wellbeing Tools”. In: *Proceedings of the 11th Nordic Conference on Human-Computer Interaction: Shaping Experiences, Shaping Society*. 2020, pp. 1–6.

[20] Alberto Monge Roffarello and Luigi De Russis. “The Race Towards Digital Wellbeing: Issues and Opportunities”. In: *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. CHI ’19. Glasgow, Scotland Uk: ACM, 2019, 386:1–386:14. ISBN: 978-1-4503-5970-2. DOI: 10.1145/3290605.3300616.

[21] Ken Peffers et al. “A Design Science Research Methodology for Information Systems Research”. In: *J. Manage. Inf. Syst.* 24.3 (Dec. 2007), pp. 45–77. ISSN: 0742-1222. DOI: 10.2753/MIS0742-1222240302. URL: https://doi.org/10.2753/MIS0742-1222240302.

[22] Richard H Thaler and Cass R Sunstein. *Nudge: Improving decisions about health, wealth, and happiness*. Penguin, 2009.

[23] Ana Caraban et al. “23 Ways to Nudge: A Review of Technology-Mediated Nudging in Human-Computer Interaction”. In: *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. ACM. 2019, p. 503.

[24] Kristoffer Bergram et al. “Digital Nudges for Privacy Awareness: From consent to informed consent?” In: *Proceedings of the 28th European Conference on Information Systems (ECIS), An Online AIS Conference*. 2020.

[25] Markus Weinmann, Christoph Schneider, and Jan vom Brocke. "Digital nudging". In: *Business & Information Systems Engineering* 58.6 (2016), pp. 433–436.

[26] Fabian Okeke et al. "Good Vibrations: Can a Digital Nudge Reduce Digital Overload?" In: *Proceedings of the 20th International Conference on Human-Computer Interaction with Mobile Devices and Services*. MobileHCI '18. Barcelona, Spain: ACM, 2018, 4:1–4:12. ISBN: 978-1-4503-5898-9. DOI: 10.1145/3229434.3229463.

[27] Jaejeung Kim et al. "Goalkeeper: Exploring interaction lockout mechanisms for regulating smartphone use". In: *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 3.1 (2019), pp. 1–29.

[28] Aditya Kumar Purohit and Adrian Holzer. "Functional Digital Nudges: Identifying Optimal Timing for Effective Behavior Change". In: *Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems*. CHI EA '19. Glasgow, Scotland Uk: Association for Computing Machinery, 2019, pp. 1–6. DOI: 10.1145/3290607.3312876.

[29] Piotr D. Adamczyk and Brian P. Bailey. "If Not Now, when?: The Effects of Interruption at Different Moments Within Task Execution". In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. CHI '04. Vienna, Austria: ACM, 2004, pp. 271–278. ISBN: 1-58113-702-8. DOI: 10.1145/985692.985727.

[30] Kostadin Kushlev, Jason Proulx, and Elizabeth W Dunn. "Silence your phones: Smartphone notifications increase inattention and hyperactivity symptoms". In: *Proceedings of the 2016 CHI conference on human factors in computing systems*. ACM. 2016, pp. 1011–1020.

[31] Gloria Mark, Daniela Gudith, and Ulrich Klocke. “The cost of interrupted work: more speed and stress”. In: *Proceedings of the SIGCHI conference on Human Factors in Computing Systems*. ACM. 2008, pp. 107–110.

[32] Abhinav Mehrotra et al. “My phone and me: understanding people’s receptivity to mobile notifications”. In: *Proceedings of the 2016 CHI conference on human factors in computing systems*. ACM. 2016, pp. 1021–1032.

[33] Tadashi Okoshi et al. “Reducing users’ perceived mental effort due to interruptive notifications in multi-device mobile environments”. In: *Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing*. ACM. 2015, pp. 475–486.

[34] Veljko Pejovic, Mirco Musolesi, and Abhinav Mehrotra. “Investigating the role of task engagement in mobile interruptibility”. In: *Proceedings of the 17th International Conference on Human-Computer Interaction with Mobile Devices and Services Adjunct*. ACM. 2015, pp. 1100–1105.

[35] Martin Pielot et al. “When attention is not scarce-detecting boredom from mobile phone usage”. In: *Proceedings of the 2015 ACM international joint conference on pervasive and ubiquitous computing*. ACM. 2015, pp. 825–836.

[36] Vincent W.-S. Tseng et al. “Overcoming Distractions during Transitions from Break to Work Using a Conversational Website-Blocking System”. In: *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. CHI ’19. Glasgow, Scotland Uk: Association for Computing Machinery, 2019, pp. 1–13. ISBN: 9781450359702. DOI: 10.1145/3290605.3300697. URL: https://doi.org/10.1145/3290605.3300697.

[37] Simon Kloker, Maximilian Luis Riegel, and Christof Weinhardt. “Sensible or too Sensitive? Do Privacy Concerns Hinder the Acceptance of

Digital Solutions to Treat Smartphone Addiction?" In: *2020 IEEE 22nd Conference on Business Informatics (CBI)*. Vol. 2. IEEE. 2020, pp. 10–19.

[38] Uichin Lee et al. "Intelligent positive computing with mobile, wearable, and IoT devices: Literature review and research directions". In: *Ad Hoc Networks* 83 (2019), pp. 8–24. ISSN: 1570-8705. DOI: https://doi.org/10.1016/j.adhoc.2018.08.021. URL: http://www.sciencedirect.com/science/article/pii/S157087051830619X.

[39] Rafael A Calvo and Dorian Peters. *Positive computing: technology for wellbeing and human potential*. MIT Press, 2014.

[40] Dorian Peters, Rafael A. Calvo, and Richard M. Ryan. "Designing for Motivation, Engagement and Wellbeing in Digital Experience". In: *Frontiers in Psychology* 9 (2018), p. 797. ISSN: 1664-1078. DOI: 10.3389/fpsyg.2018.00797. URL: https://www.frontiersin.org/article/10.3389/fpsyg.2018.00797.

[41] Natalie Gold et al. "'Better off, as judged by themselves': do people support nudges as a method to change their own behavior?" In: *Behavioural Public Policy* (2020), pp. 1–30.

[42] Richard H Thaler. *Nudge, not sludge*. 2018.

[43] Samuli Reijula and Ralph Hertwig. "Self-nudging and the citizen choice architect". In: *Behavioural Public Policy* (2020), pp. 1–31. DOI: 10.1017/bpp.2020.5.

[44] Leanne G. Morrison et al. "Correction: The Effect of Timing and Frequency of Push Notifications on Usage of a Smartphone-Based Stress Management Intervention: An Exploratory Trial". In: *PLOS ONE* 13.5 (May 2018), pp. 1–1. DOI: 10.1371/journal.pone.0198008.

[45] Hillol Sarker et al. "Assessing the availability of users to engage in just-in-time intervention in the natural environment". In: *Proceedings of the*

2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing. 2014, pp. 909–920.

[46] Jaejeung Kim et al. "LocknType: Lockout Task Intervention for Discouraging Smartphone App Use". In: *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. ACM. 2019, p. 697.

[47] Kagan Kircaburun and Mark D Griffiths. "Instagram addiction and the Big Five of personality: The mediating role of self-liking". In: *Journal of behavioral addictions* 7.1 (2018), pp. 158–170.

[48] "Single-case experimental designs to assess intervention effectiveness in rehabilitation: A practical guide". In: *Annals of Physical and Rehabilitation Medicine* 61.3 (2018), pp. 164–179. ISSN: 1877-0657. DOI: https://doi.org/10.1016/j.rehab.2017.12.002.

[49] Cecilie Schou Andreassen et al. "Development of a Facebook addiction scale". In: *Psychological reports* 110.2 (2012), pp. 501–517.

[50] Aaron R Lyon, Stephanie K Brewer, and Patricia A Areán. "Leveraging human-centered design to implement modern psychological science: Return on an early investment." In: *American Psychologist* 75.8 (2020), p. 1067.

[51] John Brooke. "Sus: a "quick and dirty'usability". In: *Usability evaluation in industry* 189 (1996).

[52] Thomas S Tullis and Jacqueline N Stetson. "A comparison of questionnaires for assessing website usability". In: *Usability professional association conference*. Vol. 1. Minneapolis, USA. 2004.

[53] Robert Rosenthal, Harris Cooper, L Hedges, et al. "Parametric measures of effect size". In: *The handbook of research synthesis* 621.2 (1994), pp. 231–244.

[54] Kirk Warren Brown and Richard M Ryan. "The benefits of being present: mindfulness and its role in psychological well-being." In: *Journal of personality and social psychology* 84.4 (2003), p. 822.

[55] Michael I Norton, Daniel Mochon, and Dan Ariely. "The IKEA effect: When labor leads to love". In: *Journal of consumer psychology* 22.3 (2012), pp. 453–460.

Chapter 6

Designing for Digital Wellbeing on a Smartphone: Co-creation of Digital Nudges to Mitigate Instagram Overuse

- Hawaii International Conference
on System Sciences (HICSS) 2023

Abstract - The endless stream of social media newsfeeds and stories captivates users for hours on end, sometimes exceeding what users themselves consider unhealthy. However, reducing one's social media consumption has proven to be challenging. To address this issue, this study investigates how the co-creation of digital feedback nudge can improve digital wellbeing without increasing privacy threats. To achieve this goal, a mixed method study is used through a two-week single case experimental design. Results demonstrate that co-creation significantly increased users' sense of agency sense of accomplishment and perceived sense of privacy while reducing users' privacy concern. Furthermore, the feedback nudge allowed participants to significantly decrease their social media use.

6.1 Introduction

Personal and health applications of social media are on the rise [1]. Through social media, interactions can take place around various topics related to health, including patient education, health promotion, public relations, and crisis communication [2]. Almost 67% of all internet users in the United States use social media, utilizing it to search for health information online [1] making it one of the most popular online activities [2]. In healthcare, social media is used by patients for education, information, networking, research, support, setting goals, and tracking personal progress [1]. On the flip side, social media usage in itself can be harmful to health [3]. Indeed, social media apps are becoming the central activity on our mobile phones [4] with a daily consumption topping four hours in some countries [5]. This behaviour can be linked to psychiatric disorders, such as Obsessive-Compulsive Disorder (OCD), depression, and deteriorated social interaction [6]. Additional effects in relation to social media usage can be loneliness [7], envy [8], and anxiety [9].

To overcome these adverse effects and restore digital well-being, it is important to understand the principle on which social media platforms are designed. Social media platforms are designed to maximize connections and time spent online [10, 11]. To achieve this goal, social media companies employ design elements such as reminding users with notifications, providing feedback with likes, removing friction through infinite scrolling, thereby keeping users hooked and these design choices can be characterized as digital nudges [12] i.e., indirect incentives that affect user behavior. While social media platforms are employing digital nudges as manipulative design elements, also known as dark patterns [13], to increase the time spent online, digital nudges could potentially be used to reign over one's social media use i.e., to achieve digital well-being. Indeed, such mechanisms have been

used for positive outcomes in a variety of domains from encouraging pro-environmental behaviour to privacy awareness (e.g., [14]). This leads to our first research question: **RQ 1** : What are the characteristics of effective digital nudges to reduce one's social media usage?

However, when it comes to digital nudges, ethical concern can be an issue. Indeed, nudges can be perceived as being manipulative or paternalistic [15]. One way to mitigate these concerns about manipulation is to make the interventions more transparent by including users in the intervention design process [15, 16]. Such a co-design approach could have the added benefit of reducing the privacy concerns that usually hinders the adoption of digital well-being apps [17]. This observation leads to our second research question:

RQ 2 : Does co-creation of digital nudges for digital well-being reduce privacy concern?

6.2 Theory Background and Hypotheses

Below, we provide an overview of the current state of knowledge in the field which leads to our hypotheses.

6.2.1 Digital Nudging

Digital nudges refer to the nudges that are provided via digital technology and employ user-interface design elements that guide people's choices or behaviors in digital environments [18]. For instance, Barev, Schwede, and Janson [19] used a framing nudge to encourage users to disclose less personal information online, while Dennis et al. [20] used a priming nudge to increase the consumers' willingness to pay in an online store. During the last decade, scholars and practitioners have demonstrated the effectiveness of digital nudges to change people's behavior [21] such as making individuals

mindful of the online privacy policy by changing the digital choice environment [14]. Meanwhile, in the context of social media addiction, the research is more targeted towards purposeful modification of the choice architecture by an unbiased observer via digital nudging. For instance, applying limits [22], repeating phone vibration [23], and gamification [24] aim to provide means for digital detox via digital nudging. The term “digital detox" refers to periodic abstinence from social media, or strategies for cutting back on digital media consumption.

A fundamental feature of digital nudges for digital well-being is the provision of information, i.e., offering feedback on digital habits. There are other forms of digital nudges such as defaults, commitments, social, and deception. However, research suggests that the feedback nudges are often used to reinforce behavior change as they provide information about the past or current behavior of a user [25]. In other words, the feedback nudges place targets in a favorable context, encouraging them to make a right decision [26]. For example, employing feedback intervention to increase password strength [27] and improve learning [28]. In the context of digital well-being, recently, Purohit and Holzer [16] employed the feedback nudges that nudged users after 1 minute of using the app, followed by feedback every minute thereafter. While the nudges successfully reduced the time users spent on Instagram, they were unable to reduce the number of times users opened Instagram on their smartphones. The reason could be that they informed users only about the time they spent and not how many times they opened the application. It is crucial that interventions reduce the number of times an app is opened because previous research has shown that individuals access social media in a frequent, repetitive and revisiting pattern [29]. In short, users open the app unconsciously and scroll through their news-feed mindlessly [30] out of habit. In our particular case, the goal of the digital feedback nudge is to raise awareness about this kind of social media usage

and the number of times users open the app. We assume that providing individuals with digital feedback on how many times they open the app would not only reduce the time they spend on social media applications but also the number of times they open the app. This leads to the following hypothesis:

H1: Using a feedback nudge increases social media usage awareness and reduces the number of times the app is opened

The rationale behind the efficacy of feedback nudges is the idea that by raising awareness about a certain behavior, users will become more mindful and restrict their usage of social media when they do not find it important. To prove the case in point, consider Okeke et al. [23] who employed feedback in the form of vibration to nudge users to reduce the time they spent on Facebook. In another instance, Kim et al. [31] presented time spent on desktop devices as a positive or negative feedback and successfully made users aware of their digital habits. Hence, we formally state the following hypothesis:

H2: Social media usage awareness raised through feedback nudges decreases time spent on social media

As some previous research has pointed out, such a result is far from guaranteed. Kim et al. [32] used notifications to mitigate social media use by delivering reminders after the users hit the daily goal limit. However, 92% of the participants ignored and continued using social media. While the intervention offered an opportunity for self-reflection, it was unfortunately frequently ignored [32]. Thus, it is crucial to better understand the barriers in adoption of digital detox interventions.

6.2.2 Barriers to Digital Nudge Adoption

Digital nudging adoption is hindered by two factors: usability and ethical concerns [16]. In addition to helping mitigate social media consumption, research on digital nudges has also identified potential problems, such as when

the nudge is too forceful it leads to increased friction and lower usability. For instance, researchers at Cornell Tech leveraged nudging and negative reinforcement concepts with their vibration intervention [23]. The users' phones vibrated when their daily Facebook usage exceeded the limit. As a result of the intervention design, Facebook usage declined; however, participants had a negative reaction to the digital nudge and returned to their old habits once the intervention was removed. These findings suggest that though digital nudging interventions are potentially effective,they present a usability risk that might affect their effectiveness [16]. It is important to note that a key aspect of feedback is timing [33]. As a matter of fact, digital nudges offer distinct advantages over the physical ones because they can be precisely timed and personalized based on the context [25]. When delivered at a wrong time, digital nudges can make an individual annoyed and distracted [34]. In the form of notifications that are non-interruptive, there is a favorable window of opportunity (optimal moment) for digital nudges to be delivered [33, 35]. The above observations lead to the following hypothesis:

H3: Delivering feedback nudges when launching a social media app does not negatively impact usability of the intervention

In terms of ethics, Thaler [36] proposed a set of design guidelines that should be used to design, what he called, nudges for good. Nudges should be (1) transparent, (2) easy to opt-out, and (3) designed with the well-being of the user in mind [37]. Transparency can be understood both as the goal of the nudge, which should not be deceitful or obfuscated and the mechanism of the nudge through which it operates [16]. This second aspect involves transparency about data usage and privacy. Looking at transparency in the context of digital detox app research, findings suggest that even though the goal of these apps is transparent and positive as these apps are designed to promote digital well-being, i.e., reducing digital overuse and addiction [38],

recent experiments have shed light on the key reason for users' reluctance towards digital well-being / digital detox apps: privacy [16]. Digital detox solutions compromise users' data privacy [17].

Opting out easily means that users should have the autonomy to follow the nudge or decide not to follow it [16]. However, the person receiving a nudge is often unaware of the nudge or psychological mechanisms that choice architects use [39]. In short, an individual's personal autonomy is threatened when the reflective or deliberative processes of decision-makers are ignored. Second, there is no easy way to reverse the effects of a nudge [40]. For instance, inertia and status quo bias contribute to the tendency of users not to alter their default settings even though it is relatively inexpensive to do so [40]. The well-being of users should be the central focus for nudging and not the well-being of the designer [16]; however, even with noble intentions, who is to decide what is in the best interest of users [12]?. One approach to overcome the issue is to involve users in deciding to be nudged for a particular goal. An approach that could overcome the risks of ethics and usability is co-creation.

Prior research has shown that when individuals construct a product themselves, even when the product is mediocre, they experience IKEA effect i.e., increased self-agency [41]. As *self* comes into play, individuals will feel a richer sense of agency and hold more positive perception about what they do [42]. In the context of HCI, Lukoff et al. [43] found that there is an enhanced sense of agency when users have specific intentions for how they want to use a system. Similarly, the concept of co-creation has also been explored extensively in the context of consumer-company co-creation in which customers design products based on pre-existing design tools provided by the company [44]. Co-creation may increase the individuals' awareness of being the creator of their product [45]. On the negative side, participation in co-creation activities could also increase the perceived complexity of a

product and thus impede its potential benefits [46]. Nevertheless, we believe the positive aspects will surpass the negative ones and thus we posit the following hypotheses:

H4: Co-creation will lead to increased sense of agency

H5: Co-creation will lead to increased sense of accomplishment

In previous studies, users have reported concerns with privacy in the context of digital well-being interventions. For instance, in a recent study by Purohit, Barclay, and Holzer [47] a participant reported the following for a digital nudging intervention "I did feel skeptical about letting a relative alien add-on interfere with my Facebook." The process of co-creation will most likely make the intervention transparent and the transparency of digital nudging intervention is crucial to design an ethical digital nudge [16]. We assume that the transparency of the intervention and the sense of autonomy will lead to decreased sense of privacy risk and privacy concern as privacy is an essential aspect of digital well-being [48]. This leads to the two following hypotheses:

H6: Co-creation will lead to decreased sense of privacy concern

H7: Co-creation will lead to increased sense of privacy

6.3 Co-designed Feedback Nudge

To co-design and build the digital feedback nudge, we employed Shortcuts automation app on iOS. Shortcuts app is an app that allows users to program a variety of tasks using simple visual commands without the need to master any programming language. Shortcuts allows interaction with apps and content on iOS devices by allowing a user to pack, combine and execute a set of instructions. For instance, a set of instructions can be triggered by various events, such as when any third party app on the phone is opened or closed.

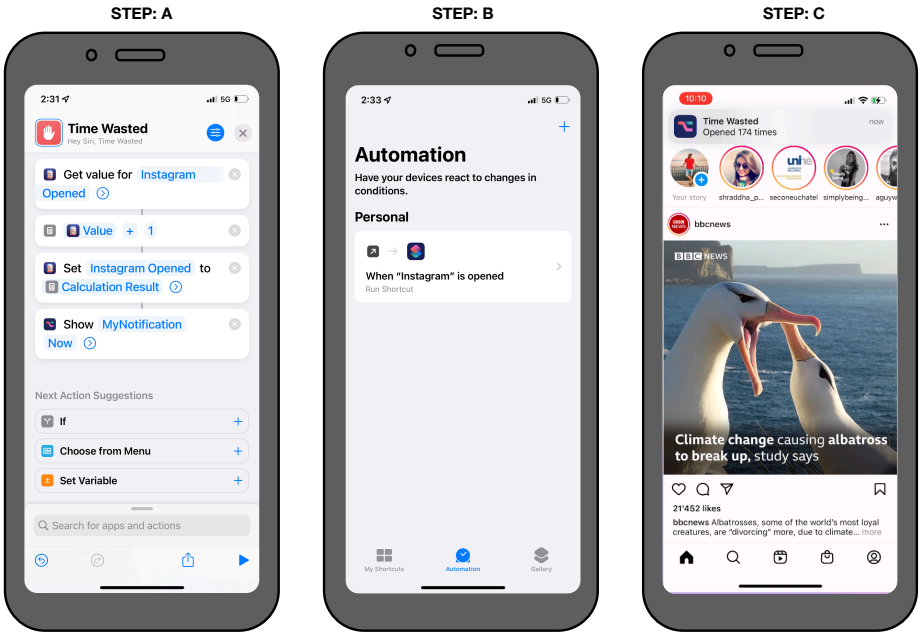


FIGURE 6.1: Intervention Design

With this functionality it becomes possible to implement a timely feedback nudge. In addition, the visual commands used to build the automation make the instructions visible and accessible for inspection. Figure 6.1 illustrates a feedback nudge designed using Shortcuts app that displays a notification when a user opens Instagram indicating the number of times it was opened. Figure 6.1.A shows the set of four instructions needed to program that nudge: (1) the program gets the value of the variable holding the number of times the app was opened, (2) this variable is incremented, (3) stored, and (4) the notification is triggered. Figure 6.1.B shows the setting of the event that triggers the automation, i.e., when Instagram is opened. Figure 6.1.C shows the automation in action with a notification banner indicating the number of times Instagram was opened. In terms of availability, Shortcuts automation app comes pre-installed on recent Apple iOS devices.

6.4 Research Method

To assess the impact of the intervention, we utilized a parallel mixed-methods research design [49]. For this purpose, we recruited 10 students from our university's graduate student pool. The participants co-created the intervention with a researcher and were then exposed to it through Instagram in a pre-post study design (N = 10). Pre-post study design has been shown to be helpful in evaluating digital health products and apps [50, 51]. We conducted our experiment over a period of two weeks: a baseline week and an intervention week. The participants acted as controls by comparing their baseline (before the intervention) with their performance after the intervention. After their consent for the study, each invited participant spent an average of 1.5 hours with the researcher to co-develop the digital nudge intervention via Shortcuts automation app. In total, it took two days to complete the co-designing process with all the 10 participants. To begin with, the participants were informed of a cover-story that the purpose of this research is to build interventions that others would like to use and also themselves for digital well-being. The cover-story was crucial to minimize the social desirability bias.

The participants were shown how Shortcuts automation app on iOS works, and then the co-designing of the intervention began with a few sketches and logical flow diagrams. The design space for the co-design phase was limited to a feedback nudge that showed information (e.g., the number of times the app was opened) when a user accessed Instagram. The participants individually personalised the messaging of the intervention to their liking.

We selected Instagram as our target social media application based on the following two conditions: (1) The participants rated their time spent on Instagram as three times more than on Facebook, (2) more attention has been paid

to Facebook and Twitter in comparison to Instagram. However, the intervention can be applied to any application. Although Instagram is extremely popular, there have been a few studies on Instagram addiction [7, 16]. The study required students to be active Instagram users (at least ten minutes per day) on iOS.

For tracking Instagram usage behavior, we followed similar methodology as Purohit and Holzer [16]. The shortcut app provided instructions for logging time stamps when the app was opened and closed onto a local CSV file. During the baseline period, the only timestamps in the CSV file were those of opening and closing Instagram. During that time, no intervention was provided. During the second week of the study, the participants were given feedback nudges. At the end of the second week, the participants received an exit survey with the instructions on how to modify, improve or delete shortcut automation. It is important to note that the participants were aware of how the data was being recorded as previous research has shown pre-familiarizing participants with experimental conditions, in particular data recording conditions, have shown to assist in decreasing the likelihood of the Hawthorne effect [52]. The researchers then double-checked the data collected by requesting the participants' CSV files and screenshots of the native screen time app.

6.5 Results

We conducted a mixed-methods analysis using both quantitative and qualitative approaches.

6.5.1 Quantitative Results

In order to assess the impact of intervention on social media use, we measured the number of time Instagram was accessed (H1) and the amount of

time the users spent on Instagram (H2). The mean number of times Instagram was accessed after the unlocking of the phone before and during the treatment is shown in Fig 6.2.

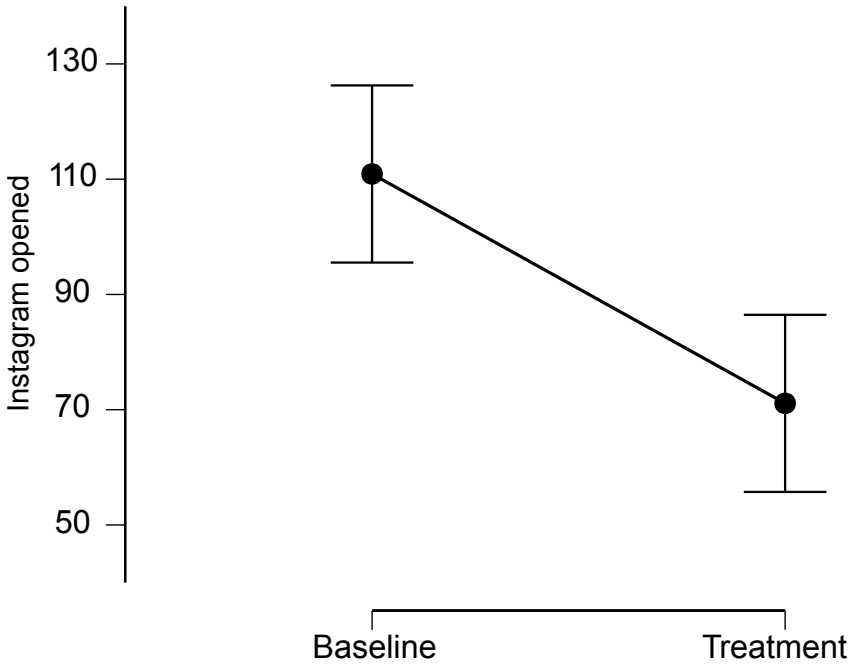


FIGURE 6.2: Baseline(Instagram opened) vs Treatment (Instagram opened)

To assess if the difference was statistically significant, we used a paired-sample t-test. Our sample size was $N < 25$, hence it required that we met the normality assumption, i.e., the difference in scores must be normally distributed in the population. So a Shapiro-wilk test was performed, which showed that difference in scores did not depart significantly from normality ($W = 0.945$, p-value = 0.612). The results show that the mean difference between the baseline and treatment is statistically significant $t(9) = 4.143$, $p < 0.001$ with a large effect size $d = 1.310$. The results indicate that the participants significantly reduced the number of times they opened Instagram after unlocking their smartphone. *H1 is supported*.

We also analyzed the intervention's impact on the total amount of time that the participants spent on Instagram for a week. Fig 6.3 shows the mean time spent before and during the treatment. Shapiro-Wilk test was

performed to test the normality required for t-test, difference in scores departed significantly from normality (W = 0.705, p-value = 0.001). In this case, we had to use a non-parametric test (Wilcoxon signed-rank). The results of the Wilcoxon signed-rank test showed that the mean difference between the baseline and the treatment is statistically significant (Z = 2.497, $p < 0.005$) with a very large effect size d = 0.89. *H2 is supported*.

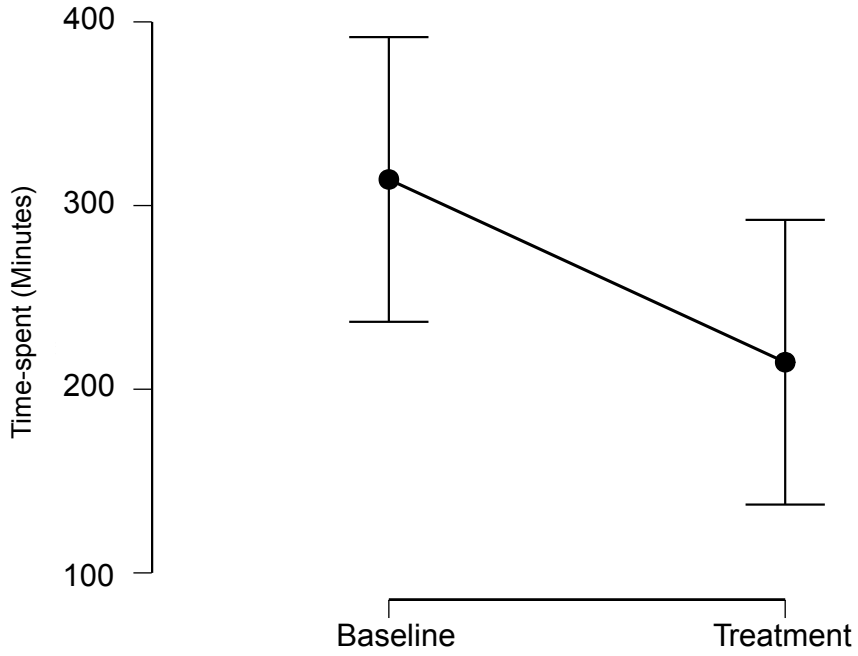


FIGURE 6.3: Baseline (Time-spent) vs Treatment (Time-spent)

In order to assess the usability of the intervention (H3), we used the IUS scale [53]. The IUS scale is based on the SUS scale by Brooke [54]. The feedback nudge intervention scored a mean of 74.68 points out of 100, indicating Good to Excellent usability. *H3 is supported*.

To measure the different attitudes towards the intervention, we measured psychometric constructs such as sense of agency [42] (H4), sense of accomplishment [42] (H5), perceived privacy [55] (H6), perceived privacy risks [56] (H7) as well as an additional usability construct perceived usefulness [57] using a 7-point likert-scale. We applied one-sample t-test to measure the impact of the intervention. The normality assumption required by our t-test was met (see Fig 6.4).

Variables	W	*p*	Normality assumed
Sense of agency	0.853	0.063	Yes
Sense of accomplishment	0.971	0.902	Yes
Perceived privacy	0.945	0.607	Yes
Privacy concern	0.907	0.258	Yes
Perceived usefulness	0.928	0.428	Yes

FIGURE 6.4: Test of normality (Shapiro-Wilk)

The results indicate that the means for sense of agency and accomplishment were significantly greater than 4. Participants reported greater sense of agency t(9) = 4.753 , $p < .001$ and sense of accomplishment t(9) = 3.354 , $p < .004$ with large effect size. *H4 and H5 are supported*. Similarly, the means for perceived privacy, perceived privacy concern and perceived usefulness were also significantly higher than 4. The participants reported greater perceived privacy t(9) = 4.367, $p < .001$, less privacy concern t(9) = -7.732, $p < .001$ and with greater perceived usefulness t(9) = 8.772, $p < .001$ with large effect size. *H6 and H7 are supported.*

6.5.2 Qualitative Results

Next, we will discuss the qualitative part of the study; we were also interested in gathering diverse perspectives on the efficacy and experiences of co-creation and the resulting digital nudge for digital well-being. The participants were presented with several open questions in the exit survey directed towards investigating the best and worst design aspects about the digital nudge and understanding their experiences on Instagram. The following open questions were asked 1) How was your experience using the "Digital

Feedback Intervention" ? 2) What is your opinion on co-creation of the "Digital Feedback Intervention" ? 3) How did the "Digital Feedback" Intervention make you feel, while using Instagram ? 4) If you were given a chance to redesign the Intervention, what kind of Intervention will you create to manage Instagram usage? The analysis was completed using grounded theory [58]. By coding the data line-by-line, we articulated emergent themes that we discuss below.

Mindfulness. One theme in particular that emerged was the various ways in which the users experienced a sense of awareness while using Instagram. The users frequently referred to awareness, realization, and the time spent indicating that the co-created digital nudge intervention made users mindful of their actions. As an example, the following comment was coded as awareness: "it makes you realize that you spend a lot of time on Instagram without realizing it." Another comment that was coded as attention to own behavior was: "it allows me to be able to control my reflexes, to keep track of how often you have opened an application". Some users realized their increased use of Instagram was caused by boredom.

Behavior change. We also looked at whether the digital feedback intervention affected behavior. One user appreciated the ease of use, thus leading to reduced Instagram addiction. For example, "It was easy to use and install, and it helped reduce my addiction to Instagram." The code that kept recurring was deliberate behavior; a user reported:"I now leave Instagram directly when I open it unnecessarily." Another user commented "even before opening Instagram, I would think of it, so I wouldn't even open it." Likewise, a user reported: " I'll reduce the number of times I open the application." *These results align with H1*.

Guilt. A negative theme emerged from the analysis i.e., guilt in the form of emotion. The feeling of guilt is used as a negative indicator based on statements from the interviews. For instance, the code that kept recurring was guilt, a user reported “It uses guilt in order to make us close the app. So it’s very strong" and “Maybe the worst thing about digital feedback intervention is that it can make you feel guilty about using your phone and create a negative feeling". Overall, guilt can be seen as ambivalent factor. As one interviewee puts it “I think it’s the most powerful emotion in this case".

Transparency of use. A theme emerged indicating the participants’ expectations on transparency of Instagram use. For instance, the following comment was coded as transparency of use, “This will allow me to better analyze my addictions, while trying to reduce the time I spend on this application and the number of times it has been opened". This also led the participants to expect a change in their use of social media. “So being able to see how many times I opened Instagram in a day will decrease the time I spend in this application". Likewise another user reported “It induces you to use social media less because it shows you concretely how much you use it and it scares you." In general, the newly gained knowledge of the number of times the users opened Instagram led them to the intention of changing their use of social media. *These results align with H2.*

Addictive design. Largely, the users spent time on Instagram in a more passive fashion instead of spending time with activities such as text messaging, posting etc. For instance, the following comment was coded passive use; a user reported “I waste my time by scrolling through photos and videos even though I know that doesn’t make me laugh or satisfy me, I keep scrolling because I search something to make me laugh that I can after send it to my friends to make them laugh with me". This confirms the notion that infinite

scrolling is an addictive dark pattern on Instagram that motivates users to keep scrolling. Other features such as the content itself, the algorithm's suggestion of content, and the steady provided stream of content were claimed to keep users on the platform. This highlights the addictive design patterns on Instagram while also suggesting a more passive use in contrast to actively messaging or creating content.

6.6 Discussion & Conclusion

Our research makes the following contributions to the existing literature for reducing social media overuse.

Co-creation, sense of agency. Our research not only focuses on nudge effectiveness but also on privacy and ethical considerations by introducing co-creation. Interestingly, co-creating the feedback nudge for digital well-being adds to the intervention effectiveness, similar to the IKEA effect [41]. The results revealed several insights on how co-creation can be supported by digital nudges to positively encourage digital well-being. The process of co-creation and setting up the intervention themselves had significant effects on the individuals' sense of agency, accomplishment and perceived usefulness. Building a digital well-being intervention appears to also have had the "I designed it myself" effect, like that of self-assembling furniture. When individuals create digital well-being interventions and become familiar with their inner workings as opposed to simply interacting with pre-assembled digital interventions, they indeed come to believe that the intervention is "mine", thus activating the "ownness heuristic".

Timely feedback and behaviour. Our results showed that the design of a feedback nudge timed during opening of the social media app can significantly reduce the time on a social media platform. The intervention also displayed good usability, which implies that increasing mindfulness was achieved without adding too much friction to the user experience, which may result in the user abandoning the nudge. This complements existing research, which focused more on using commitment nudges, e.g., setting limits with potentially strong nudges, i.e., firm limits [32]. Whereas timing has been identified as an essential factor in the design of digital nudges, few studies have explicitly investigated it. Our results show that the feedback on how many times an individual has opened the app received right at the time of the behavior, i.e., opening the app can provide a soft cue that can help users get mindful of their social media use. These findings point to the direction that unconscious and habitual opening of the app can be decreased by making an individual aware of the number of times an app has been opened. It should be noted that our results show how a nudge is used in full transparency and yet is still effective in instilling a change in behavior.

Feedback, from mindfulness to guilt. The participants indicated that the nudge made them more mindful of their social media consumption and also significantly reduced the number of times they opened Instagram while also significantly reducing the digital consumption. However, the qualitative analysis revealed that the intervention resulted in the manifestation of guilt which is a strong negative emotion. This could be due to the fact that the participants experienced the intervention to be very strong. Furthermore, the analysis also revealed that the users are not oblivious to the addictive dark patterns on social media platforms, instead they are knowledgeable on what keeps them hooked on Instagram like personalization of the content and infinite scrolling among many more. The future work could investigate

the interplay between mindfulness and guilt and devise approaches to leverage their potentially powerful behavioural component without potentially backfiring through overwhelming negative emotions.

Automation apps as research tools. In a recent research, Purohit, Barclay, and Holzer [47] found that the users desired automation in digital well-being tools. Our research leads to designing and implementing a novel artifact, namely the feedback nudge built on Apple's Shortcuts automation app. The use of this tool proved to be a powerful tool to conduct field research. First, it opens the possibilities to capture users' simple behaviour on third party apps to which researchers do not have access. Second, it allows for rapid prototyping using simple visual script languages. Third, it allows to meet the privacy and ethical requirements by potentially involving the users in a full intervention creation to ensure transparency, preventing any third-party intervention.

Lessons for the industry. While phone manufacturers provide pre-builtin mechanisms for reducing digital consumption such as screen time on iOS, they mainly focus on providing real-time reports and limiting the time spent on apps by introducing limits. Our study's results could pave the way for them to develop more subtle but visible feedback features such as notifying users on how many times an application has been opened, thereby accompanying users in their digital detox journey. The findings in the study could lead social media designers to integrate various communication strategies that users could choose (and also edit to their liking) to decrease the feeling of guilt. For instance, *You have saved 2 minutes today* (Gain frame) / *You have lost 3 minutes today* (Loss frame). The ability to choose and edit messages to their liking could further improve the users' user experience who want to reduce

their consumption without entirely leaving the platform. The use of Shortcuts, or other automation apps is still in its infancy. Presently, the automation applications like Shortcuts lack the ability to allow users to co-create an intervention remotely. However, the study we conducted may encourage developers to build features that allow co-creation in automation applications to encourage digital well-being. With the assistance of such automation applications, the creation of nudges might come in the form of haptics or visual dashboards, while being triggered by other contextual information, such as time or location.

Limitations. This research is not without limitations. Due to the limitations inherent in all design decisions, we restricted our investigation to a particular location within the infinite design space. The nudge was targeted to a specific time frame, i.e., when the target application was opened. Further exploration of the design space can be carried out with different nudges and timings to increase efficiency and reduce friction. As a result of COVID-19 restrictions, recruitment was more difficult, and using an iOS smartphone as an experimental device (iOS only) severely limited the sample size for this study. A larger sample could be used in future research with a longer study period to replicate these results. In spite of these limitations, our study found that the intervention had a significant and robust impact on social media users, which encourages co-creation and allows users to design interventions for their personal digital well-being

References

[1] Mowafa Househ, Elizabeth Borycki, and Andre Kushniruk. "Empowering patients through social media: the benefits and challenges". In: *Health informatics journal* 20.1 (2014), pp. 50–58.

[2] Petya Eckler, Gregory Worsowicz, and J Rayburn. "Social media and healthcare: an overview". In: *PM&R* 2.11 (2010), pp. 1046–1050.

[3] Chi-Ying Chen. "Smartphone addiction: psychological and social factors predict the use and abuse of a social mobile application". In: *Information, Communication & Society* 23.3 (2020), pp. 454–467.

[4] Peng Sha et al. "Linking internet communication and smartphone use disorder by taking a closer look at the Facebook and WhatsApp applications". In: *Addictive behaviors reports* 9 (2019), p. 100148.

[5] GlobalWebIndex. *Social - GWI's flagship report on the latest trends in social media*. Report. Global Web Index, 2021.

[6] Maartje Boer et al. "Social media use intensity, social media use problems, and mental health among adolescents: Investigating directionality and mediating processes". In: *Computers in Human Behavior* 116 (2021), p. 106645.

[7] Saranya Ponnusamy et al. "Drivers and outcomes of Instagram Addiction: Psychological well-being as moderator". In: *Computers in Human Behavior* 107 (2020), p. 106294.

[8] Hanna Krasnova et al. "Research note—why following friends can hurt you: an exploratory investigation of the effects of envy on social networking sites among college-age users". In: *Information systems research* 26.3 (2015), pp. 585–605.

[9] Daria J Kuss and Mark D Griffiths. "Social networking sites and addiction: Ten lessons learned". In: *International journal of environmental research and public health* 14.3 (2017), p. 311.

[10] Santiago Giraldo-Luque, Pedro Nicolás Aldana Afanador, and Cristina Fernández-Rovira. "The Struggle for Human Attention: Between the

Abuse of Social Media and Digital Wellbeing". In: *Healthcare*. Vol. 8. 4. Multidisciplinary Digital Publishing Institute. 2020, p. 497.

[11] Vikram R Bhargava and Manuel Velasquez. "Excerpt from Ethics of the Attention Economy: The Problem of Social Media Addiction". In: *Ethics of Data and Analytics*. Auerbach Publications, 2022, pp. 391–402.

[12] Richard H Thaler and Cass R Sunstein. *Nudge: Improving decisions about health, wealth, and happiness*. Penguin, 2009.

[13] Thomas Mildner and Gian-Luca Savino. "Ethical User Interfaces: Exploring the Effects of Dark Patterns on Facebook". In: *CHI EA'21*. 2021, pp. 1–7.

[14] Kristoffer Bergram et al. "Digital Nudges for Privacy Awareness: From consent to informed consent?" In: *ECIS*. 2020.

[15] Samuli Reijula and Ralph Hertwig. "Self-nudging and the citizen choice architect". In: *Behavioural Public Policy* 6.1 (2022), pp. 119–149.

[16] Aditya Kumar Purohit and Adrian Holzer. "Unhooked by Design: Scrolling Mindfully on Social Media by Automating Digital Nudges". In: (2021).

[17] Kelly Widdicks. "When the Good Turns Ugly: Speculating Next Steps for Digital Wellbeing Tools". In: *Proceedings of the 11th Nordic Conference on Human-Computer Interaction: Shaping Experiences, Shaping Society*. 2020, pp. 1–6.

[18] Markus Weinmann, Christoph Schneider, and Jan vom Brocke. "Digital nudging". In: *Business & Information Systems Engineering* 58.6 (2016), pp. 433–436.

[19] Torben Barev, Melanie Schwede, and Andreas Janson. "The Dark Side of Privacy Nudging–An Experimental Study in the Context of a Digital Work Environment". In: (2021).

[20] Alan R Dennis et al. "Digital nudging: Numeric and semantic priming in e-commerce". In: *Journal of management information systems* 37.1 (2020), pp. 39–65.

[21] Ana Caraban et al. "23 Ways to Nudge: A Review of Technology-Mediated Nudging in Human-Computer Interaction". In: *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. ACM. 2019, p. 503.

[22] Minsam Ko et al. "Lock n'LoL: group-based limiting assistance app to mitigate smartphone distractions in group activities". In: *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. 2016, pp. 998–1010.

[23] Fabian Okeke et al. "Good vibrations: can a digital nudge reduce digital overload?" In: *Proceedings of the 20th international conference on human-computer interaction with mobile devices and services*. 2018, pp. 1–12.

[24] JongSung Lee et al. "D-TOX: Inducing digital detox for nighttime via smart lamp applied gamification". In: *Proceedings of the 2017 Conference on Interaction Design and Children*. 2017, pp. 497–502.

[25] Kristoffer Bergram et al. "The Digital Landscape of Nudging: A Systematic Literature Review of Empirical Research on Digital Nudges". In: *CHI Conference on Human Factors in Computing Systems*. 2022, pp. 1–16.

[26] Aditya Kumar Purohit and Agnès Helme-Guizon. "The Power of Digital Nudge: Moving Towards Public Transportation and Debunking False Beliefs: A Conceptual Framework: An Abstract". In: *Enlightened Marketing in Challenging Times*. Ed. by Felipe Pantoja, Shuang Wu, and Nina Krey. Cham, 2020, pp. 613–614. ISBN: 978-3-030-42545-6.

[27] Verena Zimmermann and Karen Renaud. “The nudge puzzle: matching nudge interventions to cybersecurity decisions”. In: *ACM Transactions on Computer-Human Interaction (TOCHI)* 28.1 (2021), pp. 1–45.

[28] Lucas Zamprogno, Reid Holmes, and Elisa Baniassad. “Nudging student learning strategies using formative feedback in automatically graded assessments”. In: *Proceedings of the 2020 ACM SIGPLAN Symposium on SPLASH-E*. 2020, pp. 1–11.

[29] Alberto Monge Roffarello and Luigi De Russis. “Understanding and Streamlining App Switching Experiences in Mobile Interaction”. In: *Int. J. Hum.-Comput. Stud.* 158.C (Feb. 2022). ISSN: 1071-5819.

[30] Jennifer Rauch. *Slow media: Why slow is satisfying, sustainable, and smart*. Oxford University Press, 2018.

[31] Young-Ho Kim et al. “TimeAware: Leveraging framing effects to enhance personal productivity”. In: *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. 2016, pp. 272–283.

[32] Jaejeung Kim et al. “Goalkeeper: Exploring interaction lockout mechanisms for regulating smartphone use”. In: *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 3.1 (2019), pp. 1–29.

[33] Aditya Kumar Purohit and Adrian Holzer. “Functional digital nudges: Identifying optimal timing for effective behavior change”. In: *Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems*. 2019, pp. 1–6.

[34] Gloria Mark, Daniela Gudith, and Ulrich Klocke. “The cost of interrupted work: more speed and stress”. In: *Proceedings of the SIGCHI conference on Human Factors in Computing Systems*. ACM. 2008, pp. 107–110.

[35] Abhinav Mehrotra et al. "My phone and me: understanding people's receptivity to mobile notifications". In: *Proceedings of the 2016 CHI conference on human factors in computing systems*. ACM. 2016, pp. 1021–1032.

[36] Richard H Thaler. *Nudge, not sludge*. 2018.

[37] Natalie Gold et al. "'Better off, as judged by themselves': do people support nudges as a method to change their own behavior?" In: *Behavioural Public Policy* (2020), pp. 1–30.

[38] Vincent W-S Tseng et al. "Overcoming distractions during transitions from break to work using a conversational website-blocking system". In: *Proceedings of the 2019 CHI conference on human factors in computing systems*. 2019, pp. 1–13.

[39] STUART MILLS. "Nudge/sludge symmetry: on the relationship between nudge and sludge and the resulting ontological, normative and transparency implications". In: *Behavioural Public Policy* (2020), pp. 1–24.

[40] Riccardo Viale. "The normative and descriptive weaknesses of behavioral economics-informed nudge: depowered paternalism and unjustified libertarianism". In: *Mind & Society* 17.1 (2018), pp. 53–69.

[41] Michael I Norton, Daniel Mochon, and Dan Ariely. "The IKEA effect: When labor leads to love". In: *Journal of consumer psychology* 22.3 (2012), pp. 453–460.

[42] Yuan Sun and S Shyam Sundar. "Psychological importance of human agency how self-assembly affects user experience of robots". In: *2016 11th ACM/IEEE International Conference on Human-Robot Interaction (HRI)*. IEEE. 2016, pp. 189–196.

[43] Kai Lukoff et al. “How the design of youtube influences user sense of agency”. In: *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*. 2021, pp. 1–17.

[44] C Page Moreau, Leff Bonney, and Kelly B Herd. “It’s the thought (and the effort) that counts: How customizing for others differs from customizing for oneself”. In: *Journal of Marketing* 75.5 (2011), pp. 120–133.

[45] Sigurd Villads Troye and Magne Supphellen. “Consumer participation in coproduction:“I made it myself” effects on consumers’ sensory perceptions and evaluations of outcome and input product”. In: *Journal of marketing* 76.2 (2012), pp. 33–46.

[46] Taylor Randall, Christian Terwiesch, and Karl T Ulrich. “User design of customized products”. In: *Marketing Science* 26.2 (2007), pp. 268–280.

[47] Aditya Kumar Purohit, Louis Barclay, and Adrian Holzer. “Designing for Digital Detox: Making Social Media Less Addictive with Digital Nudges”. In: *Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems*. CHI EA ’20. Honolulu, HI, USA: Association for Computing Machinery, 2020, pp. 1–9. ISBN: 9781450368193. DOI: 10.1145/3334480.3382810.

[48] Dorian Peters, Rafael A Calvo, and Richard M Ryan. “Designing for motivation, engagement and wellbeing in digital experience”. In: *Frontiers in psychology* 9 (2018), p. 797.

[49] Viswanath Venkatesh, Sue A Brown, and Yulia Sullivan. “Guidelines for conducting mixed-methods research: An extension and illustration”. In: *Venkatesh, V., Brown, SA, and Sullivan, YW “Guidelines for Conducting Mixed-methods Research: An Extension and Illustration,” Journal of the AIS (17: 7)* (2016), pp. 435–495.

[50] Paul Stallard, Joanna Porter, Rebecca Grist, et al. "A smartphone app (BlueIce) for young people who self-harm: open phase 1 pre-post trial". In: *JMIR mHealth and uHealth* 6.1 (2018), e8917.

[51] Kris Martens et al. "Remediating reduced autobiographical memory in healthy older adults with computerized memory specificity training (c-MeST): An observational before-after study". In: *Journal of medical Internet research* 21.5 (2019).

[52] K Ayres, JR Ledford, and DL Gast. "Single case research methodology: applications in special education and behavioral sciences". In: (2014).

[53] Aaron R Lyon et al. "Assessing the usability of complex psychosocial interventions: The Intervention Usability Scale". In: *Implementation Research and Practice* 2 (2021), p. 2633489520987828.

[54] John Brooke. "Sus: a "quick and dirty'usability". In: *Usability evaluation in industry* 189 (1996).

[55] Shumaila Yousafzai, John Pallister, and Gordon Foxall. "Multi-dimensional role of trust in Internet banking adoption". In: *The Service Industries Journal* 29.5 (2009), pp. 591–605.

[56] Mauricio S Featherman and Paul A Pavlou. "Predicting e-services adoption: a perceived risk facets perspective". In: *International j. of human-computer studies* 59.4 (2003), pp. 451–474.

[57] Merrill Warkentin, Jordan Shropshire, and Allen Johnston. "The IT security adoption conundrum: An initial step toward validation of applicable measures". In: *AMCIS'07* (2007), p. 276.

[58] Anselm Strauss and Juliet Corbin. "Grounded theory methodology". In: *Handbook of qualitative research* 17 (1994), pp. 273–85.

Chapter 7

Starving the Newsfeed for Social Media Detox: Effects of Strict and Self-regulated Facebook Newsfeed Diets

ACM CHI'2023

ISBN 978-1-4503-9421-5/23/04

Abstract: Doomsurfing, doomscrolling or zombie scrolling. These new additions to the tech vocabulary have become part of our everyday routine, scrolling endlessly through social media feeds. Furthermore, some users report a sense of compulsion, a decrease in mental wellbeing and an increased sense of distraction. A common complaint among users harks back to the Facebook newsfeed. In a field experiment with real Facebook users ($n = 138$), we investigate the difference between a strict newsfeed diet (where the newsfeed is automatically reduced to a minimum) and self-regulated newsfeed diet (where the newsfeed is reduced, but users can then manage its content). Our results indicate that both of these newsfeed diets are effective at reducing the time spent on Facebook's platform (-64% for the strict diet, -39%

for the self-regulated diet). Our findings also suggest that these design interventions come with positive and negative user experiences such as increased self-awareness and fear of missing out (FOMO).

Keywords: Dark patterns, Digital Detox, Infinite newsfeed, Doomscrolling, Unfollow mechanisms, Social media, Digital Nudging, Multi-device, Digital Wellbeing, Facebook

7.1 Introduction

In some countries, the self-reported averages of social media use are 3–4 hours a day [1]. In 2019, average users reportedly checked their phones every 10 minutes, with 18–24-year-olds twice as often.[1]

The large-scale societal consequences of increased social media consumption range from more positive to negative use-cases such as habits [2, 3] to more disrupting mental health problems [4, 5] and degraded social interaction [6]. At the heart of this issue lies compulsive social media use which is a "*repetitive, ritualistic behavior involving an individual's inability to control, reduce, or stop the use of mobile [social media]*" [7].

Each user is potentially vulnerable to harmful use-cases through various reinforcement cycles when using social media platforms [7, 8]. During such reinforcement cycles, interactive technologies serve as a form of stimulus, compulsive usage becomes a response and the reinforcement cycle continues. Social media platforms are designed to maximize connections and time spent online leading to hyper-connectivity by employing user interface designs, sometimes referred to as dark patterns [9–11], i.e., designs that utilize knowledge of human psychology to trick individuals into an act that is not in their best interest [11, 12].

[1] Asurion-sponsored survey by Solidea Solutions in August 2019: `shorturl.at/uIZ15`

HCI researchers have previously pointed to Facebook's *infinite newsfeed* as a dark pattern [11]. The infinite newsfeed taps into three main characteristics of dark pattern as defined by Roffarello et al. [11]: (1) the design undermines individuals' autonomy and distracts them from their goal [11], (2) individuals experience that time has passed and they have no control over it [11] and (3) in retrospect, the design makes a person regret the time spent on the service [12]. In addition, infinite newsfeed negatively influences individuals' digital wellbeing [13]. As such, the newsfeed is likely to be among the factors that eventually lead people to use Facebook compulsively. In this paper we aim to better understand how newsfeed is related to time spent on Facebook and how a digital newsfeed diet, i.e., an intervention that reduces one's newsfeed, could be designed to reduce Facebook usage and potentially improve digital wellbeing. This leads to our overarching research question.

RQ: How does newsfeed restriction affect Facebook usage?

This overarching question leads to three sub-questions. First, how do different types of newsfeed restriction (abstinence vs moderation) affect time spent on Facebook? Second, how does newsfeed restriction affect user experience? Third, how does newsfeed restriction affect time spent according to users' compulsion to use Facebook? In this paper, we attempt to answer these questions by taking a design science research methodology (DSRM) approach [14–18]. In DSRM, the artifacts that impact people and organizations are created and evaluated in order to solve identified research problems [19] in six steps. This article is structured following these steps. The introduction covered the first step, namely the definition of the problem. The second step, i.e., defining the objective of the problem, is covered in Section 2, which lays out our hypotheses. The third and fourth steps, i.e., design of the solution and demonstration, are covered in Section 3. The fifth step, i.e., the evaluation of the solution, is split between Section 4, which presents the evaluation setup, Section 5, which tests the hypotheses, and Section 6, which provides

qualitative insights into the user experience through a thematic analysis. Finally, the sixth step, i.e., communication of the findings, is covered in the discussion in Section 7 and the conclusion in Section 8.

7.2 Related work & research objectives

Here, we describe relevant prior work, which led to the six specific research hypotheses that we tackle in this paper. In particular, we review work that relates social media use to compulsive use, before we give an overview of attempts to redesign the newsfeed to address this issue and how this could relate back to compulsive use and user experience.

7.2.1 Social media & compulsive use

There has been a lively debate among scholars about where chronic social media usage ends and usage more akin to "*addiction*" begins [7, 20, 21]. However, there seems to be substantial agreement among HCI researchers that social media platforms are designed in a way that facilitates compulsive use [21–25].

Typically, compulsive social media use is defined as the "*inability to self-regulate the use of the social media platform*" [26], that is, the user cannot control how frequently they use the platform or how long they spend on it. Compulsive social media use is an important societal concern because users facing it might have psycho-social and professional consequences [7, 27]. We previously mentioned that other researchers have theorized that compulsive social media usage happens through a series of reinforcement cycles, with interactive technologies serving as a form of stimulus, and compulsive usage becomes a response and the reinforcement cycle continues. We posit that the newsfeed on Facebook is one such interactive technology. While several previous studies have confirmed a strong correlation between a variety of

compulsive use measures and self-rated time on social media [28] – we want to validate this assumption by examining the relationship between compulsive use measures and actual time spent (by real users) on a well-established social media platform: Facebook. Previous scholars have also argued for the importance of validating the association between compulsive use and actual user behavior on social media platforms [7, 29]. Therefore, we hypothesize the following:

H1: Compulsive use is positively correlated with time spent on Facebook.

7.2.2 Redesigning the newsfeed

An important design feature for prolonging usage time on social media platforms comes through the newsfeed [30]. While the feature itself is the principal entry-point for a Facebook user, a recent survey suggested that it was also one of the features that tends to be associated with regret for the user [12]. Several previous studies have suggested the removal or reconfiguration of the Facebook newsfeed as a potential context for design researchers to tackle. Suggestions in the HCI literature range from complete removal [31], contextual removal that is dependent on the given user's goals [32], to adding various filtering options [24, 25, 32]. For example, both scholars and sampled users have made suggestions around configuring the newsfeed to only show content from close personal friends [24, 25]. In another study, Lyngs et al. conducted a user experiment where different Chrome extensions were used to compare a control group to goal reminders and a completely hidden/blocked newsfeed [32]. Here, a majority of sampled users suggested that they wanted more granular control over the Facebook newsfeed. In short, this newsfeed blocking intervention was effective when it came to decreasing users' visit length on Facebook's site but also led to fear of missing out (FOMO). Another study concerned the design and evaluation of a

Chrome extension that allowed to hide some parts of the Facebook user interface or remove colors to make it less appealing [24]. When considering how users spend their time and attention across apps, previous researchers have characterized design interventions along a spectrum ranging from internal to external [25]. External mechanisms entail monitoring problematic apps from the outside, and informing or notifying the user, e.g., setting a maximum duration on an app, or viewing the time spent on an app. Other external examples include the use of the phone's vibration to signal to the user that they have spent enough time on Facebook [33], framing the feedback negatively or positively [34], locking users out of apps [23] and locking users out of the device [35]. Internal design mechanisms would entail redesigning certain features of a problematic app directly inside the app, e.g., removing the newsfeed. Such internal mechanisms might remove more problematic aspects from a given app, while still retaining its most important benefits [25]. HCI researchers have highlighted that Google Play, Chrome Web and Apple App stores have created a vast marketplace for tools that help users in their online struggles for self-control (see [36, 37] for reviews of such tools).

In this research context we aim to change an internal design mechanism, more precisely the dark pattern such as infinite newsfeed that leads to mindless scrolling [11, 38]. We argue that by designing an artifact that restricts the newsfeed, that is, that reduces the content of the newsfeed from friends, pages and groups, users would be less exposed to variable rewards [24, 39] thereby breaking the inexhaustible reinforcement cycles of anticipation, uncertainty and feedback. We provide two versions of the newsfeed restriction artifact: (1) a *strict newsfeed diet* that reduces the newsfeed to the minimum and (2) *a self-regulated newsfeed diet* that reduces the newsfeed to a minimum, but lets users fill it with updates from people, pages and groups that the users opt-in to follow (as opposed to the system's default setting to follow all connections). In both cases, we hypothesize that the restriction will reduce

time spent on Facebook:

H2a: A strict newsfeed diet will decrease time spent on Facebook.

H2b: A self-regulated newsfeed diet will decrease time spent on Facebook.

7.2.3 Newsfeed diets & compulsive use

Previous research investigating various digital self-control artifacts hinted that such tools seemed especially useful for users who experienced the most intense struggles for self-control or labeled themselves as addicted [36]. This finding from sampling public user reviews can be contrasted with previous research on habits. Here, literature points to the general difficulty of changing strong (vs weak) habits [40]. That is, stated intentions are at odds with actual behavior in the presence of strong habits, and this is especially salient when the environment is stable, because the cues triggering the habitual response typically come from the environment [41]. In the case of newsfeed restriction diets, the environment stays stable; only the content of the newsfeed changes. Therefore, we expect more compulsive users to trigger their habitual response (i.e., spend time on Facebook) whatever the content and the restrictions applied to their newsfeed. This should be less the case for less-compulsive users, whose time on Facebook should be more affected by newsfeed restrictions. This is reflected in other, digital behavioral interventions, such as digital nudges, which tend to be less effective when habits are established [42].

H3: The newsfeed diets will affect less- (vs more-) compulsive users' time spent on platform to a greater (vs lesser) extent.

7.2.4 Newsfeed diets & user experience

Finally, we believe that a potential consequence of imposing a *strict* newsfeed diet, where users have no say in how the newsfeed is restricted, may adversely impact the user experience. While this intervention is not expected to affect usability components such as ease of use, users might potentially feel FOMO [32, 43], or difficulty to connect with friends and family. One way to address potential issues related to FOMO or connecting with important people in one's life is to take a self-regulation approach to the newsfeed instead of a strict restriction. A recent study that focused on increasing users' sense of agency on Twitter with internal vs external design mechanisms found that only internal mechanisms significantly increased users' sense of agency [44]. Findings from the same study suggest that usability issues were most frequently mentioned when users feel as if they are not in control [44]. The self-regulated newsfeed diet lets users define which connections to follow. In doing so, it gives users a sense of control, which is important to user satisfaction [25, 44, 45]. Moreover, HCI has long emphasized the importance of a sense of control over how users experience the interaction with technology [46]. The users want to feel that they are in charge and that the system responds to them [46]. This leads us to the following hypotheses:

H4a: A strict newsfeed diet (vs no diet) will negatively impact user experience.

H4b: A self-regulated (vs strict) newsfeed diet will positively impact user experience.

7.3 Design & demonstration

The problem statement pointed out that social media users tend to mindlessly spend too much time on social media because of the infinite newsfeed

feature. The solution's main objective is to address this issue by reducing the newsfeed.

7.3.1 Newsfeed mechanics & design

Social media platforms use different techniques to populate the user's newsfeed. Even though the exact algorithms are not open to the public, they follow certain principles. At the center of such algorithms is the notion of following some content emanating from friends, pages or groups. When a user follows a certain contact – the user's newsfeed will contain updates from that contact. It should be noted that different social media platforms have different ways to call similar types of relations. Generally, social media platforms offer at least two types of relations: a relation that allows users to establish a contact with someone (called '*friends*' in Facebook, '*contacts*' in LinkedIn, or '*followers*' in Instagram) and a second one that allows to see or not see someone's update in one's newsfeed (called '*follow*' or '*unfollow*' in Facebook and LinkedIn and '*unhide*' or '*hide*' in Instagram). By default, these platforms generally establish the second relationship, i.e., showing people's updates in one's newsfeed, when the first relationship is established. In this paper, we use the term *contact* for the first relationship and we use the terms *follow and unfollow* for the second relationship. As such, the newsfeed is a rough function of the number of contacts that a user follows. In addition to updates from followers, a Facebook user's newsfeed is also populated with different sponsored posts, as most mainstream social media platforms are monetized through advertising.[2] In the context of Facebook, sponsored posts are personalized for users, based on different information such as stated preferences, demographics, location or previous online activity [48].

[2]In 2021, Meta generated more than 99% of their total revenues (USD 115.655 billion) from advertising [47]

In some solutions, a browser extension can directly hide parts of the user interface (UI) such as the newsfeed [24, 32]. They can do this by simply modifying the HTML/CSS code on the client side. However, this type of solution has a limitation that makes it unsuitable for this study: The limitation is the fact that modifications are restricted to browser-based solutions and not applicable to native mobile apps, which is how many social media platforms are also used today. With the number of devices that allow access to social media content, data from a single device alone may not suffice to capture people's digital behavior [49]. One way to offer a cross-device solution is to provide a truly internal intervention that will, by definition, spread to all devices. One such approach to limit the newsfeed is simply unfollowing certain contacts. To unfollow means to stop seeing these contacts' posts in one's newsfeed. Unfollowing a contact does not remove you from each other's contacts list and it still allows you to go see your contacts' updates on their profiles. If a user unfollows every single contact, their newsfeed will be mostly empty, except for potential sponsored content.

To unfollow everything, users can navigate to a specific contact, but in some platforms it can be hard to find this unfollow option. To unfollow a contact, a Facebook user must currently navigate to the contact's profile, hover over "*Following*" (on a friend's profile) or click the "*Following*" button (on a page or in a group) near their cover photo and then select the "*Unfollow*" option [50]. This action then has to be repeated for each contact. Whereas the action of following a contact is the default state of affairs when a user adds a new contact, the unfollow procedure seems to suffer from lack of discoverability, which could be considered an example of another dark pattern [51]. With users following an average of over 300 friends, pages and groups on Facebook, repeating this manual procedure can also quickly become tedious [52].

7.3.2 Designing an automated unfollow solution

Automating the unfollowing process for large numbers of contacts could ease the process and could also address the cross-device issue. To enable this process to happen in a user-friendly manner, we designed a Chrome web browser extension that allows the user to unfollow all friends, pages and groups that they follow on one particular mainstream social media platform, namely Facebook. This extension was able to be downloaded and installed directly from the Chrome Web Store. From a user's perspective, the experience occurs as follows: once installed, the extension automatically unfollows a user's friends, pages and groups from Facebook, when the user opens Facebook via the Chrome browser, without any user interaction needed. Technically, the extension accesses the list of friends, pages and groups of a user through an authentication token. It then iterates through the list and performs POST requests for each friend, page and group to unfollow them. It should be noted that the process is not immediate, taking about 5–15 minutes to unfollow 300 friends, pages and groups (longer for users with many more friends, pages and groups).

By default, users are in what we are calling the '*self-regulated*' condition. That is, the extension unfollows all of the user's friends, pages and groups, and then the user can refollow anyone they please. For the purpose of the field experiment, we modified the extension in two ways: First, we added an extra prompt after the extension was installed and before it started unfollowing friends, pages and groups, in order to separate regular users and study participants, see figure 7.1. The existing extension prompted regular users to directly go to Facebook after the installation, whereas study participants were instructed via an extra pop-up window to click a link so that they could enter a randomly assigned unique ID that they were given via a Qualtrics

survey; this enabled their online behavior to be linked to their survey responses. Second, we modified the extension to assign study participants to three conditions based on their unique ID: 1) The default self-regulated diet, 2) A control condition in which the extension did not trigger any unfollow process, 3) A strict diet. To put users on the strict diet, we programmed the extension in such a way that it would unfollow all friends, pages and groups. If a new friend, page or group was added, or if an old friend, page or group was refollowed, the extension automatically unfollowed them. Finally, in order to allow users who use the extension to get their newsfeed back to normal, we designed a function to refollow everyone. Similarly to the unfollow process, this function iterates through all of the user's friends, pages and groups and refollows them one by one.

In addition to the core functionalities of the solution, we also designed infrastructure to measure the time spent on the Facebook platform for the purpose of the study on the site itself as well as on the iOS app. To measure time spent on the site (we focused on the Chrome web browser), we designed the web extension so that it would send time spent for each session to an analytics server. The extension typically performs a check every second to see if the browser's active tab is on the social media platform. If the extension detects a visit, a timestamp is created with an initial duration of 0 seconds. Then for every subsequent second on the site, the duration is incremented and sent to the analytics server.

To measure the time spent on the app (we focused on iOS devices), we implemented an automation process on the Apple shortcut app similarly to the methodology used by Purohit et al., [39, 53]. In a nutshell, the Apple Shortcut app allows the design of an automation that is triggered when a particular third-party app on the phone is opened or closed. The automation then wrote timestamps, every time the Facebook iOS app was opened and closed, in a CSV file that was stored locally on each user's phone. At the end

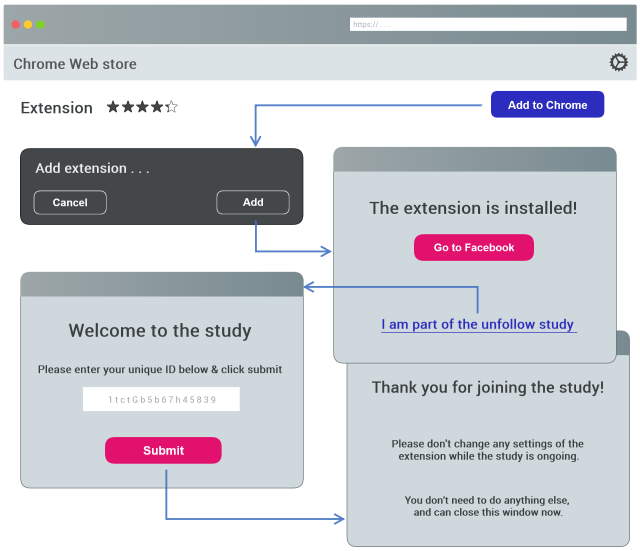


FIGURE 7.1: Mockup showing the installation of the extension: After adding the extension to the browser, three pop-up windows appeared where users (regardless of which condition they belonged to) had to click a link, input a unique code, and then close the final window

of the study we simply asked users to submit this CSV file to inspect the time they spent on the app without the need to build a client server infrastructure for the mobile data.

7.4 Evaluation

To evaluate the intervention and test the research hypotheses stated above, we conducted a three-week controlled field experiment with Facebook users randomly assigned to one of three independent conditions: the control condition (no diet), the strict newsfeed diet condition and the self-regulated newsfeed diet condition. The study was cleared with the university's ethics board beforehand. All data was collected during June 2021. Participants were recruited through Prolific and were provided instructions for the study with Qualtrics surveys. Participation through the whole study was rewarded with USD 25.

7.4.1 Measures

In addition to demographic control variables, such as age and gender, the main variables that we measured were related to compulsive use, time spent on site/app and user experience. There are several existing scales for capturing problematic or compulsive use on the Internet [54–57]. Also, Wang et al [7] built on such constructs to focus on mobile social networking services. We reused their scale and adapted it for one specific social media platform, namely Facebook. Every item for compulsive use was measured on a seven-point Likert-scale. To measure time spent on site/app, we added the daily time spent on the Facebook platform via the mobile device to the daily time spent on the Facebook platform via the browser to compute a single measure for each user, the average daily time spent on the Facebook platform for a given time period. To measure user experience, we used the system usability scale (SUS) [58] as well as an open question to let users report feedback in their own words about their user experience. Specifically we asked users to provide optional feedback on the best thing about the extension, the worst thing about the extension together with their overall impression.

7.4.2 Evaluation setup

The evaluation is divided in four main phases: (1) screening survey, (2) main survey, (3) the field experiment and (4) the exit survey.

First, participants filled out a short screening survey to confirm that they were interested in and eligible for the study. Owing to technical design choices, only Facebook users who accessed the platform with the Google Chrome browser and the iOS app were eligible. At that stage, it was already made explicit that their continued participation in the study could entail unfollowing all of their contacts on the platform.

Second, after this screening, a main survey was conducted. Users were asked to share demographic information, and fill out usability and compulsive use scales. Then they were asked to download, install, and configure the Google Chrome extension and Apple's Shortcuts app. As a verification procedure, each user received a random six-digit code to establish a link between the survey data and the behavioral data from the browser and the mobile app. During this installation, users were randomly assigned to one of the experimental groups using Qualtrics.

Third, the field experiment was performed. As mentioned previously, the field experiment had three randomized groups: no newsfeed diet (control), the strict newsfeed diet condition, and the self-regulated newsfeed diet condition. The field experiment was divided up as a seven-day baseline period, followed by a 14-day treatment period. During the baseline period, the extension remained idle for all three groups. The idea was to measure baseline daily average time on Facebook's site/app for each user. At the beginning of the treatment period, the different conditions were activated. For users in the control group, the extension was not activated and these users were told that they could continue to follow all their contacts. For users in the strict newsfeed diet condition, the strict version of extension was automatically turned on and it was communicated to this group of users that they would not be able to follow their contacts during the following 14 days. Similarly, for users in the self-regulated newsfeed diet condition, the extension was automatically turned on, but in this case in its self-regulation version which allowed users to refollow any contact they wanted. Users were again told explicitly about what was going to happen, i.e., that all their contacts would be unfollowed, but that they were able to refollow them during the succeeding 14 days if they wished to do so. As the Chrome extension's unfollowing procedure took around one hour for a thousand contacts, it could potentially take a long time for users with many contacts. We considered

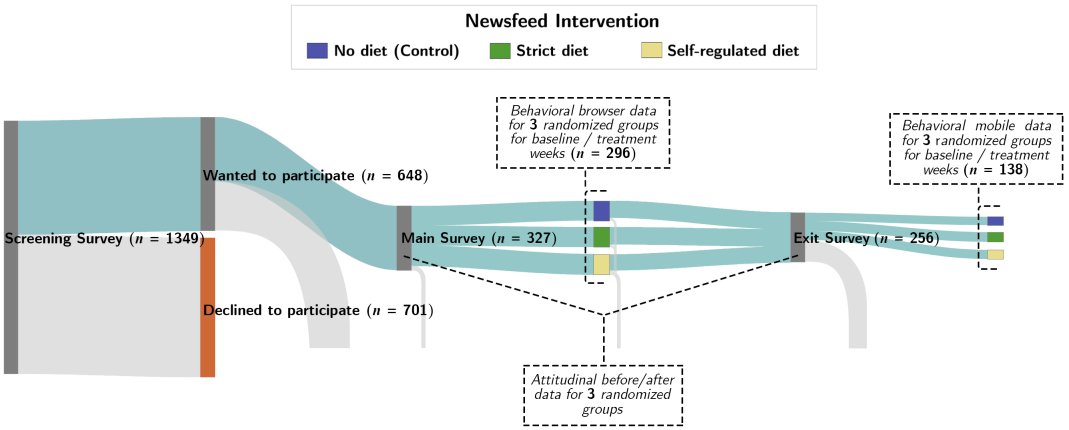


FIGURE 7.2: Sankey diagram [59] illustrating relevant data sources for the study, together with the sample attrition rate

that the process of unfollowing contacts might take several days if users did not spend enough time on Facebook to unfollow all contacts on the day they installed the extension. To minimize interference of this process with their regular usage, we only use the behavioral data of the latter seven days of the 14-day intervention as treatment period data.

Fourth, at the end of the third week, participants completed an exit survey that contained the open user experience questions and they were shown how to upload their mobile usage data (the CSV file described above) and finally they were shown how to delete the Shortcuts automation and refollow their contacts if they wished to do so.

7.5 Results

7.5.1 Study design and data overview

The Sankey diagram in figure 7.2 summarizes the overall design of the study and the most important sources of data. The size of each pipe and node is proportional to the number valid responses, i.e., the size of the sample.

The Sankey diagram is ordered from left to right in terms of sample attrition rate. That is, the pool of valid cases decreases from left to right in figure 7.2. The data sources in figure 7.2 are not necessarily in chronological order. In terms of chronology, the behavioral data collection (both mobile and browser) started right after the main survey and up until the exit survey. During the exit survey, the remaining users were asked to upload their CSV files from their mobiles, which is why the sample attrition rate increases after the exit survey.

The initial sample size for the screening survey was n = 1349 US Facebook users. In total, 327 users enrolled on the study by completing the main survey. Out of those, 296 users successfully downloaded/installed the Chrome browser extension. Just 256 users finished the exit survey and thereby provided valid answers to the attitudinal before/after variables. From these, we received valid mobile data from 138 users in total. The last number constitutes the final number of users for the study and, as the next section will show, this number slightly fluctuates, depending on the variable of interest. Despite the attrition rate in the study, the three randomized groups remained fairly balanced throughout the field experiment. Fig 7.3 presents the descriptive statistics of variables of interest collected at the *baseline period* of the field experiment. This is mainly to ensure that the randomization procedure worked during the field experiment so that the intervention groups are comparable.

Figure 7.3 shows the sample medians ($\hat{m}$), averages ($\hat{\mu}$), standard deviations ($\hat{\sigma}$) and the number of valid cases (n) for each variable across the intervention groups. The high standard deviation for time on site/app shown in figure 7.3 reveal a very high variation of Facebook usage between users. Indeed, the measure ranges from roughly seven seconds to almost four and a half hours per day. Nevertheless, the average of 35.7 minutes per day that

we observe is in line with figures of the Global Web Index report 2021, which shows that the average monthly time spent on Facebook is 19.5 hours, i.e., 39 minutes per day [60].

	Control				Strict diet				Self-regulated diet			
Variable	$\hat{m}$	$\hat{\mu}$	$\hat{\sigma}$	n	$\hat{m}$	$\hat{\mu}$	$\hat{\sigma}$	n	$\hat{m}$	$\hat{\mu}$	$\hat{\sigma}$	n
Time on site/app (s)	1385.9	2044.6	2650.1	42	1594.7	2087.5	2020.2	49	1090.3	2279.9	3069.9	47
Compulsive Use	3.750	3.953	1.384	43	3.625	3.730	1.350	50	3.250	3.702	1.910	47
SUS score	80.00	80.23	14.19	43	75.00	73.50	18.70	50	80.00	78.03	13.61	47
Age	29.0	31.05	10.51	43	28.0	31.28	11.95	50	24.0	26.89	7.98	47
Gender (% female)		65.12		43		58.00		50		63.30		47

FIGURE 7.3: Descriptive statistics across each newsfeed diet intervention group during the baseline period of the field experiment.

Fig 7.3 also highlights that there seems to be a higher sample attrition rate in the control group compared to the treatment groups. While the control group is smaller, a χ^2goodness-of-fit test indicated that there were no significant differences in the proportion of valid cases in the three randomized intervention groups (42, 49, 47) when compared to the expected proportions of (46, 46, 46), $\chi^2(df = 2,\ n = 138) = 0.565$, p $= 0.754$.

In fact, Kruskal–Wallis tests and another χ^2-test detected no significant differences between the intervention groups on any of the listed variables in Fig 7.3. We therefore conclude that the medians and proportions of these variables are reasonably balanced across the intervention groups at the baseline period of the field experiment.

7.5.2 Time on platform, compulsive use & newsfeed diets (H1–H3)

When performing tests for statistical significance, we followed the guidelines outlined by Benjamin et al. [61]. The relationship between time on site/app during the baseline period and compulsive use showed a significant correlation: $\rho = 0.390$, [95% CI: 0.233, 0.526], $n = 138$, $p < 0.001$. That is, high levels

of time on site are associated with higher degrees of compulsive use. H1 is supported.

To conform to the assumptions of parametric models and tests: a natural log transformation was applied to the daily time on site/app variable. The results before and after the log transformation are visualized in figure 7.5. The raincloud plots in figure 7.5 combine the distribution curves, boxplots for indicating where the density of the distribution lies and the scattered rain of all the individual data points [62]. The colored lines highlight the mean differences between the intervention groups. Figure 7.5 is complemented by figure 7.4 which also shows the sample size, mean and standard deviation from each intervention group after the log transformation. Figure 7.4 also highlights that we were not in complete control to enforce the newsfeed diets. We captured partial data on the percentage of unfollowed contacts which suggests that the unfollow procedure was not completed by all users in the field experiment. This refers to average and median percentage changes in followed contacts between baseline and treatment periods for each newsfeed diet. Figure 7.4 highlights large differences between the control and the newsfeed diets, but not between the two newsfeed diets. We also computed the log changes in time on site/app between the baseline and treatment periods.

	Baseline period			**Treatment period**			**% Change in followed contacts**	
Newsfeed intervention	n	$\hat{\mu}$	$\hat{\sigma}$	n	$\hat{\mu}$	$\hat{\sigma}$	average	median
No diet	41	7.040	1.220	41	7.039	1.515	↓ 3.3	↓ 0.0
Strict diet	47	7.175	1.174	47	6.157	1.544	↓ 62.0	↓ 82.7
Self-regulated diet	46	7.006	1.309	46	6.489	1.560	↓ 65.1	↓ 77.4

FIGURE 7.4: Log transformed time on site/app measures for the baseline and treatment periods across each newsfeed diet intervention. Missing values in the percentage change of followed contacts across each newsfeed diet: No diet: 16, Strict diet: 19; Self-regulated diet: 24

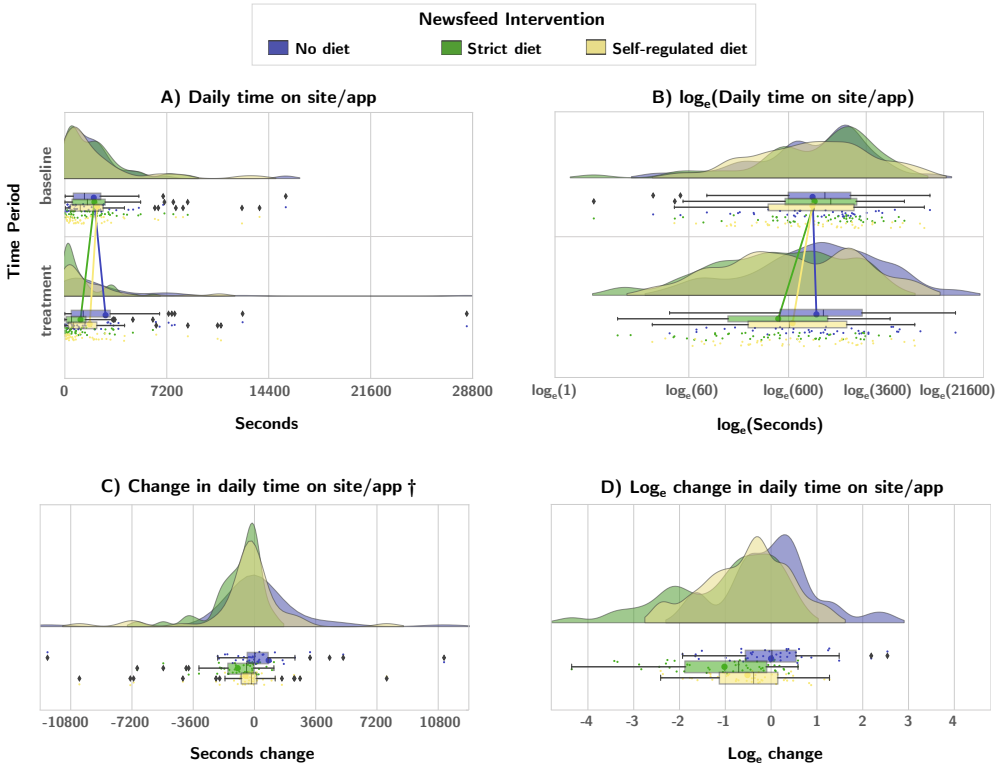


FIGURE 7.5: Raincloud plots [63] A) and B) showing time on site/app across each newsfeed diet during baseline and treatment weeks together with C) and D) showing changes in time on site/app between baseline/treatment weeks across each newsfeed diet. † The x-axis of this raincloud plot excludes one outlier at +26145 seconds that can been seen at +2.539 in raincloud plot D)

These log changes are visualized again with raincloud plots in figure 7.5 D). The untransformed changes in daily time on site/app across each newsfeed diet group can be found in figure 7.5 C) The connection between the raincloud plots in figure 7.5 is the following: The distribution curves, boxplots and scattered rain shown in C) are simply the result of subtracting the baseline week data from the treatment week data in plot A). With the log transformed data in figure 7.5 B), the same subtraction is performed which results in plot D).

To examine the change that the newsfeed diets may have had on time on site/app and to investigate whether restricting the newsfeed had a different impact on users who need it most, i.e., compulsive users, we specified three multiple regression models in a hierarchical fashion. In each model, we regressed the log changes in time on site/app between the baseline and treatment periods on a number of predictors. The dependent variable used for these models is visualized in raincloud plot D) in figure 7.5. This dependent variable is the natural log change in time spent on site/app between the treatment and baseline periods. In the first model, we simply introduce the two newsfeed diets as dummy variables with indicator coding. This model is related to H2a and H2b.

In the second model we do the same while also adding users' logged baseline measures for time on the site/app together with their compulsive use measure before the baseline period. The second model therefore accounts for the potential effect from the interventions and compulsive use, and with the fact that different users spent different amounts of time on Facebook during the baseline period. This is sometimes referred to as a conditional change model [64].

In the third model we keep the previous predictors while also introducing the moderating effects of compulsive use during the baseline period on each intervention group e.g. d_1x_2 and d_2x_2. This model relates to H3. The

Appendix contains a description of all variables used in the three regression models.

		Regression coefficients						
Model	Variable	$\widehat{\beta}$	95% CI	Std. Error	t	VIF-value	p-value	Adj. R^2
1	Constant (β_0)	0.001	[-0.320, 0.319]	0.161	-0.005		.996	.126
	Strict diet	-1.018	[-1.455, -0.581]	0.221	-4.606	1.394	.000***	
	Self-regulated diet	-0.516	[-0.955, 0.077]	0.222	-2.323	1.394	.022*	
2	Constant (β_0)	0.008	[-0.326, 0.310]	0.161	-0.050		.960	.139
	Strict diet	-0.982	[-1.417, -0.546]	0.220	-4.460	1.403	.000***	
	Self-regulated diet	-0.498	[-0.935, -0.061]	0.221	-2.257	1.398	.026*	
	† $\log_e$(Time on site/app)	-0.129	[-0.287, 0.028]	0.080	-1.624	1.208	.107	
	Z-score Compulsive Use	0.171	[-0.025, 0.362]	0.098	1.719	1.208	.088	
3	Constant (β_0)	0.001	[-0.319, 0.322]	0.162	0.009		.993	.134
	Strict diet	-0.989	[-1.427, -0.551]	0.221	-4.471	1.409	.000***	
	Self-regulated diet	-0.509	[-0.948, -0.070]	0.222	-2.293	1.403	.024*	
	† $\log_e$(Time on site/app)	-0.129	[-0.288, 0.029]	0.080	-1.619	1.211	.108	
	Z-score Compulsive Use	0.073	[-0.292, 0.439]	0.185	0.398	4.260	.691	
	Strict diet x Compulsive Use	0.262	[-0.245, 0.769]	0.256	1.024	2.003	.308	
	Self-regulated diet x Compulsive Use	0.060	[-0.376, 0.496]	0.220	0.273	3.098	.785	

* $p < 0.05$, ** $p < 0.005$, *** $p < 0.001$
Model 1: $\log_e(\frac{y_1}{y_0}) = \beta_0 + \beta_1 d_1 + \beta_2 d_2 + e$
Model 2: $\log_e(\frac{y_1}{y_0}) = \beta_0 + \beta_1 d_1 + \beta_2 d_2 + \beta_3 \log_e(x_1) + \beta_4 x_2 + e$
Model 3: $\log_e(\frac{y_1}{y_0}) = \beta_0 + \beta_1 d_1 + \beta_2 d_2 + \beta_3 \log_e(x_1) + \beta_4 x_2 + \beta_5 d_1 x_2 + \beta_6 d_2 x_2 + e$
† Refers to the baseline period, to aid interpretation this variable has been centered $(x_i - \bar{x})$

FIGURE 7.6: Multiple linear regression models: Predictors for log changes in time on site/app between baseline and treatment periods

The results of the first model in figure 7.6 show that the strict newsfeed diet is a significant predictor of log change ($p < 0.005$) whereas the self-regulated diet intervention is a suggestive predictor ($p < 0.05$). These predicted changes mirror the descriptive results seen in figure 7.4 and raincloud plot D) in figure 7.5, while controlling for the effects of the other intervention. The first model suggests that if a user was in the strict newsfeed diet group (while controlling for the effect of the self-regulated newsfeed diet) their change in time on Facebook's site/app between the baseline and treatment periods was $(\exp(\beta_1) - 1) * 100 \approx -63.868\%$.[3] H2a is supported.

If a user was in the self-regulated diet group (controlling for the effects of the other group) their change in time on site/app between the baseline and

[3]These percentage changes in time on site/app refer to the natural log transformed space. As a reference point, the untransformed median percentage changes in time on site/app between the baseline and treatment weeks for each newsfeed diet are approximately: No diet: -6%; Strict diet: -70%; Self-regulated diet: -45%.

treatment periods will be approximately $(\exp(\beta_2) - 1) * 100 \approx -40.310\%$. H2b is has suggestive support. The results of the second model indicate that the interventions remain stable predictors of log changes in time spent on the platform when controlling for the users users' logged baseline measures for time on the site/app and their standardized compulsive use before the baseline period. The increase in explained variance (Adj. R^2) between the first and second models is non-significant: R^2-change .026, F-change $(2, 129) = 1.983, p = 0.142$. That is, users' time on site/app during the baseline period and their level of compulsive use only explains an additional 2.6% of changes in time on the platform when we have already controlled for the effects of the two newsfeed diets. Also, the second model shows that neither the users' time on site/app during the baseline period nor their level of compulsive use are suggestive predictors of log changes in time on site/app, see figure 7.6. So while compulsive use has a strong association to average daily time on site/app during the baseline period, it is not a strong predictor of *changes* in time on site/app between the baseline and treatment periods when controlling for the other predictors.

Lastly, the results of the third model assess if the log changes in time on site/app for each standard deviation increase in compulsive use is significantly different between users who are in the intervention groups (while controlling for the previously mentioned effects in the first and second). As Table 7.6 shows, the moderating effects of compulsive use on the strict and the self-regulated newsfeed diet add basically no explanatory value to the third model: R^2-change .008, F-change $(2, 127) = 0.603, p = 0.549$. The regression coefficients for the interaction terms $\hat{\beta}_5 = 0.262, p = 0.308$, $\hat{\beta}_6 = 0.060, p = 0.785$ respectively, are not suggestive predictors of change in time on site/app. In fact, the proportion of explained variance goes down between the second and third models. These moderation effects (or lack thereof) suggest that the efficacy of the two newsfeed diets are not impacted

by more and less compulsive users. H3 is not supported.

7.5.3 Effects of restricting the newsfeed on user experience (H4a, H4b)

To investigate H4a and H4b we coded and analyzed the answers for the SUS questionnaire and the open usability questions, for which 140 users provided answers (367 comments, 6608 words). The SUS score, which focuses on the ease of use of Facebook did not change significantly between the baseline and the treatment periods. The answers to the open questions were coded line by line by two of the co-authors based on the negativity of the emotions related to the usability, such as negative sentiment, hate, frustration, boredom or annoyance about missing important information. For instance, the following answer was coded as negative: "*It was annoying not getting updates from friends, but particularly from my groups – I was actually trying to sell and give away some items in some groups and I had to find the notifications and information and messages manually!*"

To validate the codes, we measured inter-rater reliability [65]. The two coders agreed on 135 ratings and disagreed on 5. That translates to 96.4% agreement which is above 75% and hence considered acceptable [66]. The coders discussed the disagreements to reach a consensus. The results show a proportion of negative comments of 23.3% in the control group, 21.2% in the self-regulated diet group and 56% in the strict diet group. The chi-square test of independence showed that the proportion of users reporting negative comments differed significantly between the newsfeed interventions $\chi^2(2, n = 140) = 16.316$, $p < 0.001$. Additional χ^2tests showed that users in the strict newsfeed diet condition reported a significantly more negative user experience than the control condition $\chi^2(1, n = 93) = 10.258$, $p < 0.001$ and users in

the self-regulated diet group reported significantly less negative user experience than the strict newsfeed diet condition $\chi^2(1, n = 97) = 12.259$, $p < 0.001$. These results are supportive of H4a and H4b.

The content of the negative comments was different between newsfeed diet groups. In the control group, with no diet, some users had the impression that the extension that they installed affected their user experience of Facebook, even though the extension was not active in this condition. Consequently, most negative comments in this condition mentioned unspecific effects such as: "*Your feed can get a bit boring*", "*Feeling anxious about maybe missing out on something important*", "*Feeling like you missed out*", "*When I opened Facebook it would show a lot of white at first. It worried me what I would miss.*" In the strict newsfeed diet, in contrast, the negative comments mentioned specific effects such as "*It was annoying that there was absolutely nothing left on my Facebook feed*", "*I actually missed out on some key things referenced by friends in conversation mentioned on Facebook*", "*It unfollowed some people and caused me to miss some important posts.*" The negative comments of the self-regulated diet condition were overall similar in tone to the strict newsfeed diet condition such as: "*I lost everyone who I enjoyed following*" or "*I wasn't able to keep up with any of my family or friends that live far away.*"

7.6 Exploratory thematic analysis

To go beyond the hypothesis we tested in Section 7.5 and to broaden the analysis of the user experience, we conducted an exploratory thematic analysis [67, 68] of the three open usability questions about their positive, negative and overall user experience. We first established reliable codes for user experience and then used those codes to generate themes representing shared

meaning. We used an inductive and deductive hybrid approach [69]. Deductive codes were developed such as disconnect, mindfulness and autonomy, to name a few based on previous research on user experience that we reviewed in Section 2. Inductive codes were added after reviewing the data. Then we iteratively coded the 140 responses over a period of one week. During our coding, we focused on responses indicating user experience. We excluded several responses that did not relate to user experience but rather referred to some technical glitches during the experiment that participants experienced such as, "*I want to say that I messed up when creating a shortcut when I close Facebook on my iPhone. I rechecked my mistake and saw that the file path was the same as /Open.csv. I am sorry for my mistake.*" Also, the responses such as "*study was fine*" and "*I think it was well done*" were also not taken into account. The process of coding was done by two researchers independently. The researchers then came together to share their independent analysis, which was discussed, and relevant themes were generated. In total, six main themes emerged and are discussed in the following section: fear of missing out (FOMO), focus, self-awareness, ease-of-use, sense of control and liberation. These results are summarized in figure 7.7.

7.6.1 Fear of missing out (FOMO)

FOMO is having a persistent fear that others may be having rewarding experiences while one is deprived [70]. More precisely, it is people's fear of missing out on experiences across their extended social network. The users in the field experiment experienced the fear of missing out despite knowing that they could contact their friends via messages on Facebook. This suggests that these relationships can quite passive or dormant on Facebook. The responses such as "*Feeling anxious about maybe missing out on something important*" were coded as "*missing*". One user reported that they actually missed

Main themes	Associated codes	Representative quotes related to each newsfeed intervention
FOMO	missing, anxious, missed information, fewer connections, less content, disconnection	*No diet:* "Feeling like you missed out" *Strict diet:* "I was not updated about anything on Facebook" *Self reg diet:* "Not being able to see a lot of content on Facebook, only seeing the same content over and over"
Focus	declutter, less notifications, reduced distraction, time for other tasks, UX improved	*No diet:* "Seeing fewer notifications" *Strict diet:* "Focus on my work and accomplish what i needed to" *Self reg diet:* "It allowed me to selectively follow and focus on posts that I really care about. When choosing people to re-follow I found there are a lot of people I don't really care to follow. I also didn't feel guilty because I knew that they wouldn't know I wasn't following them"
Self-awareness	less time-spent, behavior change, increased consciousness, mindful	*No diet:* "The mental clarity it provides" *Strict diet:* "In a way helped me to see exactly how much time I inadvertently spent on Facebook and how often I went on there" *Self reg diet:* "I have decided to reduce my time using social media. Also, I removed all of them from my phone 2 days ago. This survey probably led to big changes in my life and I hope it will change my life for better"
Ease-of-use	automation, effortless, painless, automatic	*No diet:* "I was expecting it to feel a lot more intrusive but it wasn't" *Strict diet:* "The best thing about the extension is that it does everything for you automatically" *Self reg diet:* "It is very hidden and does not interfere with my actions"
Sense of control	manage newsfeed, ability to control, capability, autonomy	*No diet:* "It gives you more power to control what you see and don't see on your Facebook feed, which could make your experience more positive. Things that irritate you will not irritate you anymore" *Strict diet:* "Now I can choose what I actually care about to pay attention to" *Self reg diet:* "It makes you deliberately decide who to re-follow and what fits your interest"
Liberation	stopped using Facebook, reduced desire, reduced motivation	*No diet:* "It more or less will defeat the purpose of continuing to have a Facebook account. You might as well either not log on or deactivate your account" *Strict diet:* "Not seeing my feed on Facebook for 2 weeks convinced me that I really don't need Facebook anymore" *Self reg diet:* "There's no point in checking it"

FIGURE 7.7: Main themes and their codes from the thematic analysis with representative quotes from each newsfeed intervention.

out on an important event: *"I missed my friend's memorial service because I did not see the posts about her death."* It also came to light that participants used Facebook to track the wellbeing of their friends and family: *"I would miss out on important things that are happening with friends and family."* In the strict newsfeed diet a participant mentioned, *"But I did find myself wondering quite often what I might be missing. I worried particularly about missing some important news in my friends' lives."* Not just the feeling of missing out but the feeling of being judged by others also emerged: *"I was worried people thought I was ignoring them or didn't care about what was happening in their lives."* figure 7.8 suggests that the members of the self-regulated diet were less likely to worry about missing out than those in the strict group, yet they reported that they received fewer posts on their newsfeed from their friends and family than

they had expected: *"It doesn't update with new things that you've followed often enough."* In figure 7.8, the FOMO theme emerged about twice as often for users in the strict diet compared to the other newsfeed diets. figure 7.8 also highlights that there is a suggestive association between the occurrence of this theme and the newsfeed interventions ($\chi^2 = 6.356$, $V = 0.213$, $p = 0.042$). As an interesting side note, some users in the control group reported seeing fewer posts after installing the chrome extension, despite no changes on their newsfeed being made by the extension.

7.6.2 Focus

In our analysis we consider focus to be a state when individuals are able to direct their attention to meaningful activities without being distracted. Previous studies suggest that users are often preoccupied with distractions, which leads to difficulties focusing their attention on other tasks [32, 71]. The responses such as "*my Facebook experience became more wholesome overall*" were coded "*UX improved*". While the responses that referred to the improvement of their ability to focus, such as "*it cleared my Facebook newsfeed of post and pictures I didn't want to see, which I really liked. Ever since downloading the extension I see more relevant and important things on Facebook*" were coded as "*declutter*".

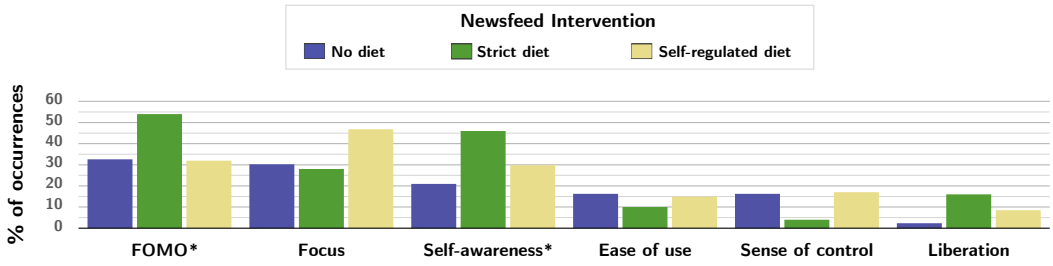


FIGURE 7.8: Percentage of users in a given newsfeed intervention group who mentioned a given theme. χ^2 tests were conducted to test the likelihood of occurrence of a given theme across the interventions $(2, n = 140)$, * p<0.05, ** p<0.005, *** p<0.001. These tests were performed without using a family-wise error correction, i.e., $(\alpha_E/1)$

Our analysis indicates that individuals were able to focus on tasks after cleaning their newsfeed. For instance, some individuals felt that the newsfeed intervention helped them to focus by removing distractions, while keeping relevant content on their newsfeed, (e.g., *"The best thing is that it can help reset your Facebook feed, and by that I mean that it can help clear your Facebook feed so that you can go back and choose what you want to see everyday. It can help declutter your feed"*). A user from the self-regulated diet reported increased ability to focus on other tasks: "there was more time to complete other tasks." Likewise, another user reported that the unfollow process has enabled focusing on spending more time with family members: *"I felt slightly disconnected from others but it was kind of good because I spent more time with my family than scrolling Facebook."* Not only did users report reduction in distractions but they indicated that the posts on Facebook newsfeed had become more relevant, allowing them to focus on relevant posts: *"ever since downloading the extension I see more relevant and important things on Facebook."* Figure 7.8 highlights that users in the self-regulated diet condition reported often that cleaning the newsfeed has led to a decreased number of notifications that usually leads to distraction: *"the best part is not being overwhelmed with several notifications"*. figure 7.8 describes a more frequent occurrence of *"focus"* as a theme in the self-regulated newsfeed compared to the other two groups. However, there was no suggestive association between the occurrence of this theme and the different newsfeed diets ($\chi^2 = 4.387$, $V = 0.177$, $p = 0.112$).

7.6.3 Self-awareness

Our study referred to the following definition of self-awareness: the ability to reflect and evaluate oneself objectively through introspection [72]. Most often, individuals open the app unconsciously after a certain period of time, eventually leading to automatic behaviors of checking social media regularly

and not being mindful of their habit [73, 74]. When participants reported several responses such as the following "*in a way helped me to see exactly how much time I inadvertently spent on Facebook and how often I went on there*" we coded them as "increased consciousness." Some comments suggested that the participants began to get out of the habit loop of opening Facebook often, especially the users in the strict diet group: "*After a while I just got out of the habit of checking Facebook on my laptop*". Moreover, many participants became self-aware that spending time on Facebook was not the best allocation of their time: "*Not seeing my feed on Facebook for 2 weeks convinced me that I really don't need Facebook anymore and that's a good thing*". Also, the reason behind the participants' increased Facebook use came to light as individuals' Facebook feed became more empty and decluttered: "*Interesting to see how often I look to Facebook to relieve boredom.*" The participants in the self-regulated diet group often reported that they decreased the time they spent on Facebook: "*it caused me to spend less time on Facebook*" and the intervention made them realize that they do not need Facebook: "*I found that I don't need Facebook overall, and this study helped me figure that out.*" While the only difference between self-regulated and strict diets was that participants in the strict diet were forbidden from following their friends, pages and groups, the theme of self-awareness emerged more often among those on the strict newsfeed diet compared to the other diets, as shown in figure 7.8. There is also a suggestive association between the occurrence of this theme and the newsfeed interventions ($\chi^2 = 6.888$, $V = 0.222$, $p = 0.032$).

7.6.4 Ease-of-use

In previous research, it was found that platforms with fewer frictions or interruptions and greater ease of use improve user experience [75]. Our analysis followed previous research and deemed reduced effort an indicator of

ease of use. Users generally did not need to put a lot of effort into unfollowing their contacts. Several participants emphasized "*ease-of-use*" which is an essential component of usability. The responses such as "*I appreciate how the extension has the ability to automatically unfollow friends, pages, and groups*" were as coded as "*effortless*." The users appreciated the ease-of-use of the intervention as it worked in the background, and individuals did not have to manually unfollow any of the friends, pages and groups: "*I like that it automatically unfollowed pages for me since I followed a lot of them.*" Furthermore, users appreciated that extension does not interfere with their other Facebook activities: "*It is very hidden and does not interfere with my actions.*" A code that kept recurring in the strict diet condition was automated: "*The best thing about the extension is that it does everything for you automatically.*" The difference between the interventions regarding how many times their responses came under the theme related to ease-of-use is non-significant, as seen in figure 7.8, ($\chi^2 = 0.883$, $V = 0.079$, $p = 0.643$).

7.6.5 Sense of control

Sense of control is a psychological phenomenon that occurs when individuals feel that their actions and consequences are under their control, i.e., they feel that they are in the driving seat [76]. The newsfeed diets seemed to instill in users a feeling of autonomy and control. The idea of automating the unfollowing of contacts that users have been following by default and then allowing them to choose which friends, pages and groups to follow increased their sense of agency and control on Facebook: "*the best thing is that it can help reset your Facebook feed, and by that I mean that it can help clear your Facebook feed so that you can go back and choose what you want to see everyday.*" Another user from the self-regulated diet reported that, "*It allows me to have control over my Facebook account. I enjoy the overall user friendly interface and design.*" Responses

of this kind indicate that when the sense of agency increases, the user experience may be enhanced. One user mentioned the following: *"It allowed me to selectively follow people I really care about. When choosing people to re-follow I found there are a lot of people I don't really care to follow. I also didn't feel guilty because I knew that they wouldn't know I wasn't following them."* It is important to mention that Facebook's UI already gives users the option to selectively follow contacts they really care about. As we mentioned in the section on related work, this option exists on Facebook, but can be difficult for users to discover.

In figure 7.8, we also observe that users in the strict diet condition did not feel as much of a sense of agency or control as those in the self-regulated condition. That said, there was no suggestive association between the newsfeed diets and the occurrence of this particular theme
($\chi^2 = 4.846$, $V = 0.186$, $p = 0.089$).

7.6.6 Liberation

When individuals are able to put an end to their dependence on a certain activity or pattern, they feel liberated [77]. With regard to Facebook use, liberation is when individuals lose their desire or motivation to use Facebook, which they had been captivated by. Several users reported a sense of liberation as their motivation to use Facebook declined over the course of the field experiment. Few users in the self-regulated diet reported a loss of motivation and desire to use Facebook, see figure 7.8.

The users in the strict diet condition reported more frequently that their motivation and desire had taken a hit: *"I am less motivated to use Facebook when I should be doing something else, like working or studying."* As one user reported, the lack of motivation and desire also led them to question their need for the service itself: *"Not seeing my feed on Facebook for 2 weeks convinced*

me that I really don't need Facebook anymore." Sometimes users in the strict diet reported that the resulting friction around the access to posts and information as something positive: *"The best thing about the app is it really removed my desire to go onto Facebook. I couldn't easily see posts or information from any of my friends, so I didn't feel very motivated to check the site at all."* However, we saw no suggestive association between the newsfeed diets and the occurrence of liberation as a theme (χ^2 = 5.182, F = 5.012, $p = 0.076$)[4].

7.7 Discussion

The present paper investigated the effects of a novel automated digital unfollow intervention that restricted and practically reduced the content of individuals' newsfeed by unfollowing the users' friends, pages and groups. We conducted a field experiment with real Facebook users randomly assigned to one of three independent conditions: the control condition (no diet), a strict newsfeed diet and a self-regulated newsfeed diet. Unlike other digital wellbeing research that focuses on external interventions such as timers [39], overlays, feedback [33] and limits [78], we focused on changing the internal choice architecture of the platform itself. We structure the following three subsections by laying out first our contribution, and we close the subsections with the implications to the relevant stakeholders.

7.7.1 Newsfeed diet interventions

Our results show that users reduce their Facebook use just due to the restriction or reduction of their newsfeed. We observe that a strict newsfeed diet is a significant predictor of change in time on site/app (H2a) by around -64%. Understanding exactly how individual design mechanisms translate

[4] F refers to Fisher–Freeman–Halton's Exact test statistic as the cell count for this particular theme is < 5 for the No Diet intervention

into more or less usage of a social media app is difficult owing to the subtle nuances in the design space of previous interventions. The results of a previous study that related to the Facebook accounts of several US police departments indicate that posts containing UI elements such as links and images translate into more likes and interaction from users [79]. This suggests that if such UI elements are limited upstream (e.g., by a newsfeed diet) then users would spend less time on the platform itself. However, previous research results related to filtering or blocking the newsfeed are mixed. As we mentioned in the section on related work, Lyngs et al. conducted a user experiment where one of the interventions was a completely hidden/blocked newsfeed [32]. This newsfeed blocking intervention did decrease users' visit length on Facebook's site with FOMO being a major theme among the users. While we did not use visit length as a dependent measure, our overall results are quite well in line with those findings. Another study found no significant differences in usage time when introducing a feed filter on Twitter [44]. However, this feature was partially responsible for increasing users' sense of agency on the platform itself. In the strict condition, we observed that the drop in time on site/app was happened in parallel to more frequent reporting of negative user experiences, as measured by negative emotions (H4a). Yet, our thematic analysis provides a more mixed picture of this result where users in the strict condition more frequently express rather positive themes such as liberation and self-awareness. These results indicate that such a drastic intervention may be effective at reducing time spent on Facebook, but is not satisfactory from a user perspective. This result is also in line with previous studies that have underlined that more restrictive mechanisms cause more frustration among the users [32, 80]. Previous design researchers have attributed this reaction to the diversity of usage contexts and user needs [36, 80].

In addition to these observations, we also found that the self-regulated

newsfeed diet had a suggestive decrease in time on site/app (H2b) by around 40%. Furthermore, our findings indicate that this type of intervention is associated with a more positive user experience as compared to the strict newsfeed diet condition (H4b). Indeed, over half of the comments in the strict diet condition reported negative feelings compared to only around one in five in the control and the self-regulated diet conditions. This is a novel contribution to the field, which indicates that not only complete abstinence but also limitation of the number of content providers of the newsfeed may reduce time spent on the platform while enhancing users' experience compared to more strict abstinence. Looking in more details at the user experience, our thematic analysis provides a first tentative explanation that such a self-regulated diet helps users to avoid distractions and to focus on the useful interactions that a social media newsfeed can provide.

Future research could further explore the mechanisms through which modifications in the newsfeed affect user experience and time on site. For instance, our research cannot answer questions about whether the observed effect is due to the number of connections unfollowed, the type of connections unfollowed or the type of content that appeared in the newsfeed itself. In a nutshell, these questions relate to the social graph architecture which connects nodes (users), through edges (follow relationships), on which messages (content) can be passed. This leads to future research questions such as how do social graph architecture components affect time on site and user experience?

Also, future research could further investigate the value provided to users by different types of connections. Our thematic analysis related to FOMO provides some preliminary indications that users valued interaction with friends and family, which aligns with some previous findings [24, 25]. Future research could, however, formally confirm whether that value enhances user experience.

Implication for designers

Our results suggest that the current newsfeed design might work as expected by social media platforms: it increases time spent on site compared to more curated versions. In this regard, social media platforms have little direct incentive to give users the tools to easily unfollow those connections that are less interesting to them. However, approaches that increase user benefits at the expense of time spent on the platform (resulting in potential short-term revenue decline from advertising) could give longer-term benefits to the platform, such as increased loyalty, increased brand image and less regulatory scrutiny. Furthermore, potential FOMO associated with cutting ties with updates from friends and family might indicate that social media companies could build on these connections rather than on unconnected content updates, which seems to be a current trend. Recent reports suggest that Facebook will modify the platform's newsfeed feature to focus more on "*unconnected*" content sources in an effort to compete with TikTok [81, 82]. Finally, from the perspective of designers of apps, those plug-ins or extensions that help users spend less time on social media or at least help them regain control over their time on social media may target the newsfeed to effectively intervene in the platform. Removing the newsfeed or limiting its content are useful tools in that respect.

7.7.2 Understanding compulsive use

In our research, and contrary to what we predicted, different levels of compulsive use did not moderate the effectiveness of our interventions (H3). These results are surprising, since they contradict what could have been predicted based on previous literature on habits [40]. Nevertheless, the results seem to confirm more recent literature on closely related digital wellbeing

interventions [36]. This is an interesting prospect, showing that digital interventions can curb Facebook use even for compulsive users. Our thematic analysis hints at potential novel mechanisms explaining the impact of that type of digital interventions on time on site. For instance, the strict diet intervention could increase users' self-awareness, which allows them to reflect on their behavior as well as to decrease the motivation to go online due to a potentially less rich user experience. According to our data, these mechanisms would be operating irrespective of the user's level of compulsive use.

In addition, previous scholars have argued for more comprehensive research into the underlying mechanisms that may influence users' compulsive behavior on social media platforms [7]. In this respect, our study contributes to quantifying the antecedent of users' compulsive use. We have investigated the association between the time spent on Facebook's site/app and compulsive use (H1). Our data suggests a clear statistical relationship between time on Facebook and self-rated compulsive use. However, the Pearson correlation between compulsive use and log transformed time on site/app results in a coefficient of determination of $(0.388^2 = 0.151)$. That is, only about 15% of the variation in compulsive use is explained by its relationship with time on site/app. This means that roughly 85% is still unexplained. In other words, there are several other relevant factors that are associated with compulsive use.

Future research could allocate more attention to the effect of newsfeed (and more broadly digital) interventions on compulsive users. One such research direction could further dissect time spent on site/app as the measure itself might not be enough to account for digital wellbeing [44]. The type of interaction and the context of the interaction could be further explored. Also, it could be useful to look in more details at cases at the margin, such as high use but low compulsion or high compulsion but low use, which could shed

further light on how to best design social media-like interactions in the interest of users. Furthermore, although we show that 15% of the variation in compulsive use is explained by its relationship with time on site/app, we do not know how a decrease in time on site/app affects the level of compulsiveness.

Implication for designers

The major implication is that newsfeed modifications can significantly affect the time on site/app of compulsive users and, as a result, serve as a potential tool to increase digital wellbeing. Furthermore, policy designers who are currently interested in curbing dark patterns online [83] could leverage our results to push for better support for compulsive users and push social media companies for more accountability on this matter.

7.7.3 Designing for agency

Previous HCI researchers have demonstrated the importance of users feeling in control of their interaction with social media platforms [25, 32, 44]. As described in cognitive neuroscience, control refers to being in charge of one's own actions and affecting the external environment through that control [84]. Through years of scientific research and testing, it has been demonstrated that a positive user experience is associated with a sense of agency [85]. Indeed, a recent study showed that users are willing to have more options. For instance, one user reported *"I wish there could be some kind of middle ground. Like a feed with only my best friends and favorite pages?"* [24]. To further support the statement, a study by Lyngs et al., [32] found that most participants expressed a desire for easy ways to filter, limit or disable newsfeeds.

Against this backdrop, our study provides a novel intervention to reduce use while giving users more control over their newsfeed. Furthermore, the

thematic analysis highlights that users in the self-regulated diet as well as in the no diet (control) condition, reported a sense of control that was mostly missing from users in the strict diet condition. As a result, while both interventions led to less time spent on Facebook, only the self-regulated diet reported a retained a sense of control that was similar to the no diet group. It should be noted that with current mainstream social media platforms, users could potentially implement such a self-regulated diet. However, as mentioned above, the default option which follows all contacts and forces users to explicitly opt-out works in a way that agency is reduced [86]. Future work could further investigate restrictions of the newsfeed while maintaining user agency. For instance, reversing the default in terms of following connections, from opting out to opting in, may give users more control. This would look like our self-regulated diet intervention, except that users would not have been exposed to the control (i.e., everyone followed by default) beforehand. Another possibility could be to follow by default close connections (e.g., start following users with whom there are messenger interactions), but not other types of connections. If needed, users could then follow other connections by themselves.

Implication for designers

Our findings suggest to designers of apps, plug-ins or extensions that whereas a strict diet might be more powerful, if followed by the users, it may trigger more reactance because of the freedom of restriction that it entails. In this case, users might more easily abandon it than they would with a self-regulated diet. Facebook and social media platforms seem to have limited incentives to give users agency in a way that would reduce their time on site. However, policymakers (e.g., regulators) could give users more agency by ensuring that they have the possibility to implement their intentions on the platforms that they are using. This is what the GDPR

offers with the prohibition of the opt-out policy. Closer to our context, the regulator could enforce a principle of fair and symmetric frictions in user choice. If following all friends on a platform like Facebook is easy and friction-less (because it is the default option), unfollowing all friends could be made as easy as one click, in order to let users re-follow just their few important connections. Such a design principle could have broader reach than just the newsfeed. For instance, if creating an account needs two clicks, regulation could force the platform to allow the removal of users' account in two clicks.

7.7.4 Limitations

This study faces several limitations that could be addressed by future research. First, the Chrome extension's unfollowing procedure could take a long time depending on how many contacts users have. Consequently, the results suggest that some users in the strict unfollow condition did not fully unfollow all contacts as planned (the median percentage drop in followed contacts was 82% for this newsfeed diet). As such not all users in the strict diet had an empty newsfeed. Also, a given user's newsfeed could still potentially contain sponsored content even if all contacts are unfollowed. However, in the strict diet condition, even if the newsfeed was not empty for all users, no user could re-follow a contact in the browser. In this way, the fundamental difference in control over the newsfeed across conditions remained. Second, our data did not allow us to infer precise refollow behaviors. Identifying users' behaviors and attitudes behind the use of the newsfeed and further exploring who and why they chose to re-follow specific friends, pages and groups could have contributed to insights that would have been very helpful when designing for digital wellbeing in social media contexts. Third, our study only measured time on site/app on one particular social media

platform, namely Facebook. We can therefore not assess whether the changes in time spent on Facebook was replaced by more time spent on other platforms such as Instagram or TikTok.

7.8 Conclusion

In this paper, we tackled the pressing issue of compulsive social media use. We took a design science approach to design a solution to reduce Facebook use specifically. Our solution – which consisted of reducing the endless newsfeed, breaking the relationship, called following, which makes a contact's updates spill over into the user's newsfeed – does indeed reduce the time spent on the platform, but it can have negative consequences in terms of usability. An alternative approach that lets users self-regulate their newsfeed diet suggests a decrease in time on the platform – without steep costs to the user experience. Our results also indicated that both of these approaches seemed to work for more compulsive as well as for less compulsive users.

References

[1] GlobalWebIndex. *Flagship Report 2019*. Report. Global Web Index, 2019.

[2] Antti Oulasvirta et al. "Habits make smartphone use more pervasive". In: *Personal and Ubiquitous Computing* 16.1 (2012), pp. 105–114.

[3] Joseph B. Bayer, Ian A. Anderson, and Robert S. Tokunaga. "Building and breaking social media habits". In: *Current Opinion in Psychology* 45 (2022), p. 101303. ISSN: 2352-250X. DOI: https://doi.org/10.1016/j.copsyc.2022.101303.

[4] Klodiana Lanaj, Russell E. Johnson, and Christopher M. Barnes. "Beginning the workday yet already depleted? Consequences of late-night smartphone use and sleep". In: *Organizational Behavior and Human Decision Processes* 124.1 (2014), pp. 11–23. ISSN: 0749-5978. DOI: https://doi.org/10.1016/j.obhdp.2014.01.001.

[5] Joshua C Watson, Elizabeth A Prosek, and Amanda L Giordano. "Distress among adolescents: An exploration of mattering, social media addiction, and school connectedness". In: *Journal of Psychoeducational Assessment* 40.1 (2022), pp. 95–107.

[6] Yu-Kang Lee et al. "The dark side of smartphone usage: Psychological traits, compulsive behavior and technostress". In: *Computers in Human Behavior* 31 (2014), pp. 373–383. ISSN: 0747-5632. DOI: https://doi.org/10.1016/j.chb.2013.10.047.

[7] Chuang Wang and Matthew KO Lee. "Why we cannot resist our smartphones: investigating compulsive use of mobile SNS from a Stimulus-Response-Reinforcement perspective". In: *Journal of the Association for Information Systems* 21.1 (2020), p. 4.

[8] Simon Kloker. "Non-addictive information systems". In: *Information Systems Frontiers* 22 (2020), pp. 549–562.

[9] Santiago Giraldo-Luque, Pedro Nicolás Aldana Afanador, and Cristina Fernández-Rovira. "The Struggle for Human Attention: Between the Abuse of Social Media and Digital Wellbeing". In: *Healthcare*. Vol. 8. 4. Multidisciplinary Digital Publishing Institute. 2020, p. 497.

[10] Vikram R Bhargava and Manuel Velasquez. "Excerpt from Ethics of the Attention Economy: The Problem of Social Media Addiction". In: *Ethics of Data and Analytics*. Auerbach Publications, 2022, pp. 391–402.

[11] Alberto Monge Roffarello and Luigi De Russis. "Towards Understanding the Dark Patterns That Steal Our Attention". In: *CHI Conference on Human Factors in Computing Systems Extended Abstracts*. 2022, pp. 1–7.

[12] Thomas Mildner and Gian-Luca Savino. "Ethical User Interfaces: Exploring the Effects of Dark Patterns on Facebook". In: *CHI EA'21*. 2021, pp. 1–7.

[13] Philippe Verduyn et al. "Passive Facebook usage undermines affective well-being: Experimental and longitudinal evidence." In: *Journal of Experimental Psychology: General* 144.2 (2015), p. 480.

[14] Shirley Gregor, David Jones, et al. "The anatomy of a design theory". In: Association for Information Systems. 2007.

[15] Alan R Hevner et al. "Design science in information systems research". In: *MIS quarterly* (2004), pp. 75–105.

[16] Alan R Hevner. "A three cycle view of design science research". In: *Scandinavian journal of information systems* 19.2 (2007), p. 4.

[17] Jan Holmström, Mikko Ketokivi, and Ari-Pekka Hameri. "Bridging practice and theory: A design science approach". In: *Decision sciences* 40.1 (2009), pp. 65–87.

[18] Adrian Holzer et al. "Gamifying knowledge sharing in humanitarian organisations: a design science journey". In: *European Journal of Information Systems* 29.2 (2020), pp. 153–171.

[19] Ken Peffers et al. "A design science research methodology for information systems research". In: *Journal of management information systems* 24.3 (2007), pp. 45–77.

[20] Simone Lanette et al. "How much is' too much'? The role of a smartphone addiction narrative in individuals' experience of use". In:

Proceedings of the ACM on Human-Computer Interaction 2.CSCW (2018), pp. 1–22.

[21] Jonathan A Tran et al. "Modeling the engagement-disengagement cycle of compulsive phone use". In: *Proceedings of the 2019 CHI conference on human factors in computing systems*. 2019, pp. 1–14.

[22] Amanda Baughan et al. ""I Don't Even Remember What I Read": How Design Influences Dissociation on Social Media". In: *CHI Conference on Human Factors in Computing Systems*. 2022, pp. 1–13.

[23] Kai Lukoff et al. "What makes smartphone use meaningful or meaningless?" In: *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 2.1 (2018), pp. 1–26.

[24] Aditya K. Purohit, Louis Barclay, and Adrian Holzer. "Designing for Digital Detox: Making Social Media Less Addictive with Digital Nudges". In: *Extended abstracts of the CHI conference on human factors in computing systems*. CHI EA '20. Honolulu, HI, USA: Association for Computing Machinery, 2020, pp. 1–9. ISBN: 9781450368193.

[25] Kai Lukoff et al. "How the design of youtube influences user sense of agency". In: *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*. 2021, pp. 1–17.

[26] Jane E Klobas et al. "Compulsive YouTube usage: A comparison of use motivation and personality effects". In: *Computers in Human Behavior* 87 (2018), pp. 129–139.

[27] Mark D Griffiths, Daria J Kuss, and Zsolt Demetrovics. "Social networking addiction: An overview of preliminary findings". In: *Behavioral addictions* (2014), pp. 119–141.

[28] Emma Fontes-Perryman and Roy Spina. "Fear of missing out and compulsive social media use as mediators between OCD symptoms and social media fatigue." In: *Psychology of Popular Media* 11.2 (2022), p. 173.

[29] Vladlena Benson, Chris Hand, and Richard Hartshorne. "How compulsive use of social media affects performance: insights from the UK by purpose of use". In: *Behaviour & Information Technology* 38.6 (2019), pp. 549–563.

[30] Christian Montag et al. "Addictive features of social media/messenger platforms and freemium games against the background of psychological and economic theories". In: *International journal of environmental research and public health* 16.14 (2019), p. 2612.

[31] Siddhartha Datta, Konrad Kollnig, and Nigel Shadbolt. "Mindproofing Your Phone: Navigating the Digital Minefield with GreaseTerminator". In: *27th International Conference on Intelligent User Interfaces*. 2022, pp. 523–536.

[32] Ulrik Lyngs et al. "'I Just Want to Hack Myself to Not Get Distracted' Evaluating Design Interventions for Self-Control on Facebook". In: *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. CHI '20. 2020, pp. 1–15.

[33] Fabian Okeke et al. "Good Vibrations: Can a Digital Nudge Reduce Digital Overload?" In: *Proceedings of the 20th International Conference on Human-Computer Interaction with Mobile Devices and Services*. MobileHCI '18. Barcelona, Spain: ACM, 2018, 4:1–4:12. ISBN: 978-1-4503-5898-9. DOI: 10.1145/3229434.3229463.

[34] Young-Ho Kim et al. "TimeAware: Leveraging framing effects to enhance personal productivity". In: *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. 2016, pp. 272–283.

[35] Sarawut Thongsrikum. "The Art of Screen Time: How Your Family Can Balance Digital Media and Real Life". In: *Asian Journal of Arts and Culture* 21.2 (2021), pp. 71–73.

[36] Ulrik Lyngs et al. "The Goldilocks level of support: Using user reviews, ratings, and installation numbers to investigate digital self-control tools". In: *International journal of human-computer studies* 166 (2022), p. 102869.

[37] Ulrik Lyngs et al. "Self-control in cyberspace: Applying dual systems theory to a review of digital self-control tools". In: *proceedings of the 2019 CHI conference on human factors in computing systems*. 2019, pp. 1–18.

[38] Stephanie Nguyen and Jasmine McNealy. *I, Obscura — Illuminating deceptive design patterns in the wild*. 2021.

[39] Aditya K. Purohit and Adrian Holzer. "Unhooked by Design: Scrolling Mindfully on Social Media by Automating Digital Nudges". In: *Proceeding of the 27th Americas Conference on Information Systems, AMCIS 2021, Virtual Conference*. AIS, 2021.

[40] Wendy Wood and David T Neal. "The habitual consumer". In: *Journal of Consumer Psychology* 19.4 (2009), pp. 579–592.

[41] Unna N Danner, Henk Aarts, and Nanne K De Vries. "Habit vs. intention in the prediction of future behaviour: The role of frequency, context stability and mental accessibility of past behaviour". In: *British Journal of Social Psychology* 47.2 (2008), pp. 245–265.

[42] Ana Caraban et al. "23 Ways to Nudge: A Review of Technology-Mediated Nudging in Human-Computer Interaction". In: *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. ACM. 2019, p. 503.

[43] Agata Błachnio and Aneta Przepiórka. "Facebook intrusion, fear of missing out, narcissism, and life satisfaction: A cross-sectional study". In: *Psychiatry Research* 259 (2018), pp. 514–519. ISSN: 0165-1781.

[44] Mingrui Ray Zhang et al. "Monitoring Screen Time or Redesigning It? Two Approaches to Supporting Intentional Social Media Use". In: *CHI Conference on Human Factors in Computing Systems*. CHI '22. New Orleans, LA, USA: ACM, 2022, pp. 1–19.

[45] Edward L Deci and Richard M Ryan. "Self-determination theory." In: (2012).

[46] Hannah Limerick, David Coyle, and James W Moore. "The experience of agency in human-computer interactions: a review". In: *Frontiers in human neuroscience* 8 (2014), p. 643.

[47] Meta. *Meta Reports Fourth Quarter and Full Year 2021 Results*. Website, Accessed on: 05/07/2022. Available at: https://investor.fb.com/investor-news/press-release-details/2022/Meta-Reports-Fourth-Quarter-and-Full-Year-2021-Results/default.aspx. Feb. 2022.

[48] Meta. *How does Facebook decide which ads to show me?* Website, Accessed on: 05/07/2022. Available at: https://cutt.ly/M0V5j1I. 2022.

[49] Alberto Monge Roffarello and Luigi De Russis. "Coping with digital wellbeing in a multi-device world". In: *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*. 2021, pp. 1–14.

[50] Facebook. *Tools*. Retrieved January 30, 2023 from: `https://edu.nl/jhdfu`. 2023.

[51] Colin M Gray et al. "The dark (patterns) side of UX design". In: *Proceedings of the 2018 CHI conference on human factors in computing systems*. 2018, pp. 1–14.

[52] Aaron Smith. “What people like and dislike about Facebook”. In: (2014).

[53] Aditya Kumar Purohit et al. “Designing for Digital Wellbeing on a Smartphone: Co-creation of Digital Nudges to Mitigate Instagram Overuse”. In: *Hawaii International Conference on System Sciences (HICSS)*. 2023.

[54] Fernando Calvo-Francés. “Internet abusive use questionnaire: psychometric properties”. In: *Computers in Human Behavior* 59 (2016), pp. 187–194.

[55] Lauren A Jelenchick et al. “The Problematic and Risky Internet Use Screening Scale (PRIUSS) for adolescents and young adults: Scale development and refinement”. In: *Computers in human behavior* 35 (2014), pp. 171–178.

[56] Scott E Caplan. “Theory and measurement of generalized problematic Internet use: A two-step approach”. In: *Computers in human behavior* 26.5 (2010), pp. 1089–1097.

[57] G-J Meerkerk et al. “Is compulsive internet use related to sensitivity to reward and punishment, and impulsivity?” In: *Computers in human behavior* 26.4 (2010), pp. 729–735.

[58] Aaron Bangor, Philip T Kortum, and James T Miller. “An empirical evaluation of the system usability scale”. In: *Intl. Journal of Human–Computer Interaction* 24.6 (2008), pp. 574–594.

[59] *Highcharts.* Highcharts Javascript Charting Library, Accessed on: 22/09/2021. Available at: https://www.highcharts.com/products/highcharts/, 2021.

[60] Global Web Index. *Social - GWI’s flagship report on the latest trends in social media*. Report. Global Web Index, 2021.

[61] Daniel J Benjamin et al. "Redefine statistical significance". In: *Nature Human Behaviour* 2.1 (2018), p. 6.

[62] Micah Allen et al. "Raincloud plots: a multi-platform tool for robust data visualization [version 2; peer review: 2 approved]". In: *Wellcome open research* 4.63 (2021).

[63] Micah Allen et al. *RainCloudPlots tutorials and codebase (Version 1.1). Zenodo*. Retrieved November 14, 2022 from: https://zenodo.org/record/3368186#.Y3yQmnbMIuU. 2019.

[64] Mikel Aickin. "Dealing with change: using the conditional change model for clinical research". In: *The Permanente Journal* 13.2 (2009), p. 80.

[65] Kevin A Hallgren. "Computing inter-rater reliability for observational data: an overview and tutorial". In: *Tutorials in quantitative methods for psychology* 8.1 (2012), p. 23.

[66] Nahathai Wongpakaran et al. "A comparison of Cohen's Kappa and Gwet's AC1 when calculating inter-rater reliability coefficients: a study conducted with personality disorder samples". In: *BMC medical research methodology* 13.1 (2013), pp. 1–7.

[67] J. Saldana. *The Coding Manual for Qualitative Researchers*. SAGE Publications, 2015. ISBN: 9781473943599.

[68] Virginia Braun and Victoria Clarke. *Thematic analysis.* American Psychological Association, 2012.

[69] Jennifer Fereday and Eimear Muir-Cochrane. "Demonstrating rigor using thematic analysis: A hybrid approach of inductive and deductive coding and theme development". In: *International journal of qualitative methods* 5.1 (2006), pp. 80–92.

[70] Elisa Wegmann et al. “Online-specific fear of missing out and Internet-use expectancies contribute to symptoms of Internet-communication disorder”. In: *Addictive Behaviors Reports* 5 (2017), pp. 33–42.

[71] Teun Siebers et al. “Social media and distraction: An experience sampling study among adolescents”. In: *Media Psychology* 25.3 (2022), pp. 343–366.

[72] Caio A. Lage, De Wet Wolmarans, and Daniel C. Mograbi. “An evolutionary view of self-awareness”. In: *Behavioural Processes* 194 (2022), p. 104543. ISSN: 0376-6357.

[73] Joseph B. Bayer, Scott W. Campbell, and Rich Ling. “Connection Cues: Activating the Norms and Habits of Social Connectedness”. In: *Communication Theory* 26.2 (Nov. 2015), pp. 128–149. ISSN: 1050-3293.

[74] Jin P Gerlach and Ronald T Cenfetelli. “Constant Checking Is Not Addiction: A Grounded Theory of IT-Mediated State-Tracking.” In: *MIS Quarterly* 44.4 (2020).

[75] Christian Crumlish and Erin Malone. *Designing social interfaces: Principles, patterns, and practices for improving the user experience*. " O’Reilly Media, Inc.", 2009.

[76] James W Moore. “What is the sense of agency and why does it matter?” In: *Frontiers in psychology* 7 (2016), p. 1272.

[77] Carolyn R Plateau, Trent A Petrie, and Anthony Papathomas. “Learning to eat again: Intuitive eating practices among retired female collegiate athletes”. In: *Eating disorders* 25.1 (2017), pp. 92–98.

[78] Minsam Ko et al. “Lock N’ LoL: Group-based Limiting Assistance App to Mitigate Smartphone Distractions in Group Activities”. In: *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*.

CHI '16. San Jose, California, USA: ACM, 2016, pp. 998–1010. ISBN: 978-1-4503-3362-7. DOI: 10.1145/2858036.2858568.

[79] Jennifer Xu, Jane Fedorowicz, and Christine B Williams. "Effects of symbol sets and needs gratifications on audience engagement: Contextualizing police social media communication". In: *Journal of the Association for Information Systems* 20.5 (2019), p. 5.

[80] Jaejeung Kim et al. "GoalKeeper: Exploring Interaction Lockout Mechanisms for Regulating Smartphone Use". In: *Proc. ACM Interact. Mob. Wearable Ubiquitous Technol.* 3.1 (Mar. 2019).

[81] Alex Heath. *Facebook is changing its algorithm to take on TikTok, leaked memo reveals*. Available at: shorturl.at/qES13. 2022.

[82] Cal Newport. *TikTok and the Fall of the Social-Media Giants*. Available at: shorturl.at/gCXZ7. 2022.

[83] MR Leiser and M Caruana. "Dark Patterns: Light to be found in Europe's Consumer Protection Regime". In: *Journal of European Consumer and Market Law* 10.6 (2021), pp. 237–251.

[84] David Coyle et al. "I Did That! Measuring Users' Experience of Agency in Their Own Actions". In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. CHI '12. Austin, Texas, USA: ACM, 2012, pp. 2025–2034. ISBN: 9781450310154.

[85] Ben Shneiderman. "Shneiderman's eight golden rules of interface design". In: *Retrieved july* 25 (2005), p. 2009.

[86] Richard H Thaler. *Nudge, not sludge*. 2018.

Chapter 8

Conclusion

8.1 Summary of contributions

The aim of this thesis was to better understand how digital nudges can be designed to better support digital wellbeing. In short, we conclude that digital nudges can contribute to maintaining or increasing digital well-being when developed ethically under the guideline of the digital nudge development framework. These digital nudge designs, for example, can be built on feedback nudges, message framing delivered externally on the smartphone as a notification, or changing the choice architecture internally, as shown in our research. In detail, we provided a study subdivided in three parts providing (1) Development of framework to design digital nudges, (2) designs evaluations and development of digital nudges for digital wellbeing, and (3) increasing the understanding of digital nudges in the digital health space.

Development of framework to design digital nudges. In order to design digital nudges, previously a design process was proposed similar to the development of systems (planning, analysis, design, implementation). To further improve the process to design digital nudges we extended the design framework to design digital nudges by assessing the significance of the timing of digital nudges. The three components we proposed to extend the framework included three additional components : (1) identifying the optimal digital nudge moment (2) inferring the optimal digital nudge moment

(3) delivering the digital nudge at the optimal moment. Further, we classified dimensions such as location, address, date and several other dimensions that would allow digital nudges to be categorized under various contexts. We attempted to provide a framework that could assist in designing timely functional digital nudges as success of several digital nudges relies on their timely delivery.

Evaluation and development of digital nudges. Along the line of improving the understanding of digital nudges in the context of digital wellbeing a series of four field experiments were conducted. In the first study, we studied how friction can be used in various forms of digital nudges i.e., interventions such as hiding, default pause-reminders and feedback to mitigate the use of social media. We also measured their usability in the real world. The results paved a way forward for designers as to how digital nudges can be designed without impacting usability. Next, we explored the concept of self-nudging by using design science research methodology in the second field study. We found that through automation, digital nudges can be developed without sacrificing security and also overcome the critics of digital nudging being coercive and deceptive. Self-nudging did not impact the efficacy of digital nudges as digital consumption was significantly reduced by over 20.58%. Moreover, development of digital nudges via automation makes it easier to build fast prototypes of interventions and measure their success.

As part of the third field study, we investigated co-creation and its use in the area of digital wellbeing. We discovered that co-creation increased the individuals' awareness of being the creator of the feedback digital nudge intervention which lead to increase sense of agency and accomplishment among the social media users. Moreover, the process of co-creation instilled a greater sense of privacy and decreased privacy concern significantly. The feedback nudge intervention that was co-created reduced significantly reduced their

Instagram use. These results provide designers and developers with the basis for building tools that enable users to collaborate on the creation of digital nudges that promote digital wellbeing. For the fourth experiment, we conducted a field test with real Facebook users (n = 138) in order to examine the differences between a strict newsfeed diet (which automatically reduces the newsfeed to a minimum) and a self-regulated newsfeed diet (which automatically reduces the newsfeed but allows the user to manage its content). We discovered that reducing the content on the newsfeed not only reduced the consumption of Facebook but enhanced the users experience on the Facebook platform. It was found that digital intervention was effective not only for compulsive users but also for users who were less compulsive.

Understanding digital nudges in the the digital health space. Along that line, we assessed electronic database of JMIR (Journal of Medical Internet Research) articles and how digital health nudges can be applied to the continuum of healthcare. Based on our research, feedback and reminders are the most commonly used digital nudges for behavior change in digital health. We discovered that most digital nudges research focuses on prevention and the post-acute phase of the continuum of care, with none of the studies investigating nudges for the acute phase. In most studies, ethical considerations were not taken into account. These results from our study provide practitioners and healthcare system designers with a better understanding of how digital nudges could enhance health applications throughout the continuum of care and the need to put attention to privacy when developing interventions for digital health.

8.2 Future research

Aside from providing practical implications and contributing to the academic literature through the six studies in this thesis, this research identified

a number of unexplored research areas. We elaborate on potential avenues of research that can be explored as we continue to explore the topic of digital nudges for digital wellbeing. There are, in our opinion, two main avenues of research, under the umbrella of digital wellbeing, that are worthy of further investigation: (1) cross-device implementation and (2) Changing Internal choice architecture.

Cross-device Implementation. On the basis of our research, we strongly believe that people's work productivity, emotional and psychological wellbeing are all affected by digital wellbeing in cross-device interaction. There has been evidence that contemporary solutions for achieving digital wellbeing rarely include features that allow them to be used across multiple devices. Instead, they are designed to work as tools to enhance the digital wellbeing of a single device [1]. A common multi-device session could look like the following: A user habitually visits a multi-device app on both their smartphone and desktop browser, regardless of the context in which these habits occur. For instance, it is possible that an individual may be accustomed to watching a television series on Disney during the day on their smartphone, while performing another task (not necessarily technology related).

Researchers Müller et al., [2] conducted the analysis of smartphone and tablet usage patterns through the use of a diary study, and determined that watching television is the favorite secondary activity while using a smartphone or tablet. In chapter 7, we used an unfollow intervention that had an effect on individuals' web and mobile Facebook use. The intervention unfollowed contacts that users were following by default thus the reduced newsfeed replicated itself on both the web and mobile. However, there are not many studies that are able to track and deliver interventions across many devices. In addition, it is unclear which interventions and under what conditions are effective, particularly when it comes to delivering and tracking

interventions across multiple devices. Moreover, designers should pay attention to the characteristics of each device in the design of cross-device interventions, while interventions must adapt themselves to the target device. Besides the design of interventions, there remains the challenge of data integration i.e, the process of making sense of raw data coming from a variety of technological sources. Consequently, a generic approach to designing interventions for a single device seems not to be recommended for multi-device interactions. We argue that an innovative framework needs to be developed to guide the development and deployment of cross-device interventions.

Changing Internal choice architecture. Through this research, it has been demonstrated that tweaking external choice architecture like feedback intervention in Chapter 5 and Chapter 6 could make users more mindful of their social media use and significantly decrease social media use. In parallel, we also found that changing internal choice architecture like we did in Chapter 7 is potentially effective way to increase users' digital wellbeing while keeping the usability intact. Additionally, internal interventions have been shown to increase users' sense of agency when compared with external interventions focused on providing information and nudges that encourage self-regulation [3].

The internal choice architecture that we changed in Chapter 7 was the newsfeed ie., a truly internal intervention that will by definition spread to all devices. The results indicated that there seems to be promise in exploring designs that focuses on developing interventions that change internal choice architecture. Our and another study by Zhang et al., [3] focused on the newsfeed to change the internal choice architecture. For instance, implementing a filter to limit the type of tweets displayed in the feed (original

tweets, retweets, replies). Hence, the challenge is to identify the internal designs beyond the newsfeed that can be tweaked and adapt to the ever changing interfaces that social media companies change to test their interfaces[1]. This agenda can then be further abstracted so that these internal intervention designs can be further used in similar designs that provide similar experiences.

References

[1] Alberto Monge Roffarello and Luigi De Russis. "Coping with digital wellbeing in a multi-device world". In: *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*. 2021, pp. 1–14.

[2] Hendrik Müller et al. "Understanding and comparing smartphone and tablet use: Insights from a large-scale diary study". In: *Proceedings of the annual meeting of the australian special interest group for computer human interaction*. 2015, pp. 427–436.

[3] Mingrui Ray Zhang et al. "Monitoring Screen Time or Redesigning It? Two Approaches to Supporting Intentional Social Media Use". In: *CHI Conference on Human Factors in Computing Systems*. CHI '22. New Orleans, LA, USA: ACM, 2022, pp. 1–19.

[4] Sarah Perez. *Facebook tests a new page design with a cleaner layout and no more 'like' button*. July 2020. URL: https://t.ly/xB2s.

[1] "Facebook tests a new Page design with a cleaner layout and no more 'Like' button" [4]