Digital communication technologies and mental health

Digital communication technologies and mental health: An interplay between usage types and user characteristics

DISSERTATION

to obtain the degree of Doctor at
the Maastricht University
and
Doctor of Philosophy
at the University of Tartu
on the authority of the Rector Magnifici,
Prof. dr. Pamela Habibović
and
Prof. T. Asser,
in accordance with the decision of the Board of Deans

to be defended in public
on Monday 20 March 2023 at 16:00 hours

by

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DISSERTATIONES PSYCHOLOGICAE UNIVERSITATIS TARTUENSIS
62

DOCTORAL DISSERTATION
MAASTRICHT UNIVERSITY

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UNIVERSITY OF TARTU
Press
1632

Institute of Psychology, University of Tartu, Estonia

The dissertation has been accepted for the commencement of the degree of Doctor of Philosophy (in Psychology) on 23 February, 2023 by the Council of the Institute of Psychology, University of Tartu.

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Commencement: 20 March 2023 at 16.00 in Minderbroedersberg 4-6, 6211 LK Maastricht

Publication of this thesis is granted by the Institute of Psychology, University of Tartu

ISSN 1024-3291 (print)
ISBN 978-9916-27-148-3 (print)
ISSN 2806-2531 (pdf)
ISBN 978-9916-27-149-0 (pdf)

University of Tartu Press
www.tyk.ee

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CHAPTER 1

General introduction

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"Man is a tool-using animal.
Without tools he is nothing.
Nowhere do you find him without tools."
Thomas Carlyle, 1831

When the Covid-19 pandemic spread across the world, elderly people living in nursing homes were isolated from their loved ones. Lockdowns and social distancing measures prevented people to visit their families and increased loneliness among all layers of the population but especially among the elderly. That is why Sarah Firth started a "FaceTime for Nana" campaign on Facebook. Initially, she intended to collect $300, just enough to buy one iPad for a particular nursing home such that residents could connect with their family members. In the end, she collected ten times more, thanks to social media. As a result, several nursing homes across Massachusetts received iPads, and in just one day, in one facility, more than 75 calls were made using this device.

While social media proved to be a blessing for Sarah Firth and nursing home residents in Massachusetts, this cannot be said for Matilda Rosewarne. Matilda was a fifteen-year-old girl living in Bathurst, Australia. She was confronted with the dark side of social media when she became a victim of cyberbullying. In high school, Matilda was targeted by bullies on Snapchat and was subject to abusive comments and spreading of fake porn on this social networking site. After a long period of cruel and relentless abuse, she eventually took her own life.

These two stories illustrate the possible impact of smartphones and social networking sites. These technologies can be used to enhance or undermine mental health. Even though in most cases the outcomes are far less dramatic than those described above, it is critical to understand when, how, and for whom using these digital communication technologies impacts mental health. This is especially important given the widespread use of these communication tools across the world.

Indeed, the rapid evolution in information and communication technologies during the past two decades has led to the massive adoption of smartphones in today's society. Smartphones are "mobile phones capable of running general-purpose computer applications" (Oxford University Press, n.d.), and recent smartphones also provide internet access and the possibility to install a wide range of specific apps. Smartphones offer many benefits and do not only allow to call or send messages but also to make and share pictures or videos, listen to music or purchase goods (Magaudda, 2021; Rashid et al., 2020). It is therefore no surprise that smartphones are very often used. Today, more than 6.6 billion people own a smartphone, which corresponds to 84% of the world's population (Ericsson, 2021). Moreover, people spend a lot of time on their smartphone – on average 4 hours and 48 minutes each day (Kemp, 2022).

Smartphones offer a wide range of affordances but one highly popular functionality is usage of social networking sites (SNS). SNS are the most often downloaded apps on smartphones (Statista, 2021b) and more than 85% of SNS users access these online platforms using their smartphones (Dean, 2021). SNS allow users to create a personal profile and a list of online social connections. Moreover, SNS users can post content on the SNS platform but also access or react to content posted by other users. Finally, most contemporary SNS allow to connect with other users by sending direct messages (Bayer et al., 2020). SNS such as Facebook, WeChat, Instagram, TikTok, and Snapchat are highly popular worldwide. As of 2022, more than 4.2 billion people use SNS (Datareportal, 2022) and spend on average 145 minutes on these platforms each day (Statista Research Department, 2021).

The massive adoption of smartphones and SNS has sparked substantial public concern and debate about the effects of these digital communication technologies on users' mental health (Anthony, 2020; Haidt & Twenge, 2021). In response, a large number of studies have been conducted and meta-analyses of this evidence revealed that time spent on smartphones is negatively but only weakly associated with mental health ($r \approx -.10$) (Ferguson et al., 2022; Vahedi & Saiphoo, 2018). Similarly, the relationship between time spent on SNS and mental health has also been found to be characterized by a weak negative effect ($r \approx -.10$) (Appel et al., 2020).

These observations led some authors to conclude that the effects of smartphone and SNS use are too small to have a meaningful impact on users' mental health (Appel et al., 2020; Odgers & Jensen, 2020; Orben & Przybylski, 2019). However, several authors argued that such conclusions are premature and hide deeper complexities characterizing the relationship between smartphones, SNS and mental health (Dienlin & Johannes, 2020; Johannes et al., 2021; Kushlev & Leitao, 2020; Valkenburg, 2022). Specifically, aggregate effect sizes on the impact of amount of time spent on smartphones and SNS do not take into account that (a) smartphones and SNS can be used in different ways with differential consequences for mental health (Griffioen et al., 2020; Kross et al., 2021; van Deursen et al., 2015; Verduyn et al., 2017), (b) the impact of (subtypes of) smartphone and SNS use on mental health differs across users (Johannes et al., 2021; Valkenburg & Peter, 2013), and (c) initially adaptive ways of engaging with smartphones or SNS may over time take on problematic properties or even result in an addiction-like behaviour. Below, I elaborate on each of these limitations.

Limitations of Past Research and Aims of the Dissertation

1. Research on Aggregate Effects of Overall Usage Time Does not Take Usage Types Into Account

Most studies on the impact of smartphones or SNS on mental health focused on the amount of time people use these digital communication tools. However, smartphones and SNS can be used in many different ways (Elhai, Hall, et al., 2017; Ellison et al., 2020; Kross et al., 2021; Rozgonjuk & Elhai, 2021; Trifiro & Gerson, 2019; van Deursen et al., 2015; Verduyn et al., 2022) and there is growing consensus that in order to understand the impact of smartphone and SNS usage on mental health, it is critical to consider how users engage with these technologies (Kross et al., 2021; Kushlev & Leitao, 2020; Shaw et al., 2021; Trifiro & Gerson, 2019). This is reflected in several recent theoretical frameworks and empirical studies, which increasingly often take usage types into account.

According to the Hierarchical Computer-Mediated Communication taxonomy (Meier & Reinecke, 2021), a distinction needs to be made between different levels of interaction during smartphone or SNS use, ranging from not interactive at all to highly interactive. Several theories have been proposed to describe differences in interactivity and there is currently a lot of debate which categorizations are optimally suited for this purpose (Meier & Krause, 2022).

In research on smartphone use, one dominant approach is to distinguish between social and non-social usage of smartphones (van Deursen et al., 2015). Social usage covers activities such as calling, sending SMS, usage of instant messaging apps, and SNS use. Non-social use, on the other hand, refers to activities such as information seeking, browsing, and playing non-social games. Past studies show that social use of smartphones is primarily associated with positive outcomes in terms of mental health (Bae, 2019; Chan, 2015; Lapierre & Zhao, 2022; Stevic et al., 2022). However, social use has also been found to be related to problematic usage of smartphones (van Deursen et al., 2015) and information overload (Li & Chan, 2021). In contrast, non-social usage of smartphones has been found to be primarily associated with negative mental health outcomes (Chan, 2015; Elhai, Gallinari, et al., 2020; Lukoff et al., 2018; Rozgonjuk, Elhai, et al., 2019; Stevic, Schmuck, Matthes, et al., 2021) but some studies demonstrated that non-social use can be associated with positive mental health outcomes as well (Abbasi et al., 2021; Li & Chan, 2021). As such, while it is often argued that social use enhances mental health and non-social use undermines it, empirical findings are actually mixed.

In research zooming into the consequences of usage of SNS, one popular approach is to make a distinction between active and passive SNS use (Burke et al., 2010; Krasnova et al., 2015). Active use encompasses activities that directly foster communication with other users (e.g., commenting, uploading

photos or videos, writing a status update, and chatting). Passive use of SNS refers to viewing content posted by others without interacting with them e.g., browsing and scrolling). According to the active-passive model of SNS use (Verduyn et al., 2017), active use has a positive impact on mental health by increasing social capital and associated feelings of social connectedness. In contrast, passive SNS has a negative impact on mental health by eliciting upward social comparisons and associated feelings of envy or inferiority. However, while initial evidence was largely consistent with these claims, recent findings challenged the active-passive model (e.g., Valkenburg et al., 2021; Yin et al., 2019).

In sum, early studies on the impact of smartphone and SNS use mainly focused on the overall amount of time spent using these digital communication tools. While such studies are still highly prevalent and often cited (Orben et al., 2019; Twenge & Campbell, 2019), there is an increasing trend to move towards more fine-grained measures of SNS and smartphone use (social vs non-social smartphone use, active vs. passive SNS use). However, recent findings suggest that current popular distinctions between usage types are too coarse. As such, these frameworks should be extended, either by further decomposing usage types or by crossing usage types with user characteristics, which I turn to in the next section.

2. Research on Aggregate Effects of Overall Usage Time Does not Take User Characteristics Into Account

Users of digital communication technologies differ in terms of a wide range of characteristics such as age, gender, and personality. These user characteristics may play a key role in the relationship between digital communication technologies and mental health. According to the Differential Susceptibility to Media Effects Model (DSMM) (Valkenburg & Peter, 2013), the effects of social media use are not universal but strongly differ across persons. Moreover, these individual differences can be related to dispositional, social, and developmental factors.

However, past studies have mainly focused on aggregate (average) effects of usage of (different types of) digital communication technologies on mental health (Johannes et al., 2021; Vuorre et al., 2022). While research on average effects is undeniably valuable for understanding the impact of digital communication technologies in the overall population (Johannes et al., 2021), these aggregate effects do not tell us for whom usage of digital communication technologies is beneficial, detrimental, or non-significant (Bolger et al., 2019; Bryan et al., 2021; Johannes et al., 2021). There is a need to shift from focusing on aggregate effect sizes to research on individual differences and user characteristics that explain this interpersonal variability (Bryan et al., 2021; Johannes et al., 2021; Vuorre et al., 2022).

Recently, it has been convincingly demonstrated that the relationship between digital communication technologies and mental health strongly differs across participants. For example, Valkenburg and colleagues (2021) showed that the

effect of the amount of time spent on SNS on self-esteem varies across persons. Similarly, Beyens and colleagues (2020) showed that the impact of passive and active SNS use on mental health varies from person to person. Moreover, Aalbers and colleagues (2022) found that the relationship between different indicators of smartphone use (e.g., the amount of time spent, sum of received notifications, multitasking) and procrastination also varies from user to user.

While it is informative to identify individual differences, a key challenge is to explain these differences by systematically identifying user characteristics moderating the relationship between usage of digital communication technologies and mental health. With regard to smartphone use, first evidence suggests that the relationship between (subtypes) of smartphone use and mental health depends on demographic user characteristics, such as age (Stevic, Schmuck, Karsay, et al., 2021) and gender (Amez et al., 2020; Nishida et al., 2019) but this was not confirmed in other studies (Jensen et al., 2019; Sewall et al., 2022; Yang et al., 2018). Similarly, recent studies have shown that the effects of (subtypes of) SNS use on mental health are especially negative for females (Barthorpe et al., 2020; Frison & Eggermont, 2016; Orben et al., 2022) or younger adults (Vannucci et al., 2017), but, again, these findings were not supported in other studies (Coyne et al., 2020; Hardy & Castonguay, 2018; Verduyn et al., 2015a).

In sum, past studies on the consequences of usage of smartphones and SNS mainly focused on aggregate effect sizes. Such studies are still highly prevalent but attention is gradually shifting towards studies on individual differences. However, it is largely unclear which user characteristics account for this variability. To advance our understanding of user characteristics moderating the relationship between digital communication tools and mental health, it is critical to create a systematic overview of research that already has been done in this regard. Moreover, it is necessary to expand the scope by not only examining demographic user characteristics but also other stable dispositions including personality traits such as neuroticism or extraversion.

3. Research on Aggregate Effects of Overall Usage Time Does not Distinguish Non-Problematic From Problematic Usage

Two different persons may spend a lot of time using smartphones or SNS but while one person may feel in control to stop whenever that person wants to, the other person may experience withdrawal-like symptoms akin to addictions when trying to stop. The latter usage pattern has been referred to by the term *problematic* usage (Haug et al., 2015; Ryan et al., 2014). Problematic smartphone use (PSU) pertains to excessive use of smartphones manifested through behavioural addiction-like symptoms (Billieux, Maurage, et al., 2015). Similarly, problematic SNS use is defined as excessive use of SNS characterized by symptoms akin to addictions (Andreassen, 2015). Some authors prefer the terms “smartphone addiction” and “SNS addiction” (for a discussion, see Montag et al., 2021) but

Panova and Carbonell (2018) argue that, unlike other (behavioural) addictions, excessive use of smartphones or SNS often implies non-clinical or milder forms of functional impairment. Moreover, as the terms smartphone addiction and SNS addiction are not (yet) officially recognized as formal psychiatric disorders, we will follow the suggestion by Panova and Carbonell (2018) and use the terms "problematic smartphone use" and "problematic SNS use" throughout the dissertation.

Recent evidence revealed that problematic usage of smartphones and SNS increased over time (Olson et al., 2022) and created major economic and societal burden (Rumpf et al., 2022) including drops in mental health across the population (for overviews, see Elhai, Dvorak, et al., 2017; Hussain & Griffiths, 2018). Due to the deleterious consequences of problematic smartphone and SNS use, it is of key importance to examine which users are especially likely to engage in problematic usage patterns.

According to the Interaction of Person-Affect-Cognition-Execution model (I-PACE) (Brand et al., 2016, 2019), the development and maintenance of problematic usage of technologies, including smartphones and SNS, is a multifaceted and complex process. One key set of predisposing factors pertains to core user characteristics, which may directly or indirectly impact problematic usage. For example, prior research suggests that younger users (Mitchell & Hussain, 2018; Monacis et al., 2017; van Deursen et al., 2015; Vujić & Szabo, 2022) and females (Stănculescu & Griffiths, 2022; Su et al., 2020; Vujić & Szabo, 2022) are more prone to overusing SNS and smartphones.

However, demographic characteristics only covers a subset of relevant user characteristics. According to the I-PACE model, certain personality traits may also be drivers of problematic usage of digital communication technologies (Wegmann & Brand, 2019). Among the big five personality traits, especially neuroticism was found to be a critical predictor of problematic use of SNS (for meta-analytic evidence, see Huang, 2019, 2022) and smartphones (for meta-analytic evidence, see Carvalho et al., 2018; Marengo, Sindermann, et al., 2020). Similarly, fear of missing out has been found to be another key user characteristic predicting problematic usage patterns (for an overview, see Elhai et al., 2021). However, it is not clear why people high in neuroticism and FoMO are especially vulnerable to engage in problematic smartphone or SNS use.

In sum, research on the impact of smartphones and SNS on mental health has predominantly focused on the amount of time people spend on these technologies. However, this approach does not take into account usage types and user characteristics, and does not distinguish problematic from non-problematic use. The aim of this dissertation is to increase our understanding of the impact of smartphone and SNS use on mental health while considering these limitations. Since the start of this doctoral research project, exciting novel approaches have been proposed (e.g., Kross et al., 2021; Valkenburg, 2022; Vuorre et al., 2022) and I have built on these recent advancements to demonstrate how the impact of digital communication technologies on mental health depends on an interaction between usage

types and user characteristics. Specifically, this dissertation will answer the following questions:

1) How does usage of SNS and smartphones influence mental health?
2) Which user characteristics have been investigated as moderators of the relationship between (different types of) SNS use and mental health in prior research?
3) How do major personality traits (e.g., neuroticism) moderate the relationship between (different types of) smartphones use, SNS use and mental health?
4) How do demographic (e.g., age) and personality traits (e.g., neuroticism) moderate the relationship between non-problematic SNS use and problematic SNS use, and what are the associated consequences for mental health?
5) Why is neuroticism a vulnerability factor in the context of problematic SNS use? Do fear of missing out and self-control mediate the relationship between neuroticism and problematic SNS use?
6) Why is FoMO a vulnerability factor in the context of problematic smartphone use? Do dimensions of problematic smartphone use mediate the relationship between fear of missing out and mental health?

Dissertation Outline

The dissertation consists of the introduction, six core chapters, four of which are already accepted or published, and the general discussion. In **Chapter 2,** we address the 1st and 2nd limitation. Specifically, we propose the extended active-passive model of SNS use as an extension of the original active-passive model formulated in 2017 (Verduyn et al., 2017). Compared to the original model, the extended active-passive model provides a more nuanced understanding of the relationship between SNS use and mental health. In particular, in response to the 1st limitation we decompose active SNS use in four subtypes by crossing two fundamental interaction dimensions: reciprocity and communion. Moreover, we decompose passive SNS use in four subtypes by crossing two fundamental content dimensions: self-relevance and achievement. Finally, in response to the 2nd limitation, we propose to cross usage types and user characteristics in the prediction of mental health outcomes as the effect of SNS usage types are not uniform across users.

In **Chapter 3,** we address the 1st and 2nd limitations by conducting a systematic review on user characteristics moderating the relationship between (subtypes) of SNS use and mental health. Specifically, to address the 1st limitation, we decompose SNS use into overall, active, and passive usage types. To address the 2nd limitation, we review for each of these usage types which user characteristics moderate their relationship with mental health. Moreover, when describing our

results, we make a distinction between robust and non-robust moderating user characteristics.

In **Chapter 4,** we address the 1st and 2nd limitation in a diary study on user characteristics moderating the relationship between (usage types of) digital communication technologies and mental health. Specifically, to address the 1st limitation, we decompose smartphone usage into time spent on smartphones, social usage of smartphones, and non-social usage of smartphones. Similarly, we decompose Instagram use into time spent on Instagram, active use of Instagram and passive use of Instagram. To address the 2nd limitation, we test the moderating roles of two key personality traits in these relationships: neuroticism and extraversion.

In **Chapter 5,** we address the 2nd and 3rd limitation in a cross-sectional study on the relationship between non-problematic SNS use, problematic SNS use and mental health. Specifically, in response to the 2nd limitation, we test whether the relationship between Facebook use and mental health depends on the age of users and their degree of neuroticism and extraversion. In response to the 3rd limitation, we examine problematic Facebook use as a mediator between non-problematic Facebook use and mental health, and investigate whether age, neuroticism and extraversion impacts the probability of non-problematic Facebook use turning into problematic Facebook use.

In **Chapter 6**, we address the third limitation in a cross-sectional study on the relationship between neuroticism and problematic SNS use. Specifically, we examine whether the relationship between neuroticism and problematic usage of SNS is parallelly mediated by two possible mechanisms: fear of missing out and self-control. This allows to explore the unique and joint role of these mechanisms in the vulnerability of neurotic users to develop problematic usage of SNS.

In **Chapter 7,** we address the third limitation in a cross-sectional study where we zoom into the role of fear of missing out in the context of problematic smartphone use. Specifically, we examine which dimensions of problematic smartphone use (tolerance, positive anticipation, cyberspace-oriented relationships, withdrawal, and physical symptoms) are most relevant to explain why fear of missing out predicts reduced emotional well-being.

Finally, **Chapter 8,** summarizes the key findings of this dissertation and discusses the theoretical and practical implications. Moreover, it highlights strengths and limitations of the conducted studies, provides recommendations for future research and closes the dissertation with an overall conclusion.

General Contributions

The present dissertation makes several general contributions to the field. First, this dissertation goes beyond the "good" versus "bad" dichotomy of technological determinism according to which usage of digital communication technologies is either good or bad for mental health (Livingstone et al., 2018; Orben, 2020). The

results of this dissertation unequivocally show that there is no simple answer to the question how smartphones and SNS impact mental health as this impact depends on a wide range of factors.

Second, the dissertation demonstrates the value of decomposing overall measures of smartphone and SNS use into subtypes. Chapter 2, Chapter 3, and Chapter 4 demonstrate that the impact of smartphones and SNS on mental health depends on how smartphones and SNS are used. This may explain why prior research that did not take these key nuances into account resulted in mixed findings.

Third, the findings from this dissertation underscore the importance of user characteristics in understanding the effects of smartphone and SNS use on mental health. The results from Chapter 3 and Chapter 4 demonstrate that only by crossing user characteristics with usage patterns the impact of digital communication technologies on mental health can be understood. This also implies that inconsistencies in past research may be partially attributed to the neglect of relevant user-level moderators.

Fourth, the present dissertation extends our understanding of precursors of problematic usage of smartphones and SNS. We did not only show for which users non-problematic usage is especially likely to turn into problematic usage (Chapter 5), but also explored due to which lower-level mechanisms these users are especially vulnerable (Chapter 6 and Chapter 7).

Together, the present dissertation offers a nuanced understanding of the relationship between digital communication technologies and mental health.

CHAPTER 2

Do social networking sites influence well-being? The extended active-passive model

This chapter is based on: Verduyn, P., Gugushvili, N., & Kross, E. (2022).
Do social networking sites influence well-being?
The extended active-passive model.
Current Directions in Psychological Science, *31*(1), 62–68.

Abstract

Do social networking sites (SNSs) influence well-being? According to the active-passive model of SNS use, the impact of SNSs on well-being depends on how they are used: Using SNSs actively to interact with other users positively affects well-being, whereas passive consumption of SNS content negatively affects well-being. However, emerging evidence suggests that the active-passive distinction is too coarse to fully capture the relationship between SNS use and well-being. Here we describe the extended active-passive model of SNS use, which refines the original model in three ways: It decomposes active use, decomposes passive use, and crosses usage types with user characteristics. We describe recent empirical evidence illustrating the benefits of these three extensions and highlight important future research directions. The extended active-passive model of SNS use provides a nuanced understanding of the relationship between SNS use and well-being by highlighting that active use of SNSs is not always beneficial and passive use is not always detrimental.

Keywords: social media, social networking sites, well-being, extended active-passive model

Do social networking sites (SNSs) influence well-being? One framework that has addressed this question is the active-passive model of SNS use (for a review, see Verduyn et al., 2017). According to this model, actively using SNSs to interact with other people enhances well-being by increasing social capital and associated feelings of connectedness. In contrast, passive consumption of SNS content undermines well-being by stimulating harmful social comparisons and associated feelings of envy or inferiority. Although this model has increased understanding of how SNS use affects well-being, here we suggest that the model should be refined.

In the first section of this article, we position the active-passive model in the broader research landscape, clarify the main tenets of the model, and highlight the model's limitations. In the second section, we introduce the extended active-passive model of SNS use. This extended model refines the original model in three ways: It decomposes active use, decomposes passive use, and crosses usage types with user characteristics.

The Active-Passive Model of SNS Use

Positioning the Model

SNSs have changed the way people interact. These online platforms share three defining features: Users can create a personal profile, build a list of connections, and traverse a stream of frequently updated information (Ellison & Boyd, 2013). Facebook, the most popular SNS, has 2.9 billion monthly active users, but other SNSs, such as Instagram and Twitter, have massive user bases as well. These users invest a significant amount of time on these platforms – on average, more than 2 hours each day (Kemp, 2020).

An overwhelming number of studies have examined the impact of SNS use on well-being. Initial studies, mainly using cross-sectional methods, provided mixed evidence, but these studies were not well positioned to make claims about the causal impact of SNS use on well-being. However, recent large-scale experiments, the gold-standard tool for drawing causal inferences, revealed that SNS use has a small negative effect on well-being (for a review, see Kross et al., 2021). This conclusion is consistent with meta-analyses, which have revealed a small negative correlation ($r \approx -.10$) between SNS use and well-being (Appel et al., 2020).

The finding that SNS use has a small impact on well-being may lead one to conclude that worries (or enthusiasm) about SNS use are unjustified. However, this conclusion is premature for at least three reasons. First, small effects may have substantial consequences when the predictive behavior is prevalent and applies to a large number of people (Funder & Ozer, 2019). This certainly holds

for SNS use, as a large number of people repeatedly spend a lot of time on these platforms. Second, most prior research in this domain examined a possible linear relationship between SNS use and well-being. However, this relationship might actually be nonlinear. Recent studies suggest that some use of SNSs is better than not using them at all or using them excessively (Twenge & Campbell, 2019). Third, and most important, SNSs allow for a wide range of activities (e.g., posting pictures, chatting, looking at profiles), and a growing consensus suggests that the impact of SNSs on well-being depends on how they are used (Kross et al., 2021). Moreover, these specific usage types may have stronger positive and negative consequences for well-being than the overall amount of time spent on SNSs. In this vein, a popular distinction that has been made between usage types is the distinction between active and passive use (e.g., Verduyn et al., 2017).

Clarifying the Model

Active usage pertains to activities that facilitate interactions with other people. When engaging in active SNS use, people reach out to other users or provide feedback on other users' posts. Typical examples of such behavior include posting a status update, picture, or video; posting a comment or reply; and chatting with other users. It is notable that when engaging with SNSs actively, users produce content but may also necessarily consume some content as well (e.g., read responses during a chat conversation). Passive usage pertains to viewing content on an SNS without engaging in interactions with other users. When using SNSs passively, people do not reach out to others but merely consume the content others have posted. Typical examples are lurking, reading status updates, watching pictures, and browsing news feeds. Most SNS behaviors can be easily categorized into one of these two categories even though there are borderline cases. For example, although we consider the act of liking a post to belong to the active usage category (i.e., liking is a shortcut to express one's positive evaluation of or attitude toward a certain post), it is unlikely to stimulate rich interactions.

The distinction between active and passive use has advanced understanding of the relationship between SNS use and well-being in three principal ways. First, it has revealed that SNSs are not often used the way they are intended. Most SNSs are intended to foster social interaction. This requires active SNS use, but the majority of time, most users engage in passive use (Verduyn et al., 2015a).

Second, the active-passive distinction has stimulated researchers to go beyond overall measures of SNS use, such as the total amount of time people spend on SNSs or the frequency with which they log in to their account. Consensus is growing that SNSs are not inherently good or bad but that much depends on how they are being used (Kross et al., 2021).

Finally, the active-passive model has helped clarify the mechanisms underlying the relationship between SNS use and well-being. According to this model, active usage offers people the possibility of fulfilling their need to connect with

others, allowing users to increase their social capital (i.e., informational, instrumental, or emotional support from others) and associated feelings of connectedness. Passive usage may fulfill people's need to evaluate their opinions and abilities by providing a massive amount of social comparison information. However, as information on SNSs is generally positively biased, the social comparison information they provide generally negatively affects the well-being of people who are consuming this information passively; these people perceive other users as more successful or attractive than they themselves are (for a review, see Verduyn et al., 2020).

Limitations of the Model

Despite these benefits, the active-passive distinction does not fully capture the complexity of the relationship between SNS use and well-being. First, it is not hard to think of counterexamples. A grandmother is unlikely to feel bad, envious, or inferior when looking at pictures of her grandchildren having fun (passive use), and a teenager is unlikely to become happy when involved in a nasty discussion with cyberbullies (active use). Second, although several studies have revealed negative effects of passive SNS use on well-being, a number of studies have found nonsignificant (e.g., Wenninger et al., 2019) or even positive (e.g., Yang, 2016) effects. The same holds for active use; multiple studies have found nonsignificant (e.g., (Pang, 2021) or even negative (e.g., Zheng et al., 2019) effects. These conflicting findings suggest that an extension of the active-passive framework is needed. In the next section, we outline three current directions in research on SNS use that are promising for refining the active-passive framework and formulate the extended active-passive model of SNS use (see Fig. 1).

The Extended Active-Passive Model of SNS Use

Decomposing Active Use

The effect of active SNS use on well-being is unlikely to be identical for all types of active use. Accumulating evidence suggests that two features of active usage are essential to consider: reciprocity and communion (see the top left of Fig. 1).

Reciprocity: targeted versus nontargeted. Active usage of SNS is theorized to foster accrual of social capital and feelings of connectedness, but this does not hold for all types of active use. According to theories on social capital, the creation and accrual of social capital depends on the occurrence of reciprocity during social interactions (Wenninger et al., 2019). Research on social sharing of emotions indicates that feelings of connectedness depend on partners expressing concern for and interest in one another (Rimé, 2009), and research on self-disclosure reveals that people feel a stronger sense of connection when their partners reciprocate by sharing information themselves (Sprecher & Treger, 2015).

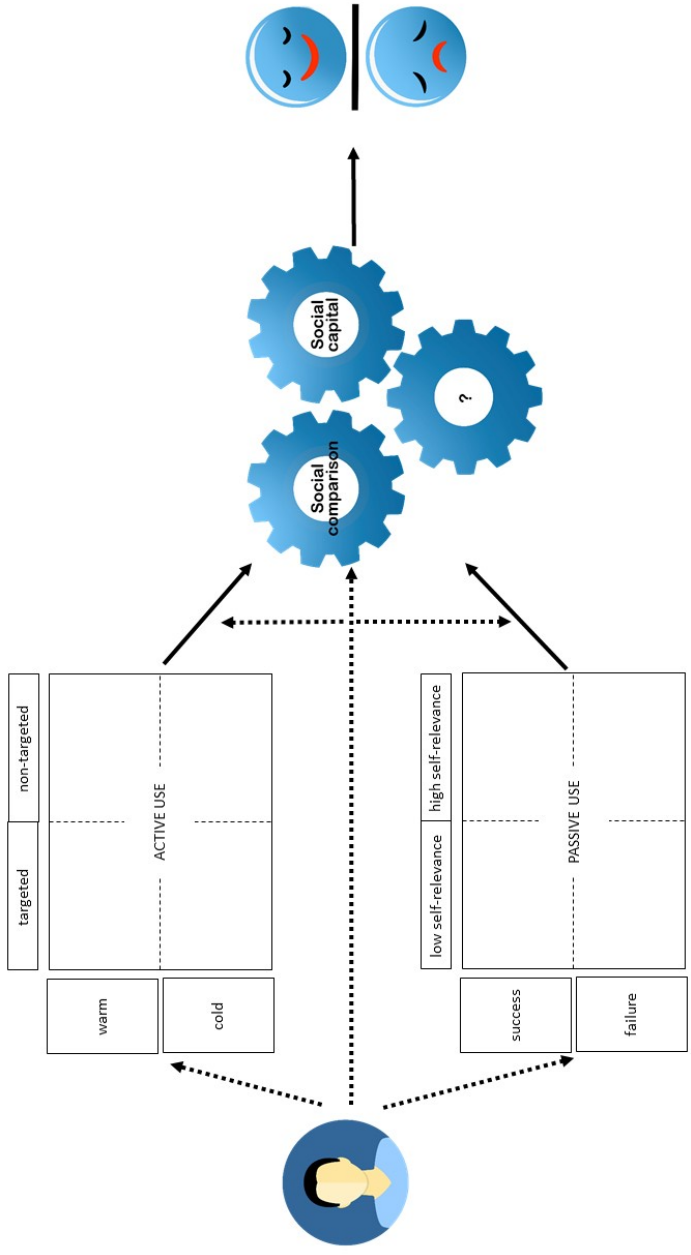


Figure 1. The extended active-passive model of SNS use. Subtypes of active (targeted: yes/no X communion: warm/cold) and passive (self-relevance: high/low X achievement: success/failure) SNS use interact with user characteristics as they impact social comparison, social capital and other psychological mechanisms underlying the impact of SNS on well-being. Active use of SNS is expected to stimulate social capital and associated feelings of connectedness when users engage in warm active use that is targeted at a particular other(s). This is less or not the case when engaging in non-targeted active use and cold active use may even prevent social capital accrual. Passive SNS use is expected to stimulate damaging upward social comparisons when users consume success stories of others that are relevant for their self-concept. This is less or not the case when consuming self-irrelevant information or failure stories. The relationship between subtypes of SNS use and well-being varies across participants (person icon at the left and dotted arrows). Social comparison and social capital are only two out of many psychological mechanisms that explain the relationship between SNS and well-being (question mark in the third gear). Future research is necessary to identify (a) additional explanatory mechanisms, (b) additional decomposition dimensions of active and passive SNS and their impact on well-being, and (c) user characteristics that consistently moderate the impact of SNS use on well-being.

The degree to which active usage is reciprocated depends on the type of active use people engage in. Active usage encompasses nontargeted communication in a public context (e.g., broadcasting, such as posting a status update) as well as communication targeted at a particular person or small group of people, in either a public (e.g., commenting) or a private (e.g., direct messaging) context. Targeted active use elicits a stronger social obligation to respond because of the norm of reciprocity and has been positively linked with greater well-being compared with nontargeted active use (Wenninger et al., 2019). For example, when a user tags someone in a comment or directly messages someone, there is a high probability that the targeted person will respond. In contrast, when a user writes a status update, it is unlikely that the majority of the user's network will reciprocate, and responses may be rather superficial. Supporting this idea, meta-analytic evidence (D. Liu et al., 2019) indicates that replying, commenting, and liking (i.e., targeted active use) are positively associated with well-being, whereas status updating and photo posting (nontargeted active use) are not. Non-targeted active use may result in feelings of connectedness and improved well-being only when people receive substantial feedback from their connections (Marengo et al., 2021).

Communion: warm versus cold. Targeted active use is likely to foster well-being, but only when aimed at establishing positive connections. According to the interpersonal circumplex model (Wiggins, 1991), the main dimension underlying behavior promoting interpersonal ties is communion, which ranges from warm (agreeable) to cold (quarrelsome) behavior. Although most behavior on most SNSs is warm (Wenninger et al., 2019), both targeted (e.g., cyberbullying) and nontargeted (e.g., broadcasting hate speech) active use can also be cold. These types of cold active SNS use prevent the development of social bonds and are negatively related to well-being (Kowalski et al., 2014).

Decomposing Passive Use

SNSs contain a wide variety of content. Emerging evidence suggests that the consequences of passive SNS use depend on the nature of the content consumed. Two content features are essential to consider: self-relevance and achievement (see the bottom left of Fig. 1).

Self-relevance: high versus low. Although passive usage of SNS may stimulate accrual of some types of social capital (e.g., access to information), theorizing suggests that it mainly fosters damaging social comparisons. However, the occurrence of social comparison depends on the nature of the SNS content consumed. According to the self-evaluation maintenance model (Tesser, 1988), social comparisons are more likely to occur when the comparison dimension is relevant, rather than irrelevant, for the evaluation of one's self concept. For example, a graduate student may feel a sting of envy when reading about a fellow student who published an important article, but not when discovering that the other

student won a major swimming contest. In the latter case, the graduate student may actually feel happy by basking in the reflected glory of the fellow student.

Research on the relationship between SNS use and body image further highlights the importance of self-relevance. Looking good is a major concern for young people (Levine & Smolak, 2002), and passively consuming appearance-related content on SNSs is negatively associated with people's body-image perceptions (for a review, see Ryding & Kuss, 2020). In several experiments, the impact of passive consumption of SNS content depicting "ideal" appearance (e.g., models who look thin or toned) has been contrasted with passive consumption of content that is neutral regarding appearance (e.g., nature scenes or popular travel destinations). These studies show that content depicting ideal appearance, but not appearance-neutral content, negatively affects body image and well-being, and these effects are mediated by social comparison (e.g., Tiggemann & Zaccardo, 2015). In summary, damaging social comparisons are more likely to occur when people consume self-relevant content on SNSs than when they consume content that has no repercussions for the evaluation of their self-concept.

Achievement: success versus failure. Passive consumption of content that is relevant to one's self-concept may foster damaging social comparisons, but this holds only when the content concerns other people's accomplishments. This type of content is very prevalent on SNSs, as people tend to share their successes rather than their failures (Kross et al., 2013) and to upload beautiful rather than unflattering pictures of themselves (Chua & Chang, 2016). Consumption of this content results in the impression that other people are better off than oneself (i.e., upward social comparison: other > self), which generally affects well-being negatively (for a review, see Verduyn et al., 2020).

However, SNSs are occasionally used to share failures (Kross et al., 2013). Consuming this type of content may result in the impression that other people are worse off than oneself. Such downward social comparisons (self > other) do not tend to affect well-being negatively and may even foster it. For example, people reported feeling worse about their own body when they viewed pictures on SNSs of others looking great, but this was not the case when they viewed unflattering pictures of others (Fox & Vendemia, 2016). However, exposure to other people's failures may also elicit negative feelings as a result of empathy or emotional contagion (Hancock et al., 2008). In fact, positive and negative responses may occur simultaneously. For example, graduate students may empathize and feel sad when reading that the manuscript of a fellow student was rejected by a prestigious journal while simultaneously feeling proud because they managed to publish in that journal themselves.

Crossing Usage Types with User Characteristics

The active-passive framework can be improved not only by decomposing active and passive SNS use, but also by examining the interaction between usage and

user characteristics (Kross et al., 2021). A growing body of research suggests that the consequences of active and passive usage differ across persons (e.g., Beyens et al., 2020). This may be because different people engage in different subtypes of active and passive usage. Alternatively, certain user characteristics may act as vulnerability or protective factors influencing the relationship between SNS use and well-being (see the person icon and dotted arrows in Fig. 1).

A first set of studies examined the possible moderating impact of the demographic variables gender and age. A popular claim is that women and young people are especially vulnerable to the negative consequences of SNS use. However, empirical evidence on the role of gender and age is mixed. Although some studies have suggested that certain types of SNS use are especially detrimental to women's well-being, gender has not been found to be a robust moderator (for a review, see Meier & Reinecke, 2021). The results for age as a moderator are also mixed (Meier & Reinecke, 2021). It should be noted, however, that the age range studied has been rather limited (e.g., comparison of adolescents with young adults). Thus, future research is needed to examine the possible differential effect of SNS use on well-being for different age groups.

A second set of studies examined user characteristics that are more directly related to the psychological mechanisms that are assumed to explain the relationship between SNS use and well-being. According to the active-passive model of SNS use, SNSs can elicit damaging social comparisons. However, people differ in their tendency to engage in social comparisons; people scoring high on this trait are particularly vulnerable when confronted with the successes of others. Consistent with this trait-state approach, studies have found that passive SNS usage predicts increases in upward social comparisons (J. L. Wang et al., 2017) and decreases in well-being (de Vries et al., 2018), but only among users scoring high on social comparison orientation. This further demonstrates that social comparison is both an explanatory mechanism (mediator) and a vulnerability factor (moderator). Whereas social comparison orientation is a key vulnerability factor, other personal characteristics can protect people from the consequences of social comparisons. For example, people with higher self-esteem are less vulnerable to social comparisons in the context of SNS use (Niu et al., 2018).

According to the active-passive model of SNS use, SNS use can also stimulate accrual of social capital and associated feelings of connectedness. However, people use SNSs for different purposes, and individual differences in these motivations may have consequences for the relationship between SNS use and well-being. Research indicates that the positive relationship between SNS use and social capital is stronger for people who were more motivated to use SNSs for interpersonal communication (G. Wang et al., 2019). Moreover, although reciprocity following active SNS use generally fosters accrual of social capital, the positive impact of the amount and speed of other users' feedback appears to be stronger among people who tend to care more about other's feelings, opinions, and behaviors (Seo et al., 2016).

Conclusion and Future Research

In this article, we have introduced the extended active-passive model of SNS use, which provides a nuanced understanding of the relationship between SNS use and well-being. In contrast to the active-passive model of SNS use, the extended active-passive model posits that active use is not always beneficial and passive use is not always detrimental for well-being.

Future research is needed to test and expand the extended active-passive model. We have described several avenues for decomposing active SNS use (reciprocity and communion) and passive SNS use (self-relevance and achievement), but we expect future research to identify additional decomposition dimensions, and user characteristics that moderate their effects. Similarly, we have focused on social comparison and accrual of social capital, but these are only two out of many psychological mechanisms that explain the relationship between SNS use and well-being. Ultimately, more work is needed to see how the three extensions of the active-passive model of SNS use interact and affect the psychological mechanisms that underlie the relationship between SNS use and well-being.

For investigating these interactions in future studies, experimental designs are to be preferred as they allow making stronger claims on the causal direction of effects. Moreover, it is of key importance that SNS use is measured and categorized accurately. Ideally, time spent on SNSs should be measured objectively, as self-reports are not strongly correlated with corresponding objective assessments (Ernala et al., 2020). Ideally, the process of categorizing subtypes of SNS use would be automated given the large amounts of available data on SNSs. However, although automation may be relatively straightforward for certain SNS activities (e.g., counting the number of posts, comments, or likes), manual coding may still be a necessary (albeit imperfect) tool to capture psychological dimensions (e.g., is a particular comment a warm expression of concern or a cold expression of sarcasm?). Yet the continued development of coding algorithms may reduce the need for manual coding in the future. We are confident that continued improvements in research methodology and theoretical frameworks will synergistically deepen understanding of the impact of SNS use on well-being.

CHAPTER 3

A systematic review of user characteristics moderating the relationship between overall, active, and passive use of social networking sites and mental health

This chapter is based on: Gugushvili, N., Rozgonjuk, D., Täht, K., Ruiter, R. A. C., Kross, E., & Verduyn, P. (In preparation). A systematic review of user characteristics moderating the relationship between overall, active, and passive use of social networking sites and mental health.

CHAPTER 4

The moderating role of extraversion and neuroticism in the relationship between digital communication technologies and mental health: A diary study

This chapter is based on: Gugushvili, N., Täht, K., Ruiter, R. A. C., & Verduyn, P. (In preparation). The moderating role of extraversion and neuroticism in the relationship between digital communication technologies and mental health: A diary study.

CHAPTER 5

Facebook use intensity and depressive symptoms: A moderated mediation model of problematic Facebook use, age, neuroticism, and extraversion

This chapter is based on: Gugushvili, N., Täht, K., Ruiter, R. A. C., & Verduyn, P. (2022). Facebook use intensity and depressive symptoms: A moderated mediation model of problematic Facebook use, age, neuroticism, and extraversion. *BMC psychology*, *10*(1), 279.

Abstract

Research on the relationship between Facebook use intensity and depressive symptoms has resulted in mixed findings. In contrast, problematic Facebook use has been found to be a robust predictor of depressive symptoms. This suggests that when intense Facebook use results in a problematic usage pattern, it may indirectly predict depressive symptoms. However, this mediation pathway has never been examined. Moreover, it remains unclear whether the possible indirect relationship between Facebook use intensity and depressive symptoms through problematic Facebook use is moderated by demographic (age), and personality (neuroticism and extraversion) characteristics. To address these gaps, we conducted an online cross-sectional study (n = 210, 55% female, age range: 18–70 years old, M_{age}= 30.26, SD = 12.25). We measured Facebook use intensity (Facebook Intensity Scale), problematic Facebook use (Bergen Facebook Addiction Scale), depressive symptoms (Center for Epidemiologic Studies Depression Scale Revised), and neuroticism and extraversion (Ten Item Personality Inventory). A mediation analysis revealed that problematic Facebook use fully mediates the relationship between Facebook use intensity and depressive symptoms. Moreover, a moderated mediation analysis demonstrated that this indirect relationship is especially strong among young users and users scoring high on neuroticism. These findings expand our understanding of the mechanisms underlying the relationship between Facebook use intensity and depressive symptoms and describe user characteristics that act as vulnerability factors in this relationship.

Keywords: Facebook use intensity, problematic Facebook use, depressive symptoms, age, neuroticism, extraversion, moderated mediation

Facebook is the most often used social networking site worldwide with almost 3 billion users (Tankovska, 2021). Many of these users engage in intense Facebook use by (a) spending a lot of time on Facebook, (b) having a substantial number of friends on Facebook, and (c) feeling emotionally connected to Facebook (Ellison et al., 2007; Orosz et al., 2016; Vanden Abeele et al., 2018). There is a public concern that intense Facebook use may negatively impact mental health and even contributed to the recent increase in depression rates observed in society (O'Connell, 2018; Orlowski, 2020).

A large number of studies have been conducted to examine whether this concern is justified. Some studies have focused on the intensity of Facebook usage but these studies yielded mixed evidence (Frost & Rickwood, 2017; Kross et al., 2021). For instance, while it has been found that the intensity of Facebook use positively predicts depressive symptoms (Brailovskaia, Ströse, et al., 2020; Steers et al., 2014), other studies could not replicate this effect (Boer et al., 2021; Jelenchick et al., 2013). Recent meta-analytical evidence reveals a positive association between the intensity of using social networking sites and depressive symptoms but this association is small (Cunningham et al., 2021).

Other studies have taken a more fine-grained approach and decomposed social networking sites usage into active and passive usage types (Escobar-Viera et al., 2018; Krasnova et al., 2015; Ozimek & Bierhoff, 2019; Verduyn et al., 2015a). Active usage encompasses activities that foster interactions with other users and is assumed to enhance mental health. Passive usage pertains to content consumption without direct communication with other users and is assumed to undermine mental health (Verduyn et al., 2021). While initial studies were largely consistent with this active-passive model of social networking sites use (Verduyn et al., 2017), recent studies resulted in mixed findings (Valkenburg, van Driel, et al., 2021), illustrating that this model should be extended (Verduyn et al., 2022).

Several psychological mechanisms have been proposed to explain the effect of Facebook use on depressive symptoms but one key mechanism is problematic Facebook use. Notably, a large volume of studies confirms that the intensity of Facebook use is a consistent predictor of problematic Facebook use (Boer et al., 2021; Fuster et al., 2017; Müller et al., 2016; Ryan et al., 2014), whereas findings for the relationship between active and passive use of social networking sites and problematic usage of social networking sites are mixed (Brailovskaia & Margraf, 2022; Fioravanti & Casale, 2020; Keum et al., 2022).

Problematic Facebook use pertains to addictive properties of Facebook use, such as an inability to cut down on one's time spent on Facebook or using Facebook to manage one's mood (Andreassen et al., 2012). Whereas prior research on the impact of Facebook use intensity on depression is rather mixed, problematic Facebook use has been found to be a robust predictor of depressive symptoms (Huang, 2020). As such, when intense Facebook use gradually develops into problematic Facebook use (Guedes et al., 2016; Ryan et al., 2014), it may result

in depressive symptoms. Surprisingly, however, this mediation pathway has never been tested. Moreover, the strength of this pathway may differ across individuals but user characteristics moderating this mediation pathway have not been studied.

The present study seeks to address these gaps by testing a moderated mediation model, in which the relationship between the intensity of Facebook use and depressive symptoms is mediated by problematic Facebook use, and this indirect association is moderated by demographic (age), and personality characteristics (neuroticism and extraversion). Testing this model enhances our understanding of the mechanisms underlying the relationship between Facebook use intensity and depressive symptoms and elucidates which user populations are especially vulnerable to negative consequences of intense Facebook use. It is notable that we focused on Facebook as the social networking site under study as Facebook is still the social networking platform with most users worldwide (Kemp, 2022). Furthermore, since past studies suggest that women are more prone to use social networking sites excessively (Spilková et al., 2017; Su et al., 2020) and score higher on depressive symptoms (Nolen-Hoeksema et al., 1999; Thayer et al., 2003), we added gender as a control variable in our analyses.

Below, we first describe prior research on problematic Facebook use and discuss how it may act as a mediator in the relationship between the intensity of Facebook use and depressive symptoms. Next, we describe prior research on age, neuroticism and extraversion, and discuss how these user characteristics may act as vulnerability factors. At the end of the introduction, we specify our hypotheses.

The Mediating Role of Problematic Facebook Use

Problematic Facebook use is a subtype of problematic social media use that specifically focuses on addiction-like behaviours occurring on Facebook (Balcerowska et al., 2020; D Griffiths, 2013). Problematic Facebook use is most often assessed via the Bergen Facebook Addiction Scale (Andreassen et al., 2012), which measures six components that are typical for substance addictions but then in the context of Facebook use: tolerance, withdrawal, conflict, salience, relapse, and mood modification (Andreassen et al., 2012, 2017; Griffiths, 2005). The prevalence of problematic Facebook use poses a serious public health issue. This is reflected by a recent meta-analysis that summarized studies across 32 nations and found that 5 to 25% (depending on cut-off criteria) of users experience problematic Facebook use (Cheng et al., 2021).

There is an ongoing debate among scholars (Andreassen et al., 2012; Kardefelt-Winther et al., 2017; Panova & Carbonell, 2018) whether problematic use of Facebook and other types of digital technologies represent genuine behavioural addictions (Billieux, Philippot, et al., 2015; Billieux, Schimmenti, et al., 2015). This is reflected by some researchers preferring the term “Facebook addiction” (Andreassen et al., 2012; Brailovskaia et al., 2018) or “Facebook use disorder” (Montag, Wegmann, et al., 2021), while other researchers prefer terms such as

"excessive Facebook use" (Guedes et al., 2016), Facebook intrusion" (Błachnio et al., 2015), or "problematic Facebook use" (Marino et al., 2018; Satici & Uysal, 2015) to describe the same phenomenon. Considering that Facebook addiction is not (yet) officially recognized as a formal psychiatric disorder, we will follow the approach suggested by Panova and Carbonel (2018) and use the term "problematic Facebook use".

Intense use of Facebook may result in problematic Facebook use. Specifically, findings from two systematic reviews consistently showed that Facebook usage positively predicts problematic Facebook use (Frost & Rickwood, 2017; Ryan et al., 2014). Moreover, seeking positive reinforcement (e.g., likes) (Vaillancourt-Morel et al., 2020) and entertainment usage of social networking sites (Brailovskaia, Bierhoff, et al., 2020) are positively associated with problematic use of social networking sites (Zhao, 2021).

Why does intense Facebook use sometimes transform into an addiction-like usage pattern? The Online Social Regulation Theory (SOS-T) (Ozimek & Förster, 2021) states that people use social networking sites for self-regulation. It is assumed that different needs and goals (e.g., need for comparison, need for belongingness, and need for self-presentation) underlie usage of social networking sites. Fulfillment of these goals is strived for to achieve broader desired outcomes, such as increasing happiness or self-esteem. However, the SOS-T also argues that self-regulation on social networking sites does not necessarily lead to these desired end-states and can also be dysfunctional.

Additionally, Montag and colleagues (2019; Montag, Hegelich, et al., 2021) argue that due to the Data Business Model (DBM), social networking sites, including Facebook, are designed to make people spend long periods of time on these platforms. For instance, the possibility to endlessly scroll on Facebook might lead to a state of flow and distorted time perception (P. A. Hancock et al., 2019). Experience of flow pertains to being fully immersed into an activity (Csikszentmihalyi, 2002) and has been shown to be associated with problematic use of social networking sites (Brailovskaia & Teichert, 2020). Moreover, a personalized "newsfeed" on Facebook that displays relevant content tailored to each individual, might further encourage users to spend excessive amounts of time on Facebook. Finally, positive reinforcement derived from Facebook in the form of receiving (Sherman et al., 2016) or providing (Sherman et al., 2018) "likes" and "loves" activates the reward system in the brain, which is known to contribute to the maintenance of excessive usage patterns (A. J. Roberts & Koob, 1997). In line with this reasoning, a longitudinal study investigating the directionality between use of social networking sites and problematic use of social networking sites has found that increases in the intensity of use of social networking sites predicted problematic use of social networking sites one year later (Boer et al., 2021).

Lastly, according to the Interaction of Person-Affect-Cognition-Execution (I-PACE) model (Brand et al., 2019), when developing problematic and addiction-like Facebook usage patterns, one's control over Facebook use declines and users

experience negative consequences such as increases in negative affect (Brand et al., 2016), health-related issues, relational problems, and declined mental health (Andreassen, 2015). Consistently, empirical studies found that problematic Facebook use is associated with negative outcomes including insomnia (Koc & Gulyagci, 2013, 2013), stress (Brailovskaia & Margraf, 2017), relationship dissatisfaction (Elphinston & Noller, 2011), anxiety (Koc & Gulyagci, 2013), social anxiety (Atroszko et al., 2018; Foroughi et al., 2019), and depressive symptoms (Foroughi et al., 2019; Hong et al., 2014; Koc & Gulyagci, 2013).

Surprisingly, there are only two studies (Donnelly, 2017; Yan Li et al., 2019) that directly investigated whether problematic use of social networking sites mediates the relationship between usage of these platforms and negative outcomes. Specifically, WeChat addiction was found to fully mediate the negative relationship between the intensity of WeChat use and academic performance (Yan Li et al., 2019) and social network sites addiction was found to partially mediate the negative relationship between Instagram use and subjective well-being (Donnelly, 2017). However, neither of these studies examined these relationships in the context of Facebook use.

The Moderating Role of Age, Neuroticism, and Extraversion

Problematic Facebook use may mediate the relationship between the intensity of Facebook use and depressive symptoms but the strength of this mediation pathway might vary across people. Specifically, not all people are equally vulnerable towards developing problematic Facebook use when engaging in intense Facebook use. According to the SOS-T (Ozimek & Förster, 2021), individual differences impact self-regulatory goals and outcomes associated with these goals.

Regarding demographic features, being young may act as a vulnerability factor in developing problematic Facebook use. Young people already had first access to digital technologies at a very young age (H.-Y. Wang et al., 2019) and use social networking sites for construing their identity (Longobardi et al., 2020), developing a sense of belonging (Pang, 2020), and for comparison with others (Ozimek & Bierhoff, 2016). Moreover, the prefrontal cortex is only fully developed at the age of 24 (Arain et al., 2013) and incomplete development of this brain region is expressed in risky (Crews et al., 2007) and addictive behaviours (S.-W. Choi et al., 2014; Crews et al., 2007). In the context of social networking sites, it has been found that being young predicts higher levels of problematic Facebook use (Andreassen et al., 2012; Andreassen, 2015; Błachnio & Przepiorka, 2016a; Jafarkarimi et al., 2016) but the possible moderating impact of age in the relationship between the intensity of Facebook use and depressive symptoms through problematic Facebook use remains untested.

Among the core personality traits, neuroticism and extraversion have been found to be most strongly and consistently associated with use of social net-

working sites (Amichai-Hamburger & Vinitzky, 2010) and social networking sites addiction (Marengo, Poletti, et al., 2020; C.-W. Wang et al., 2015). Neuroticism pertains to frequent experiences of negative affect, moodiness, lack of emotional stability, anger, worry, frustration, and proneness to anxiety (Costa & McCrae, 1992; Goldberg, 1992). Due to these features, users scoring high on neuroticism favour online communication as a less threatening alternative to face-to-face communication (Amichai-Hamburger et al., 2002). As such, they use social networking sites for strategic self-presentations (Michikyan et al., 2014) and compensation for lack of real-life social support (Shen et al., 2015). In turn, the gratification of these social needs places neurotic users at a greater risk of developing an addiction-like dependency on social networking sites (A. Chen & Roberts, 2019; Marengo, Poletti, et al., 2020). Furthermore, according to the vulnerability model of neuroticism (Marciano et al., 2020; Ormel et al., 2013), individuals with high levels of neuroticism are more vulnerable to develop addiction-like behaviour due to negative biases in attention and interpretation, and usage of maladaptive coping strategies (Ormel et al., 2013). Consistently, neuroticism has been found to have a significant positive relationship with different kinds of problematic usage of technologies (Marciano et al., 2020) but the possible moderating impact of neuroticism in the relationship between the intensity of Facebook use and depressive symptoms through problematic Facebook use remains untested.

People scoring high on extraversion are warm, assertive, gregarious, highly active, impulsive, and experience often positive emotions (Costa & McCrae, 1992). Moreover, extraverted individuals are reward-seeking and highly sociable, and Facebook provides ample opportunities for social interaction and active self-presentation. It has been shown that on social networking sites, extraverted individuals fulfil their needs for self-presentation (Seidman, 2013), mood enhancement (e.g., maximization of positive affect), and social needs (e.g., connection and communication) (A. Chen & Roberts, 2019). Moreover, it has been found that extraverted individuals tend to have larger online social networks, post more status updates, and photos, engage more frequently in social activities and receive more positive feedback (e.g., likes) than introverted users (Shen et al., 2015). In turn, positive feedback (Marengo, Poletti, et al., 2020), and pleasurable emotions (A. Chen & Roberts, 2019) derived from use of social networking sites may be associated with problematic use of social networking sites for extraverts. Consistently, prior empirical research reveals that a higher level of extraversion is positively related with problematic use of social networking sites (Andreassen et al., 2012; Atroszko et al., 2018; Biolcati et al., 2018; Nikbin et al., 2021). Furthermore, among the different types of digital technology addictions, only social networking sites addiction is associated with extraversion (C.-W. Wang et al., 2015). Nevertheless, it remains unknown whether extraversion moderates the relationship between the intensity of Facebook use and depressive symptoms through problematic Facebook use.

The Present Study

The aim of the current study is to contribute to our understanding of the relationship between the intensity of Facebook use and depressive symptoms by examining the possible mediating role of problematic Facebook use and moderating role of age, neuroticism, and extraversion. Specifically, we will test four models. First, we will test the mediating effect of problematic Facebook use in the relationship between the intensity of Facebook use and depressive symptoms. Next, we will test whether this indirect effect is moderated by age, neuroticism, and extraversion in three separate models (figure 1). In each moderated mediation model, we will test moderation of the relationship between the intensity of Facebook use and problematic Facebook use (path a), problematic Facebook use and depressive symptoms (path b), and the intensity of Facebook use and depressive symptoms (path c'). We have the following hypotheses:

H1*: The intensity of Facebook use is positively related to depressive symptoms.* Recent meta-analytical evidence reveals that the intensity of use of social networking sites (including Facebook) has a small but statistically significant positive association with depressive symptoms (Cunningham et al., 2021).

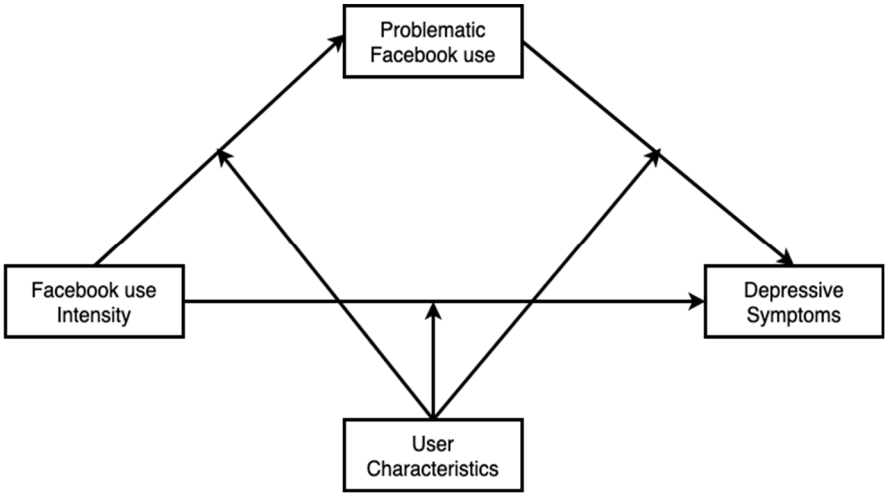
H2*: Problematic Facebook use mediates the relationship between the intensity of Facebook use and depressive symptoms.* This mediation pathway has never been directly tested but studies conducted on Instagram (Donnelly, 2017) and WeChat (2019) suggest this hypothesis to hold true.

H3: *Age moderates the indirect relationship between the intensity of Facebook use and depressive symptoms with the relationship being stronger for younger participants.* This hypothesis has never been directly tested but it is consistent with prior research revealing a direct relation between being young and high levels of problematic Facebook use (Andreassen et al., 2012; Andreassen, 2015; Błachnio & Przepiorka, 2016a; Jafarkarimi et al., 2016).

H4: *Neuroticism moderates the indirect relationship between the intensity of Facebook use and depressive symptoms with the relationship being stronger for users scoring high on neuroticism.* This hypothesis has never been directly tested but it is consistent with prior evidence revealing a direct relationship between neuroticism and problematic Facebook use (Marciano et al., 2020).

H5: *Extraversion moderates the indirect relationship between the intensity of Facebook use and depressive symptoms with the relationship being stronger for users scoring high on extraversion.* We expect this based on previous findings which suggest that the relationship between extraversion and problematic use of social networking sites is positive and significant (Andreassen et al., 2012; Atroszko et al., 2018; Biolcati et al., 2018; A. Chen & Roberts, 2019; Marengo, Poletti, et al., 2020; Nikbin et al., 2021).

Figure 1. Conceptual Model of the Relationship Between the Intensity of Facebook use and Depressive Symptoms Mediated by Problematic Facebook use and Moderated by User Characteristics (age, neuroticism, and extraversion)



Methods

Participants

Participants were recruited using a convenience sampling approach. The online questionnaire was distributed via universities' mailing list and Facebook. To take part in the study, participants had to be at least 18 years old, have a Facebook account, and provide informed consent. The initial sample consisted of 228 individuals who volunteered to participate and provided informed consent, but 12 participants did not provide information regarding their age, and six participants were younger than 18. The final sample therefore consisted of 210 participants (55% female and 45% male) with an age range from 18 to 70 (M_{age}= 30.26, SD = 12.25). Overall, the questionnaire completion rate was very high (Facebook use intensity: 98%; Problematic Facebook use: 97%; Depressive symptoms: 96%; Age: 100%; Neuroticism: 93%; Extraversion: 93%). Most participants had obtained a bachelor's degree (42%), followed by high school degree (30.1%), master's degree (18.2%), trade/technical/vocational training (6.7%) and doctoral degree (2.4%). Furthermore, about half of the sample were students (53.1%) while 40.7% indicated that they were employed, 3.3% reported they were retired, and 2.9% were unemployed.

Procedure & Materials

Upon providing informed consent, participants answered a number of demographic questions and completed a set of questionnaires. The study took place online and was approved by the Ethics Review Committee of Maastricht University.

Intensity of Facebook use

Facebook usage intensity was measured with the Facebook Intensity Scale (Ellison et al., 2007). It consists of eight items in total. The first six items are attitudinal questions regarding one's emotional investment and connection with Facebook. Example items include "Facebook is part of my everyday activity" and "I feel I am part of the Facebook community". These items were rated on a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The final two items assess the total number of friends one has on Facebook and the average amount of time one has spent on Facebook daily in the past week. The total number of friends is rated on an ordinal scale ranging from 1 (10 or less friends) to 9 (more than 400 friends) and the amount of time spent on Facebook is rated on an ordinal scale ranging from 1 (10 minutes or less) to 6 (more than 3 hours). Before calculating a mean score across the eight items for each participant, all items were standardized because different items were measured on different scales. Higher scores on this scale indicate higher intensity of Facebook usage. Cronbach's alpha for the Facebook intensity scale in the present study is .82.

Problematic Facebook use

To measure problematic Facebook use we utilized the Bergen Facebook Addiction Scale (Andreassen et al., 2012). This scale contains six items and measures the core aspects of addiction: tolerance, withdrawal, conflict, salience, relapse, and mood modification. These items are rated on a five-point Likert scale, from 1 (very rarely) to 5 (very often). For example, participants are instructed to answer how often during the last year they have "spent a lot of time thinking about Facebook or planned use of Facebook?" and "Used Facebook so much that it has had a negative impact on your job/studies?" We computed the mean score across the six items for each participant. Higher scores on this scale reflect higher problematic Facebook use. Cronbach's alpha for this measure in the present study is .85.

Depressive Symptoms

We measured depressive symptoms by the Center for Epidemiologic Studies Depression Scale Revised (CESD-R) (Eaton et al., 2004). This scale contains 20 items, such as "I felt sad" and "I felt like a bad person". All items were rated on

a scale from 0 (Not at all or less than 1 day) to 4 (Nearly every day for 2 weeks). Respondents are instructed to answer how often they felt this way during the past two weeks. The scale score was calculated by averaging the 20 items for each participant. Higher scores on this scale indicate higher levels of depressive symptoms. Cronbach's alpha for this scale in the present study is .94.

Neuroticism

Neuroticism was assessed by the two-item neuroticism subscale from the Ten Item Personality Inventory (Gosling et al., 2003). Participants were instructed to answer the extent to which the following traits applied to them: "Anxious, easily upset", "Calm, emotionally stable". Both items were rated on a seven-point Likert scale ranging from 1 (disagree strongly) to 7 (agree strongly). The second item was reverse-coded such that higher scores reflect higher levels of neuroticism. As both items were correlated (r = .52), we calculated the mean across both items.

Extraversion

Extraversion was assessed by the extraversion subscale from the Ten Item personality Inventory (Gosling et al., 2003). This subscale consists of two items: "Extraverted, enthusiastic" and "Reserved, quiet". Respondents were instructed to answer the extent to which these traits apply to them. Both items were rated on a seven-point Likert scale ranging from 1 (disagree strongly) to 7 (agree strongly). The second item was reverse coded such that higher scores reflect higher levels of extraversion. As both items were correlated (r = .39), we calculated the mean across both items.

Statistical Approach

We used IBM SPSS (version 27) for data analysis. After computing descriptive statistics and bivariate correlations among the key variables, we made use of the Process Macro (version 3.5.3) (Hayes, 2017) to examine our main hypotheses. First, using model 4, we checked whether problematic Facebook use mediated the relationship between the intensity of Facebook use and depressive symptoms. To test the moderating effect of user characteristics, we fitted three separate models in the SPSS PROCESS macro, specifically model 59 (Hayes, 2017) with age, neuroticism, or extraversion as moderator. According to Hayes (Hayes, 2017), conditional indirect effects (moderation) are established if either path a (i.e., the relationship between the intensity of Facebook use and problematic Facebook use) or path b (i.e., the relationship between problematic Facebook use and depressive symptoms) or both are influenced by the moderating variable. In all models, continuous predictors were centered and a bootstrapping procedure across 10000 samples was utilized. Moreover, in all models, we controlled for

the effects of gender on problematic use of Facebook and depressive symptoms. Gender was coded in the following way: 0 denotes males, 1 denotes females. Please note that we used the bootstrapping technique, therefore, it was not necessary to meet the assumptions with regard to the mediation model outlined by Hayes (2017). Furthermore, the variance Inflation Factors (VIF) were all below 5, indicating the absence of multicollinearity (Daoud, 2017).

Results

Table 1 displays the descriptive statistics and bivariate correlations among the assessed variables.

Does the Intensity of Facebook use Predict Depressive Symptoms?

To answers this question, we conducted a regression analysis predicting depressive symptoms by Facebook use intensity. The intensity of Facebook use was found to be positively related to depressive symptoms ($B = .191$, $\beta = .211$, $SE = .063$, $p = .003$).

Table 1. Descriptive Statistics and Correlations Between Intensity of Facebook use (standardized), Problematic Facebook use, Depressive Symptoms, Neuroticism, Extraversion, and Age

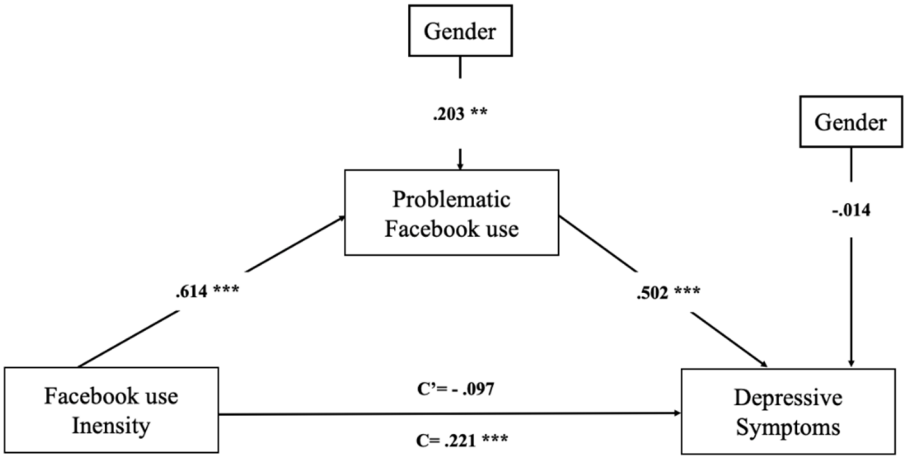
	Mean	SD	2	3	4	5	6
1. Facebook use intensity	0	0.69	.593**	.221**	.158*	.014	–.122
2. Problematic Facebook use	1.88	0.79		.454**	.320**	–.151*	–.139*
3. Depressive symptoms	0.66	0.65			.521**	–.177*	–.302**
4. Neuroticism	3.61	1.60				–.151*	–.153*
5. Extraversion	4.41	1.56					.027
6. Age	30.26	12.25					

*$p < .05$. **$p < .01$.

Does Problematic Facebook use Mediate the Relationship Between the Intensity of Facebook use and Depressive Symptoms?

The results showed that the overall model predicting problematic Facebook use was significant: $F(2, 197) = 63.56$, $p < .001$, $R^2 = .392$. Intensity of Facebook use significantly and positively predicted problematic Facebook use ($B = .706$, $\beta = .614$, $SE = .064$, $p < .001$). The overall model predicting depressive symptoms was also significant: $F(3, 196) = 16.47$, $p < .001$, $R^2 = .201$. Problematic Facebook use significantly and positively predicted depressive symptoms ($B = .396$, $\beta = .502$, $SE = .065$, $p < .001$). The indirect effect of the intensity of Facebook use on depressive symptoms through problematic Facebook use was statistically significant ($B = .279$, $\beta = .308$, $SE = .056$, Bootstrap 95% CI: [.175 – .396]). Finally, the direct association between the intensity of Facebook use on depressive symptoms was not significant ($B = –.088$, $\beta = –.097$, $SE = .074$, $p = .235$) reflecting full mediation (see figure 2).

Figure 2. Problematic Facebook Use as a Significant Mediator of the Relationship between the Intensity of Facebook use and Depressive Symptoms (Controlling for Gender)



Note. $N = 200$. Regression weights are standardized. C' is the direct effect of Facebook use intensity on Depressive symptoms; C is the total effect of Facebook use intensity on Depressive symptoms. $^{***}p < .01$.

The Moderating Role of Age

The overall model predicting problematic Facebook use was significant $F(4, 195) = 37.06$, $p < .001$. We found that the interaction term between the intensity of Facebook use and age significantly predicted problematic Facebook use (Table 2). To facilitate the interpretation of this moderation effect, figure 3

displays problematic Facebook use as a function of the intensity of Facebook use and age (1SD below the mean, 1 SD above the mean). Results from the simple slope tests indicate that the association between the intensity of Facebook use and problematic Facebook use is significant for both age groups. However, the relationship between the intensity of Facebook use and problematic Facebook use is stronger among younger users *(B* = .902, *SE* = .088, *p* < .001*)*, compared to older users *(B*= .464, *SE* = .093, *p* < .001*)*.

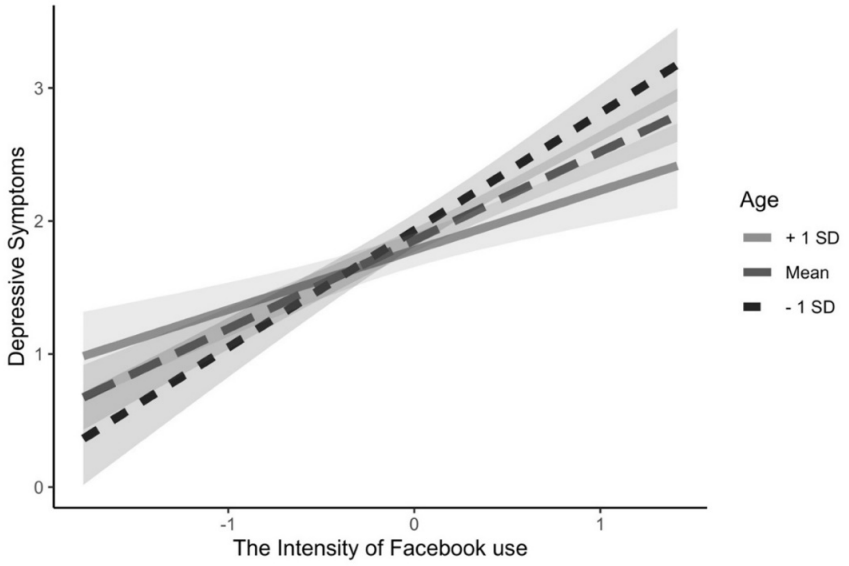
On the other hand, although the overall model predicting depressive symptoms was significant $F(6, 193) = 11.83$, $p < .001$, neither the interaction term between Facebook use intensity and age, nor between problematic Facebook use and age were significant (Table 2). Overall, age was found to moderate the indirect relationship between the intensity of Facebook use and depressive symptoms by moderating the relationship between the intensity of Facebook use and problematic Facebook use (path a). Consistently, the indirect relationship between the intensity of Facebook use and depressive symptoms through problematic Facebook use was moderated by age. The indirect effect was more pronounced among younger users (*B* = .377, *SE* = .087, Bootstrap 95% CI: [.208, .553]), compared to older users (*B* = .145, *SE* = .057, Bootstrap 95% CI: [.061, .285])

Table 2. The Moderating Role of Age in the Indirect Relationship Between the Intensity of Facebook use and Depressive Symptoms Through Problematic Facebook use

	Problematic Facebook use			Depressive Symptoms		
	b	*SE*	*p*	*b*	*SE*	*p*
Gender	.343	.087	<.001	.009	.083	.915
Facebook use Intensity	.683	.063	<.001	–.107	.073	.143
Age	–.007	.004	.038	–.013	.003	<.001
Problematic Facebook use				.365	.065	<.001
Facebook use Intensity x Age	–.018	.005	.001	.002	.005	.745
Problematic Facebook use x Age				–.004	.005	.424
R^2	.432			.269		

Note. N = 200.

Figure 3. Problematic Facebook use as a Function of Facebook use Intensity for People Scoring 1SD Below and 1SD Above the Mean Age



The Moderating Role of Neuroticism

Next, we examined the possible moderating effect of neuroticism (table 3). The overall model predicting problematic Facebook use was significant: $F(4, 189) = 41.92$, $p < .001$. The relationship between the intensity of Facebook use and problematic Facebook use was moderated by neuroticism ($B = .140$, $SE = .038$, $p < .001$). To ease the interpretation of this interaction effect, figure 4 shows the predicted value of problematic Facebook use as a function of the intensity of Facebook use and neuroticism (1SD below the mean, 1SD above the mean). Simple slopes analysis revealed that the intensity of Facebook use is related to problematic Facebook use at both levels of neuroticism, but this relationship is considerably weaker for users scoring low on neuroticism ($B = .447$, $SE = .087$, $p < .001$), compared to users scoring high on neuroticism ($B = .902$, $SE = .088$, $p < .001$).

Furthermore, the overall model predicting depressive symptoms was significant as well: $F(6, 187) = 17.01$, $p < .001$. However, the interactions between Facebook use intensity and neuroticism and between problematic Facebook use and neuroticism were not significant (Table 3).

Overall, neuroticism was found to moderate the indirect relationship between the intensity of Facebook use and depressive symptoms by moderating the relationship between the intensity of Facebook use and problematic Facebook use (path a). Consistently, the indirect relationship between the intensity of Facebook use and depressive symptoms through problematic Facebook use was moderated

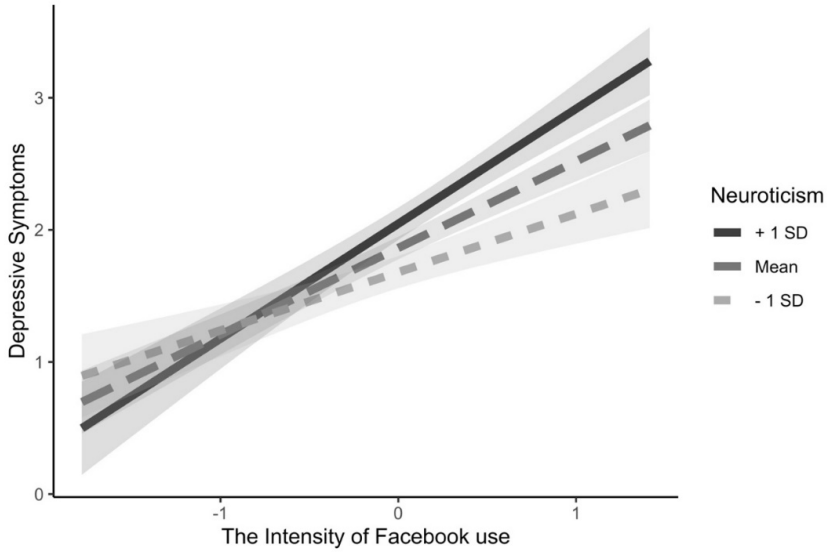
by neuroticism. The indirect effect was more pronounced among users scoring high on neuroticism (B = .275, SE = .097, Bootstrap 95% CI: [.094, .476]), compared to users scoring low on neuroticism (B = .110, SE = .044, Bootstrap 95% CI: [.036, .209]).

Table 3. The Moderating Role of Neuroticism in the Indirect Relationship Between the Intensity of Facebook use and Depressive Symptoms Through Problematic Facebook use

	Problematic Facebook use			Depressive Symptoms		
	b	*SE*	*p*	*b*	*SE*	*p*
Gender	.286	.086	.001	–.024	.077	.757
Facebook use Intensity	.679	.063	<.001	–.053	.070	.449
Neuroticism	.106	.027	<.001	.162	.025	<.001
Problematic Facebook use				.273	.065	<.001
Facebook use Intensity x Neuroticism	.140	.038	<.001	–.003	.043	.948
Problematic Facebook use x Neuroticism				.020	.038	.586
R^2	.470			.353		

Note. N = 194.

Figure 4. Problematic Facebook use as a Function of Facebook use Intensity for People Scoring 1SD Below and 1SD Above the Mean Score of Neuroticism



The Moderating Role of Extraversion

Finally, we tested the possible moderating effect of extraversion (table 4). The overall model predicting problematic Facebook use was significant $F(4, 189) = 33.69$, $p < .001$. However, the interaction term between the intensity of Facebook use and extraversion when predicting problematic Facebook use was not significant (Table 4). Similarly, while the overall model predicting depressive symptoms was significant: $F(6, 187) = 8.49$, $p < .001$, the interaction terms between Facebook use intensity and extraversion and between problematic Facebook use and extraversion were not significant (Table 4). Overall, extraversion was not found to moderate the indirect relationship between the intensity of Facebook use and depressive symptoms.

Table 4. The Moderating Role of Extraversion in the Indirect Relationship Between the Intensity of Facebook use and Depressive Symptoms Through Problematic Facebook use

	Problematic Facebook use			Depressive Symptoms		
	b	*SE*	*p*	*b*	*SE*	*p*
Gender	.283	.091	.002	–.001	.086	.995
Facebook use Intensity	.717	.065	<.001	–.054	.077	.486
Extraversion	–.074	.029	.010	–.036	.027	.178
Problematic Facebook use				.373	.067	<.001
Facebook use Intensity x Extraversion	–.051	.041	.216	–.008	.049	.866
Problematic Facebook use x Extraversion				.020	.046	.654
R^2	.416			.214		

Note. $N = 194$.

Sensitivity Analysis

In the preceding analyses, we examined the role of each moderator separately. To demonstrate the robustness of our findings, we reran the aforementioned three moderation analyses controlling for the other two moderators. For example, we re-examined the moderating role of age, while controlling for the effects of neuroticism and extraversion. These sensitivity analyses confirmed our conclusions: age and neuroticism moderate the relationship between the intensity of Facebook use and problematic Facebook use, whereas extraversion has no moderating effect.

Discussion

The aim of our study was to examine the relationship between the intensity of Facebook use and depressive symptoms and study the mediating and moderating mechanisms underlying and affecting this relationship. We found that problematic Facebook use fully mediated the relationship between the intensity of Facebook use and depressive symptoms. Moreover, we demonstrated that age and neuroticism moderated the first stage of this mediation relationship (path a: intensity of Facebook use predicting problematic Facebook use) but not the second stage (path b: problematic Facebook use predicting depressive symptoms). Extraversion did not moderate the indirect relationship between the intensity of Facebook use and depressive symptoms. We discuss these findings in more detail below.

The Mediating Role of Problematic Facebook Use

Our first aim was to investigate whether problematic Facebook use underlies the relationship between the intensity of Facebook usage and depressive symptoms. Our results confirmed that problematic Facebook use fully mediates this relationship. This finding is line with prior research showing that intensive Facebook usage can transform into problematic usage patterns (Baturay & Toker, 2017; Cudo et al., 2020; Koc & Gulyagci, 2013), which in turn, can lead to declines in mental health (Brailovskaia et al., 2018; Hong et al., 2014; Marino et al., 2018). Moreover, our results are consistent with previous studies directly examining the mediating roles of social networking site addiction and WeChat addiction in the relationship between Instagram use and subjective well-being (Donnelly, 2017) and WeChat use and academic performance (Yan Li et al., 2019), respectively. However, our study extends these findings by suggesting that also on Facebook intense but non-addictive use of this social network site may gradually transform into an addictive usage pattern.

Why does problematic Facebook use mediate the relationship between intense Facebook use and depressive symptoms? According to the Online Self-Regulation Theory (Ozimek & Förster, 2021), users resort to using social networking sites to regulate themselves. However, this attempt is not always successful and can result in detrimental outcomes. As such, it is plausible that the specific goals and motivations that underlie self-regulatory use of social networking sites seem achievable to users and make them more invested in Facebook usage. This, in turn, can lead to an overreliance on Facebook and the development of problematic usage of Facebook.

Additionally, Montag and colleagues (2019) argue that the Data Business Model (DBM) also plays a role in the development of problematic usage of social networking sites. Specifically, it is assumed that the medium-specific factors play an important role in the development of problematic usage behaviours. Therefore,

it seems plausible that specific elements and parts of the design of Facebook make people more vulnerable to develop problematic usage patterns. For instance, the experience of flow (Mauri et al., 2011) and distorted perception of time while using Facebook may contribute to problematic usage patterns (Turel et al., 2018). Moreover, once addiction-like attachment towards digital technology (including Facebook) is being developed, users may tend to lose control over their behaviour over time which results in negative outcomes for mental health (Brand et al., 2019).

The Moderating Roles of Age and Neuroticism but not Extraversion

The second aim of the present study was to test whether the indirect relationship between the intensity of Facebook use and depressive symptoms via problematic Facebook use was conditional on age, neuroticism, and extraversion. With regard to age, we found that being older acts as a protective factor as the relationship between the intensity of Facebook use and problematic Facebook use is less strong compared to younger users. Interestingly, we were unable to find a moderating impact of age on the second stage of the mediation pathway connecting problematic Facebook use to depressive symptoms. As such, this suggests that age only plays a protective role at the onset of developing addiction-like problematic behaviours on Facebook but does not protect the user from developing depressive symptoms once the user is already engaging in problematic Facebook use.

Our results corroborate previous studies showing that younger users have heightened risks to develop technology addictions (Csibi et al., 2021; Hawi et al., 2018) including problematic Facebook use (Andreassen, 2015; Andreassen et al., 2012). Our findings also support the SOS-T model (Ozimek & Förster, 2021), which maintains that individual differences influence self-regulatory goals on social networking sites. As such, our finding specify for whom self-regulation on social networking sites may become dysfunctional. A number of reasons may explain the observed relationships. First, compared to older adults, young people may engage in more social comparisons on Facebook which may results in more intense Facebook use for reasons of impression management (Ozimek & Bierhoff, 2016). Second, it has been shown that young users who experience a higher need to belong are at greater risk of developing problematic usage patterns (P. Wang et al., 2017). Alternatively, the present finding suggesting that young users are especially vulnerable towards developing problematic Facebook use may also be rooted in incomplete development of the prefrontal cortex which makes individuals vulnerable towards developing addiction-like symptoms (Chambers et al., 2003; Crews et al., 2007; Gladwin et al., 2011).

We also found that neuroticism is a vulnerability factor as it moderates the indirect relationship between the intensity of Facebook use and depressive symptoms. Specifically, we demonstrated that higher levels of neuroticism amplify the relationship between the intensity of Facebook use and problematic Facebook

use. Similar to age, neuroticism did not moderate the relationship between problematic Facebook use and depressive symptoms.

While previous research has consistently linked higher levels of neuroticism with different types of digital addictions (Bowden-Green et al., 2020; Marciano et al., 2020), our study has taken this research one step further by showing that neuroticism not only directly predicts problematic Facebook use, but also interacts with Facebook usage intensity in fostering problematic Facebook usage. Overall, our findings fit well into the vulnerability model of neuroticism (Marciano et al., 2020; Ormel et al., 2013) which argues that higher levels of neuroticism presents an important risk factor for developing common mental health disorders. Moreover, our results complement the SOS-T model (Ozimek & Förster, 2021) which posits that especially users with emotion regulation difficulties are prone to resort to dysfunctional self-regulation via social networking sites (Ozimek & Bierhoff, 2019). Here, we again clarify the specific subset of users for whom self-regulation on social networking sites is associated with detriments. As such, while neurotic users may turn to these platforms to regulate their need for self-presentation (Michikyan et al., 2014) or satisfy their need to belong (Seidman, 2013), they may fail doing in an efficient manner resulting in problematic social networking sites use. This is consistent with research showing a negative relationship between neuroticism and emotion regulation capacity (Barańczuk, 2019).

Finally, we were unable to find evidence for a moderating impact of extraversion on the indirect relationship between the intensity of Facebook use and depressive symptoms. Previous research on the relationship between extraversion and digital technologies suggested a positive link between problematic Facebook use and extraversion (Andreassen et al., 2012; Atroszko et al., 2018; Biolcati et al., 2018; Nikbin et al., 2021). However, our results suggest that extraversion is neither a vulnerability nor a protective factor in the indirect relationship between the intensity of Facebook use and depressive symptoms through problematic Facebook use. Given, that extraverts tend to have larger offline social networks (Pollet et al., 2011), are satisfied with their offline social relationships (Tov et al., 2016), and use healthy coping strategies (Amirkhan et al., 1995; Kokkonen & Pulkkinen, 2001), it is plausible to argue that they satisfy their needs for self-presentation and rewarding experiences both online and offline. As a result, extraverts are not dependent on social networking sites such as Facebook to regulate themselves and are not more prone to develop addictive patterns following intense Facebook use.

Implications and Limitations

Our findings are useful for counsellors, public health policy makers, and researchers. We have demonstrated that (non-problematic) intense Facebook use may result in problematic Facebook usage patterns, which, in turn, undermine

users' mental health. Moreover, we have shown that this indirect effect is especially outspoken among young users and users with high levels of neuroticism. Counsellors can make use of these findings to better identify and support the most vulnerable user populations. Moreover, they could rely on our findings when designing interventions, as the present study suggest that intense Facebook use is especially detrimental for mental health when it results in addictive usage patterns. Similarly, public health policy makers could make use of our findings when creating prevention strategies and campaigns by warning especially young users and users high in neuroticism of the possible dangers of excessive Facebook use and associated addiction symptoms. Moreover, also researchers who examine the relationship between usage of social networking sites and mental health might benefit from our findings. Specifically, our study directly responds to a call made by Boer and colleagues (2021) to identify groups of users for whom usage of social networking sites develops into problematic usage patterns. However, future studies are needed to further examine problematic Facebook use as a key mechanism underlying the relationship between Facebook use intensity and mental health, and to pay more attention to individual differences that either protect or make users more vulnerable towards negative outcomes of intense Facebook use. Additionally, future studies should study a broad range of different social networking sites and their unique features when examining the relationship between use of social networking sites and problematic usage patterns. The present study provides evidence that intensive Facebook use may turn into problematic usage. Moreover, this was also found for Instagram (Donnelly, 2017) and WeChat (Yan Li et al., 2019) in prior studies, but more evidence is necessary to identify the platforms for which usage is most likely to turn into problematic usage patterns.

The present study has also a number of limitations that should be taken into account when interpreting the findings of this study. First, we used a convenience sampling technique and Facebook users with higher education degrees were overrepresented. Future studies would benefit from recruiting bigger and more diverse samples. Second, while the sample size of the present study was modest, we ran a sensitivity analysis to check the range of effect sizes (two-tailed correlation) that our study design could detect reliably (80% power), given our sample size ($n = 210$) and $\alpha = .05$. The results show that our study design is sufficiently powered to detect effect sizes from $|p|$ .19 and above, i.e.,small to medium-sized effects (and larger) as specified by Cohen (Cohen, 1988). This is consistent with the effect sizes observed in previous research on the relationship between the constructs under examination (Marino et al., 2018; Przepiorka et al., 2016; Simoncic et al., 2014). However, future studies using larger sample sizes are necessary to replicate the current findings. Such larger sample sizes would also allow modelling the data with a structural equation approach rather than the PROCESS approach used in the present study. Third, in the present study, we focused on Facebook. While Facebook still has the most users worldwide (Statista, 2022), other platforms such as TikTok and Instagram are becoming increasingly popular, especially among younger users (Kemp, 2022). Future

studies are needed to examine whether our findings replicate across these other platforms, and to test whether our findings also hold when assessing social networking sites use in general without specifying specific platforms. Fourth, future studies need to replicate our findings by using different conceptualizations or subtypes of social networking sites use (e.g., active and passive usage) which may be differentially related to mental health outcomes (Verduyn et al., 2017) and problematic social networking site usage (Fioravanti & Casale, 2020). Fifth, in this study we made use of the Ten Item Personality Inventory (TIPI) (Gosling et al., 2003). While the neuroticism and extraversion dimensions of the TIPI have been shown to have good convergence with the corresponding dimensions of the International Personality Item Pool Neo-120 and Big Five Inventory-2 (Sleep et al., 2021), future research needs to replicate our findings using longer measures of extraversion and neuroticism. Furthermore, our study was cross-sectional. As such, strong causal claims cannot be made. While we examined the mediating role of problematic Facebook use in the relationship between Facebook use intensity and depressive symptoms, alternative models, including bi-directional relationships between these constructs are also possible (Stanković et al., 2021). Future studies using longitudinal or experimental designs are needed to clarify the temporal and causal relationships between the intensity of Facebook use, problematic Facebook use and depressive symptoms. Finally, future research using clinical samples is needed to advance our understanding of social networking sites usage in a clinical context.

Conclusion

In the present study, we have demonstrated that the relationship between the intensity of Facebook use and depressive symptoms is mediated by problematic Facebook use. Moreover, we have shown that this indirect relationship is moderated by age and neuroticism. Overall, our results suggest that intense Facebook use can result in adverse outcomes once it turns into a problematic (addictive) usage pattern, which is especially likely to happen among users who are young and score high on neuroticism.

CHAPTER 6

The association between neuroticism and problematic social networking sites use: The role of fear of missing out and self-control

This chapter is based on: Gugushvili, N., Täht, K., Schruff-Lim, E. M., Ruiter, R. A.C., & Verduyn, P. (2022). The association between neuroticism and problematic social networking sites use: the role of fear of missing out and self-control. *Psychological Reports*, *0*(0). https://doi.org/10.1177/00332941221142003

Abstract

Problematic use of social networking sites (SNS) has a negative impact on mental health. It has been found that people who score high on neuroticism are especially vulnerable towards engaging with SNS in a problematic way but it is not clear which psychological mechanisms explain this relationship. We addressed this issue by examining the mediating role of fear of missing out and self-control in the relationship between neuroticism and problematic SNS use. For this purpose, we conducted a cross-sectional study (n = 151, 69.5% female, M_{age}=26.23, SD = 7.52) and tested for parallel mediation using structural equation modelling. Neuroticism was found to be predictive of increased levels of problematic SNS use. Moreover, neuroticism was associated with both increased levels of fear of missing out and decreased levels of self-control. However, only fear of missing out was found to robustly mediate the relationship between neuroticism and problematic use of SNS. These findings suggest that fear of missing out could be an intervention target to prevent people scoring high on neuroticism from engaging in problematic SNS use.

Keywords: Problematic social networking sites use, neuroticism, fear of missing out, self-control, parallel mediation

Social networking sites (SNS) have changed how people interact and play a major role in today's society. During the past two decades, many SNS platforms have been developed, including Facebook, WeChat, TikTok, Twitter, and Instagram. SNS offer their users many benefits. For example, SNS allow people to present themselves (Hollenbaugh, 2021; Seidman, 2013) and communicate with others (Bayer et al., 2020). Moreover, SNS offer entertainment (Apaolaza et al., 2014), access to information (Asghar, 2015), and allow their users to build and feel part of a community (Blight et al., 2017; Ellison et al., 2007; W. Gao et al., 2017). People are aware of these benefits and SNS are therefore highly popular. Currently, more than half of the world's population uses SNS and spends on average 2 hours and 25 minutes on these platforms each day (Chaffey, 2021).

Despite the many benefits SNS may offer, SNS also have the potential to negatively impact well-being (for meta-analytic evidence, see Ivie et al., 2020; Yoon et al., 2019). This is especially the case when SNS usage turns into a problematic or addiction-like behavior (Kuss & Griffiths, 2017). There is a general consensus that problematic SNS usage is a significant public health problem when it involves excessive SNS use that interferes with important life domains including work, studies, and leisure (Andreassen, 2015).

The Interaction of Person-Affect-Cognition-Execution model (I-PACE) (Brand et al., 2016, 2019) explains how problematic and addictive behaviors online are developed and maintained. According to this model, personality traits are among the most important predisposing factors which both directly and indirectly impact problematic usage of technologies. Wegmann and Brand (2019) further hypothesize that personality traits characterized by low social competence and social deficits are key drivers of excessive compensatory use of SNS. In this regard, neuroticism, characterized by frequent experiences of loneliness, feelings of personal inadequacy, inferiority, and elevated sensitivity to social threats (Denissen & Penke, 2008; McCrae & John, 1992; Watson et al., 1994), has been shown to be a key predictor of problematic SNS use (for meta-analytic evidence, see Marciano et al., 2020). Specifically, among the big five personality traits, neuroticism is the strongest predictor of problematic SNS use (for meta-analysis, see Huang, 2022). However, it is not fully clear which mechanisms account for this relationship.

The I-PACE model (Brand et al., 2016, 2019) further states that the effect of predisposing factors (e.g., neuroticism) on problematic usage of SNS can be mediated by multiple emotional and cognitive responses simultaneously. Fear of missing out (FoMO) which is defined as "a pervasive apprehension that others might be having rewarding experiences from which one is absent" (Przybylski et al., 2013, p. 1841) is thought to be a key negative reinforcing mechanism in this context (Wegmann & Brand, 2019). Specifically, according to the Fear Driven/ Compensation Seeking Hypothesis (Wegmann & Brand, 2019), users with low social competence experience higher FoMO. Thus, they resort to excessive use

of SNS in order to reduce FoMO and gratify social needs. In line with this reasoning, past studies show that FoMO mediates the relationship between psycho-social variables, including personality traits, and problematic usage of digital technologies (Oberst et al., 2017; Reer et al., 2019; Wegmann et al., 2017).

In addition to fear of missing out, other emotional and cognitive responses may mediate the relationship between neuroticism and problematic SNS use (Brand et al., 2019; Wegmann & Brand, 2019). As such, these reinforcing mechanisms may act as parallel but different routes when connecting personality traits with problematic usage patterns of digital technology. One such potential underlying mechanism pertains to self-control. Self-control is "the ability to override or change one's inner response, as well as to interrupt undesired behavioral tendencies (such as impulses) and refrain from acting on them" (Tangney et al., 2004, p. 274).

Individuals with high neuroticism frequently experience negative mood, loneliness, and depression (Watson et al., 1994), and turn to SNS for mood regulation (Marino et al., 2016). However, according to the cognitive-behavioral model of generalized problematic internet use (Caplan, 2010), usage of internet applications for mood regulation causes failures in self-control. Furthermore, experiencing negative emotions also directly decreases self-control (Heatherton & Wagner, 2011; Schmeichel & Tang, 2015). In turn, decreased self-control (e.g., reckless behavior and acting without thinking) leads to problematic usage patterns of technology (Błachnio & Przepiorka, 2016b; Cudo et al., 2020; Turel & Qahri-Saremi, 2016) because usage behavior is driven by immediate gratification (Slater, 2003).

This pattern of findings suggests that the predictive effect of neuroticism on problematic SNS use could be explained by high levels of FOMO and low levels of self-control. However, these two explanatory mechanisms of the relationship between neuroticism and problematic SNS use have never been tested in a single integrated empirical model.

The present study aims to simultaneously test the role of FOMO and self-control as mechanisms explaining the link between neuroticism and problematic SNS use. Given that problematic usage of SNS is fairly prevalent (Alzougool, 2018; Mamun & Griffiths, 2019; Turel et al., 2018), this will increase our understanding of the relationship between personality traits and problematic SNS use. Furthermore, this will also reveal potential mechanisms for interventions.

In the next sections, we first clarify the constructs problematic SNS use and neuroticism, and subsequently describe prior research on their interrelation. Next, we define the constructs FOMO and self-control, and summarize prior empirical research that suggests that these mechanisms may explain the relationship between neuroticism and problematic SNS use. Finally, we describe the theoretical frameworks underlying the present study and describe the hypotheses of the present study.

Problematic SNS use

Problematic SNS use has been conceptualized within a behavioral addiction framework (Griffiths, 2005) and consists of six core components: (a) *salience* which implies that SNS usage becomes one's central activity and constantly occupies one's mind, (b) *mood modification* which implies that one uses SNS to alter negative emotional states, (c) *tolerance* which refers to the need to increase the amount of SNS usage to obtain former levels of pleasure derived from the same activity, (d) *withdrawal* which implies that reducing the amount of time spent on SNS leads to significant distress, (e) *relapse* which pertains to an inability to reduce SNS use, and (f) *conflict* which refers to interpersonal conflicts in the domains of work, studies, leisure or hobbies caused by excessive SNS use (Andreassen, 2015).

There is no consensus on which term is most optimally suited to cover excessive usage of SNS (Billieux, Philippot, et al., 2015; Billieux, Schimmenti, et al., 2015). While some authors prefer the term "SNS addiction" (Abbasi, 2019; Andreassen, 2015; Blackwell et al., 2017), others avoid possible over-pathologization and prefer the term "problematic SNS use" (Boer et al., 2020; Huang, 2020; Hussain & Griffiths, 2018). In this paper, we will use the term problematic SNS after Panova and Carbonell (2018), who argue that problematic patterns of technology usage may represent a milder form of behavioral addictions. Moreover, the fact that SNS addiction has not (yet) been officially recognized as a psychiatric disorder is another reason to adopt the term problematic SNS use.

While there is some disagreement on the most optimal term to describe the phenomenon, there is a general consensus that problematic usage of SNS is a major pervasive problem. According to a recent meta-analysis, prevalence estimates of problematic SNS use range from 14% (individualistic nations) to 31% (collectivist nations) (Cheng et al., 2021). Moreover, problematic SNS use has been shown to be associated with many negative outcomes, including task distraction (Moqbel & Kock, 2018), impaired academic performance (Al-Menayes, 2015), romantic disengagement (Abbasi, 2018), impaired subjective well-being (for meta-analysis, see Huang, 2020) and psychiatric disorders (for a review, see Hussain & Griffiths, 2018). Consequently, there is a growing public concern about the impact of problematic SNS use on today's society (Andersson, 2018).

Neuroticism

Neuroticism is one of the central personality traits of the big-five taxonomy (McCrae & John, 1992) and refers to a lack of emotional stability and frequent experiences of negative emotions such as anger, frustration, worry, and anxiety. Neuroticism has been found to be predictive of a host of negative outcomes. Specifically, neuroticism is associated with impaired mental and physical health, lowered quality of life (Lahey, 2009), interaction anxiety (Newby et al., 2017), low social support (Lahey, 2009), and difficulties in relationships (McNulty, 2008).

Furthermore, individuals with high levels of neuroticism frequently use maladaptive coping strategies including wishful thinking, withdrawal, denial, and substance use (Carver & Connor-Smith, 2010).

In the context of social media use, it has been shown that neurotic users gratify multiple social needs online. For instance, they use online settings for self-presentation (Seidman, 2013) and tend to express their true selves (Amichai-Hamburger et al., 2002; Tosun & Lajunen, 2010). Furthermore, users with high neuroticism prefer to engage in online communication as compared to face-to-face interactions (Abbasi, 2018) and compensate for feelings of belongingness (Seidman, 2013) and derive social support on SNS (Shen et al., 2015). However, compensation for these social needs through SNS increases the risk of SNS addiction (Marengo, Poletti, et al., 2020). As such, there is strong evidence for a positive relationship between neuroticism and problematic SNS use (Marciano et al., 2020). Nevertheless, there is a need to identify robust mediators of this relationship.

Fear of Missing out Explaining the Relation Between Neuroticism And Problematic SNS use

When individuals experience FoMO, they want to stay up to date and continuously check what others are doing (Przybylski et al., 2013). FoMO is characterized by negative emotional experiences (affective component) and worry and rumination (cognitive component) (Elhai et al., 2021; Neumann, 2020; Przybylski et al., 2013; Wegmann et al., 2017). FoMO can occur in offline contexts as well but SNS provide an especially fertile ground for these experiences to take place by making social information easily accessible for users and offering an effortless way to stay constantly connected and keep tabs on what others are doing (Elhai et al., 2021).

Empirical evidence confirms that FoMO is positively associated with problematic SNS use and the magnitude of this relationship ranges from a medium (Fioravanti et al., 2021; Yali et al., 2021) to large effect size (Elhai et al., 2021). Furthermore, past research revealed that FoMO and neuroticism are separate (Rozgonjuk et al., 2021b) but positively correlated constructs (Fioravanti et al., 2021).

Surprisingly, only one study directly examined the mediating role of FoMO in the relationship between neuroticism and problematic SNS use (Sindermann et al., 2021). Specifically, it has been demonstrated that FoMO mediates the association between neuroticism and problematic use of WeChat (Sindermann et al., 2021). However, it is unclear whether findings on problematic WeChat use hold for problematic SNS use in general. Moreover, FoMO was studied as a single mediating mechanism, ignoring the role of other possible key mechanisms such as self-control. This is troublesome as multiple mechanisms may be responsible for the association between neuroticism and problematic SNS use.

Self-Control Explaining the Relation Between Neuroticism and Problematic SNS use

Self-control is associated with a wide range of desirable outcomes, such as academic performance (Duckworth & Seligman, 2005), interpersonal success, low levels of psychopathology (Tangney et al., 2004), and increased well-being (de Ridder et al., 2012). Consistently, low levels of self-control have been found to be associated with undesirable outcomes, including impaired physical health (Miller et al., 2011), low income (Fergusson et al., 2013), and criminal and deviant behavior (Vazsonyi et al., 2017).

In the context of social media, self-control has been found to be related to problematic SNS use (for a review, see Zahrai et al., 2022). Specifically, high levels of self-control protect users from overusing social networking sites (Brevers & Turel, 2019), while deficiencies in self-control are related to problematic SNS use (Wu et al., 2015). In addition to impulsive behavior, which is aimed at immediate gratification (Duckworth & Steinberg, 2015), low self-control also implies having low self-discipline and having a hard time to break bad habits (Tangney et al., 2004), which may further contribute to maintaining problematic SNS usage patterns.

Given that users with high neuroticism have lower levels of self-control (Fetterman et al., 2010; Tangney et al., 2004), self-control might explain the relationship between neuroticism and problematic SNS use. Surprisingly, while it has been found that low levels of self-control mediate the relationship between loneliness and internet addiction (Özdemir et al., 2014), no study has examined the possible mediating role of self-control in the relationship between neuroticism and problematic SNS use. Furthermore, no study has examined whether FoMO and self-control parallelly mediate the relationship between neuroticism and problematic SNS use.

Theoretical Frameworks on the Relationship Between Neuroticism, Fomo, Self-Control and Problematic SNS use

We rely on the I-PACE model (Brand et al., 2019), the Fear Driven/Compensation Seeking Hypothesis (Wegmann & Brand, 2019), and the cognitive-behavioral model of generalized problematic internet use (Caplan, 2010) to explain the direct and indirect relationships between neuroticism and problematic SNS use. Specifically, according to the I-PACE model, the P component pertains to person-specific characteristics, such as temperamental features, genetics, and psychopathology (e.g., depression, social anxiety) which serve as vulnerability factors and precursors of different types of digital addictions. As such, they trigger specific affective (A component) and cognitive (C component) responses. While these responses and corresponding behaviors provide relief and gratification of needs (e.g., mood management, compensation of social deficiencies),

they eventually lead to habitual and problematic usage patterns. Neuroticism can be assumed to be a core vulnerability factor in this context.

Moreover, fear of missing out may act as a mediating mechanism through which neuroticism is associated with problematic SNS use. This is in line with the Fear Driven/Compensation Seeking Hypothesis, which posits that users with low social competence and social deficiencies, as is the case for neurotic users, engage in SNS use to satisfy their social needs and deal with their feelings of FoMO. In turn, social gratification, and reduction of FoMO reinforces usage patterns and leads to problematic SNS use.

Besides fear of missing out, self-control may also mediate the relationship between neuroticism and problematic SNS use. In addition to social need satisfaction, mood regulation (e.g., reduction of negative affect) (A. Chen & Roberts, 2019) is another main motivation for neurotic users to engage with SNS. The cognitive-behavioral model of generalized problematic internet use (Caplan, 2010), however, maintains that usage of internet applications for mood management, as well as preference for online interaction leads to self-control failure, which in turn leads to problematic usage patterns. Based on this, (low) self-control may act as a parallel mechanism through which neuroticism is associated with problematic SNS use.

The Present Study

The aim of this study is to shed light on the relationship between neuroticism and problematic SNS use by simultaneously testing the mediating role of FOMO and self-control. To our knowledge, no study has examined these mediating mechanisms together in a single model. To address this gap, we aim to account for the relationship between FOMO and self-control when examining their unique contribution in explaining the association between neuroticism and problematic SNS use. As problematic usage of SNS is quite prevalent, (Alzougool, 2018; Mamun & Griffiths, 2019; Turel et al., 2018), this will not only enhance our fundamental understanding of the relationship between personality traits and problematic SNS use but also pinpoint mechanisms that may be targeted by interventions to protect subpopulations of SNS users from engaging in problematic SNS use and associated declines in well-being. Moreover, the findings of this study are relevant for counsellors in order to evaluate and address excessive usage patterns of SNS among neurotic clients.

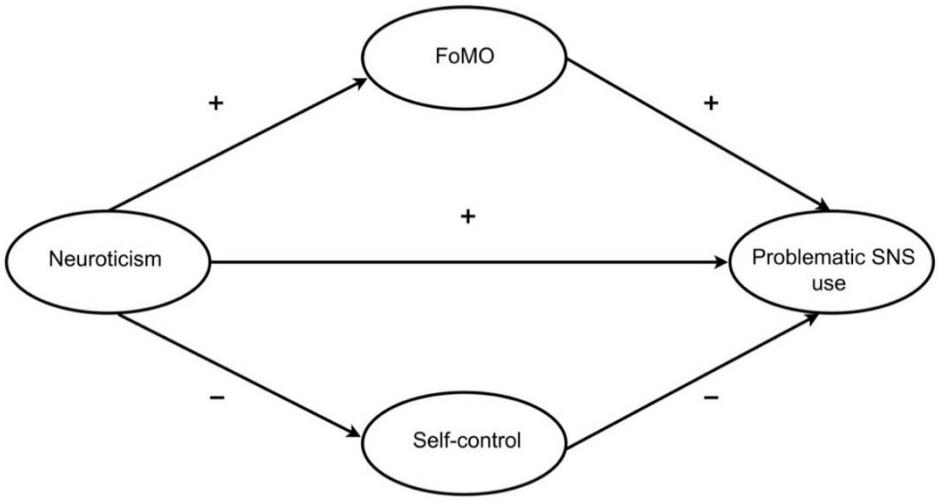
The conceptual model of the present study is displayed in figure 1. We formulated the following hypotheses:

H1: *Fear of missing out mediates the relationship between Neuroticism and Problematic SNS use.* This mediation pathway has never been directly tested but it is consistent with prior research showing that FoMO mediates the positive relationship between neuroticism and problematic WeChat use (Sindermann et al. (2021).

H2: *Self-control mediates the relationship between Neuroticism and Problematic SNS use.* This relationship has never been tested. However, past studies reveal that neuroticism is negatively related to self-control (Mao et al., 2018) and self-control is negatively associated with problematic SNS use (Brevers & Turel, 2019).

H3: *Fear of missing out and self-control have an independent explanatory effect when examined as parallel mediators of the relationship between neuroticism and problematic SNS use.* FoMO and self-control are separate constructs that are differentially related to problematic SNS use. Therefore, we expect both construct to independently contribute to explaining the relationship between neuroticism and problematic SNS use.

Figure 1. Conceptual Model of the Relation Between Neuroticism and Problematic SNS use Mediated by Fear of Missing Out and Self-control



Method

Participants

To recruit participants, we made use of a convenience sampling approach. Specifically, the study was advertised by posting a flyer of the study on several social media platforms (e.g., Facebook). Moreover, a research assistant contacted people in her social network asking them to participate in the study. The advantage of such a convenience sampling approach is that it allows to recruit participants in an efficient manner (Acharya et al., 2013). Participants were included if (a) they were 18 years or older and (b) used SNS. The latter was measured by asking participants to indicate: (1) whether they use SNS, but also (2) how much time they spent daily on SNS, and (3) which SNS apps they used most frequently. In total, 151 individuals (69.5% female) volunteered and participated in our

study. Their age ranged from 18 to 64 (average age = 28.26, SD age = 7.52). All participants reported having a SNS account. Most participants were German (49%), followed by "Other" (41%), and Dutch (10%). Most participants used SNS for 1–3 hours per day (46%), while others mentioned using SNS each day for 30 minutes to 1 hour (30%), less than 30 minutes (11%) or 3–5 hours (10%). Moreover, most participants used Facebook (77%), followed by Instagram (68%), YouTube (66%), LinkedIn (42%), and Snapchat (33%). The study complied with research ethical guidelines and was approved by the Ethics Review Committee of Maastricht University, Ethics Review Committee Code: 161_03_02_2016.

Furthermore, we conducted a sensitivity analysis to detect the range of effect sizes (two-tailed correlation) that our study could detect reliably, given our sample size, $\alpha = .05$, and 80% power. The results show that our study design is sufficiently powered to detect effect sizes of $|p| = 0.23$ and higher, which corresponds with prior research on the relationship between the constructs under consideration where typically correlations higher than .25 were reported (e.g., Balta et al., 2020; Błachnio & Przepiorka, 2016; Dempsey et al., 2019; Mao et al., 2018).

Procedure & Materials

Upon providing informed consent, participants completed an online questionnaire. This questionnaire consisted of demographic questions followed by a set of measurement scales including neuroticism, FoMO, self-control, and problematic SNS use. All questionnaires were fully completed by all participants.

Neuroticism

We measured neuroticism by the Big Five Inventory (BFI) by John and Srivastava (1999). This scale consists of eight items and asks participants to rate to what degree specific characteristics apply to them. Example items are: "Can be tense", "Can be moody", and "Is relaxed, handles stress well". All items were rated on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The average score of the scale was computed across the eight items for each participant. Reverse-scored items were recoded such that higher scores on this scale reflect higher levels of neuroticism. The Cronbach's alpha of this scale in the original study was .84 (John & Srivastava, 1999) and in the present study is .83.

Fear of Missing Out

To measure Fear of Missing Out, we used the Fear of Missing Out Scale (FOMOS) developed by Przybylski and colleagues (2013). This scale consists of ten items such as "I fear others have more rewarding experiences than me" and "I get anxious when I don't know what my friends are up to". Participants were instructed to answer whether, in general, these items reflect their everyday

experiences. All ten items were rated on a five-point Likert scale ranging from 1 (not at all true of me) to 5 (extremely true of me), and higher scores indicate higher levels of FoMO. The mean score of the scale was calculated across the ten items for each participant. The Cronbach's alpha for this scale in the original study was .87 (Przybylski et al., 2013) and in the present study is .84.

Self-control

Self-control was measured by the Brief Self-control Scale (BBSC) (Tangney et al., 2004) which contains thirteen items, such as "I am good at resisting temptation" and "I do certain things that are bad for me, if they are fun." Respondents were instructed to answer to what extent each of the statements reflects how they typically are. All items were rated on a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). We recoded reverse-scored items such that higher scores on this scale reflect higher levels of self-control and computed the mean score of the scale across all items. The Cronbach's alpha of this measure in the original study was .89 (Tangney et al., 2004) and in this study is .83.

Problematic SNS use

Problematic SNS use was measured by the six-item Bergen Social Media Addiction Scale (BSMAS) (Andreassen et al., 2017), which evaluates the six core aspects of addiction: salience, mood modification, conflict, withdrawal, tolerance, and relapse. Participants were instructed to answer how often a series of statements applied to them during the last year: e.g., "Felt an urge to use social network sites more and more" and "Spent a lot of time thinking about social network sites or planned use of social network sites". All items were rated on a five-point Likert scale, ranging from 1 (very rarely) to 5 (very often). Higher scores on this scale reflect higher levels of problematic SNS use. The mean score of the scale was calculated across six items for all participants. The Cronbach's alpha for this questionnaire in the original study was .88 (Andreassen et al., 2017), and in this study is.71.

Statistical Approach

We used R (version 4.0.3) to analyze the data. We first computed descriptive statistics and bivariate correlations among the main variables. Next, we examined the factorial structure of our main variables using the R package Lavaan v.0.6-7 (Rosseel, 2012) which allows to conduct confirmatory factor analysis. We used standard parameters for judging the goodness of fit, including the Chi Square test, Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR) (Hu & Bentler, 1999; R. B. Kline, 2012).

Finally, to test our hypotheses, we constructed structural equation models in Lavaan. Specifically, we first built a single mediation model to test whether FoMO mediates the relationship between neuroticism and problematic SNS use when self-control is not accounted for. Second, we examined a single mediation model to test whether self-control mediates this relationship when FoMO is not accounted for. Third, we built a parallel mediation model to capture the effects of multiple mediators in a single integrated model. Compared to single mediation models, parallel mediation models "allow a variable's effect to be transmitted to another through multiple mechanisms simultaneously" (Hayes, 2017, p. 147). Furthermore, in parallel mediation models, a specific indirect effect (e.g., the effect through FoMO) is estimated controlling for the other parallel mediators specified in the model. As such, by fitting a parallel mediation model we were able to take into account the correlation between FoMO and self-control (Hayes, 2017).

For the confirmatory factor analysis and mediation models, the bootstrapping technique (Preacher et al., 2007) was used across 1000 samples. Please note that both for confirmatory factor analysis and mediation models, we used Diagonally Weighted Least Squares estimation (DWLS) because this method is less biased for ordinal data (Mîndrilă, 2010). Moreover, when examining the relationship between our key constructs, we always controlled for the effect of gender and age on problematic SNS use.

Results

Descriptive Statistics and Correlations

Descriptive statistics for the main study variables, including the means, standard deviations, and correlations among them are displayed in the table 1. As expected, the relationship between neuroticism and problematic use of SNS was positive and significant.

Table 1. Descriptive Statistics and Correlations Between Age, Gender, SNS use frequency, Neuroticism, FoMO, Self-control, and Problematic SNS use

Variable	*M*	*SD*	2	3	4	5	6	7
1. Age	28.26	7.52	–.08	–.17*	–.19*	–.37**	.29**	–.32**
2. Gender[a]	1.71	0.47		.05	.27**	.08	.02	.18*
3. SNS use frequency	2.67	0.94			.21**	.32**	–.15	.42**
4. Neuroticism	2.86	0.77				.33**	–.43**	.33**
5. FoMO	2.25	0.70					–.38**	.46**
6. Self-control	3.07	0.68						–.32**
7. Problematic SNS use	2.13	0.66						

Note. * $p < .05$. ** $p < .01$. [a] 0 =male, 1 = female

The Structure of the Key Variables

Prior to testing our hypotheses, we examined the structure of our key variables (table 2). Specifically, we built four separate measurement models for neuroticism, FoMO, self-control, and problematic SNS use and utilized confirmatory factor analysis to check whether the hypothesized unidimensional models fitted our observed data well. All models except for self-control fitted data well. Specifically, the fourth item of the self-control scale, "I say inappropriate things," had a suboptimal loading (< .3). Therefore, we reran CFA without this item. After implementing this change, all items loaded well on one latent variable (self-control). As can be seen in the table 2, all measurement models fitted the data well.

Table 2. Goodness-of-fit Indicators of Models for Neuroticism, FoMO, Self-control, and Problematic SNS use

Model	χ^2 (df)	p	SRMR	TLI	CFI	RMSEA	90% CI	
							LL	UL
Neuroticism	13.460 (20)	.857	.054	1.017	1.00	.000	.000	.039
FoMO	43.712 (35)	.148	.077	.986	.989	.041	.000	.075
Self-control	53.352 (54)	.500	.070	1.00	1.00	.000	.000	.050
Problematic SNS use	9.611 (9)	.383	.057	.994	.996	.021	.000	.096
Mediation model: FMO	410.164 (295)	.000	.090	.95	.95	.051	.039	.063
Mediation model: Self-control	393.161(346)	.041	.085	.98	.98	.030	.007	.044
Mediation model: FoMO & Self-control	784.843 (658)	.000	.087	.97	.97	.036	.025	.045

Note. CI = Confidence interval; LL = Lower limit; UL = Upper limit.

Does FoMO Mediate the Relationship Between Neuroticism and Problematic SNS use?

Next, we built a simple mediation model with structural equation modelling to test whether FoMO mediates the relationship between neuroticism and problematic SNS use. Neuroticism was found to positively predict FoMO (B = .625, β = .420, SE = .185, p = .001). Moreover, FoMO positively predicted problematic SNS use (B = .360, β = .489, SE = .122, p = .003). Importantly, the indirect relationship between neuroticism and problematic SNS use through FoMO was significant (B = .225, β = .205, SE = .103, p = .029, 95% CI [.086, .481]). Moreover, the direct relationship between neuroticism and problematic SNS use was not significant (B = .255, β = .232, SE = .146, p = .080), further confirming the mediating role of FoMO. Finally, it is notable that the total relationship between neuroticism and problematic SNS use was significant (B = .480, β = .437, SE = .181, p = .008).

Does Self-Control Mediate the Relationship Between Neuroticism and Problematic SNS Use?

We built a second simple mediation model with structural equation modelling to test whether self-control mediates the relationship between neuroticism and problematic SNS use. Neuroticism was found to be negatively related to self-control (B = –.272, β = –.520, SE = .097, p = .005). However, self-control did not significantly predict problematic SNS use (B = –.428, β = –.319, SE = .320, p = .181). Consequently, the indirect relationship between neuroticism and problematic SNS use through self-control was only marginally significant (B = .116, β = .166, SE = .067, p = .081, 95% CI [.022, .283]). The direct relationship between neuroticism and problematic SNS use was also still marginally significant (B = .201, β = .287, SE = .116, p = .082). Finally, it is notable that the total relationship between neuroticism and problematic SNS use was statistically significant (B = .317, β = .453, SE = .124, p = .011).

Are Fomo and Self-Control Parallel Mediators of the Relationship Between Neuroticism and Problematic SNS use?

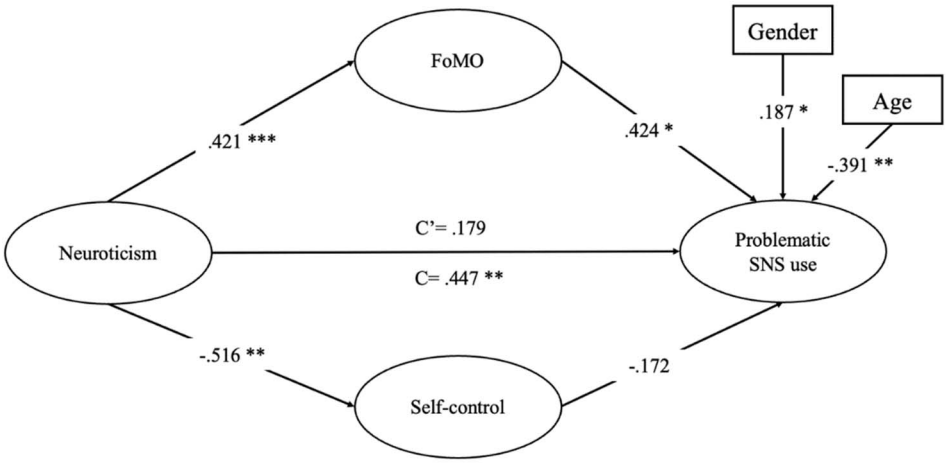
Finally, we built a parallel mediation model in Lavaan and examined whether the relationship between neuroticism and problematic SNS use was parallelly mediated via FoMO and self-control (table 3, figure 2).

Table 3. Covariances, Direct, Indirect, and Total Effects of Neuroticism on Problematic SNS use

Direct effects	***B***	***β***	***SE***	***p***
Gender → Problematic SNS use	.243	.187	.123	.049
Age → Problematic SNS use	–.031	–.391	.010	.001
Neuroticism → Problematic SNS use	.162	.179	.126	.199
Neuroticism → FoMO	.567	.421	.151	<.001
Neuroticism → Self-control	–.303	–.516	.097	.002
FoMO → Problematic SNS use	.285	.424	.124	.021
Self-control → Problematic SNS use	–.264	–.172	.299	.376
Indirect effects (Parallel mediation)				
FoMO	.162	.179	.081	.045
Self-control	.080	.089	.072	.267
Total effect				
Neuroticism → Problematic SNS use	.404	.447	.148	.006
Covariances				
FoMO – Self-control	–.086	–.321	.036	.017
Gender – Age	–.234	–.068	.248	.343

Neuroticism was found to be positively associated with FoMO (B = .567, β = .421, SE = .151, p < .001), and negatively associated with self-control (B = –.303, β = –.516, SE = .097, p = .002). In turn, FoMO was positively associated with problematic SNS use (B = .285, β = .424, SE = .124, p = .021) but the relationship between self-control and problematic SNS use was not significant (B = –.264, β = –.172, SE = .299, p = .376). With regard to indirect effects, FoMO was found to be a significant mediator of the relationship between neuroticism and problematic SNS use (B = .162, β = .178, SE = .081, p = *.045,* 95% CI [.053, .368]). However, self-control did not mediate the relationship between neuroticism and problematic SNS use (B = .080, β = .089, SE = .072, p = *.267,* 95% CI [–.062, .226]). The direct relationship between neuroticism and problematic SNS use was not significant (B = .162, β = .179, SE = .126, p = .199), suggesting full mediation. Finally, it is notable that the total effect of neuroticism on problematic SNS use was significant (B = .404, β = .447, SE = .148, p = .006).

Figure 2. FoMO and Self-control as Parallel Mediators of the Relationship Between Neuroticism and problematic SNS use



Note. Regression weights are standardized. C' is the direct effect of neuroticism on problematic SNS use. C is the total effect of neuroticism on problematic SNS use. Gender was coded as 0 = males, 1 = females. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Discussion

The aim of the present study was to examine the relationship between neuroticism and problematic SNS use by focusing on two underlying mechanisms that may explain this relationship: FoMO and self-control. First, we examined whether neuroticism predicts problematic SNS use and found this to be the case. This finding is consistent with the I-PACE model (Brand et al., 2019) which argues that maladaptive personality traits contribute to problematic usage patterns. Furthermore, this finding is also consistent with meta-analytic evidence revealing a consistent link between neuroticism and different types of problematic technology usage, including internet addiction (Kayiş et al., 2016), excessive use of smartphones, online gaming, and SNS (Marciano et al., 2020). More generally, our results are also consistent with prior research showing that people high in neuroticism engage in maladaptive coping strategies (Carver & Connor-Smith, 2010). However, we did not only describe the relationship between neuroticism and problematic SNS use but also attempted to explain it by examining the mediating role of FoMO and self-control.

Specifically, based on the I-PACE model (Brand et al., 2019) and the Fear Driven/Compensation Seeking Hypothesis (Wegmann & Brand, 2019), we expected that FoMO, which has both cognitive and affective components (Elhai et al., 2021; Przybylski et al., 2013; Wegmann et al., 2017) would act as a mediating mechanism in the relationship between neuroticism and problematic SNS use. In response to perceived social deficiencies, neurotic users would experience higher

levels of FoMO (e.g., rumination, fear of exclusion) and turn to excessive usage of SNS to compensate for lack of social relationships and relieve FoMO. In line with this theoretical reasoning, we found that FoMO explains (mediates) the relationship between neuroticism and problematic SNS use, regardless of whether the effect of self-control is controlled for. This finding is consistent with the results of prior studies demonstrating a mediating role of FoMO in the relationship between maladaptive predisposing variables and excessive use of technologies (e.g., Dempsey et al., 2019; Wegmann et al., 2017). Moreover, while Sindermann and colleagues (2021) demonstrated that FoMO mediates the relationship between neuroticism and problematic WeChat use, we extended these findings by demonstrating that the explanatory role of FoMO is not restricted to WeChat but holds for SNS more generally.

Next, based on the cognitive-behavioural model of generalized problematic internet use (Caplan, 2010), which argues that usage of SNS for mood regulation and preference for online interactions leads to failures in self-control, we expected that neurotic users would attempt to regulate negative moods and experience self-control failures. In turn, decreased self-control would contribute to excessive usage of SNS. However, self-control was not found to be a robust mediator of the relationship between neuroticism and problematic SNS use. The indirect relationship between neuroticism and problematic SNS use through self-control was only marginally significant and turned non-significant when controlling for the mediation effect of FoMO. As such, FoMO rather than self-control seems to be the key mechanism explaining the relationship between neuroticism and problematic SNS use.

Theoretical and Practical Implications

There is a growing public and scholarly concern that problematic SNS use has a negative impact on people's well-being in today's society. It is therefore of key importance to identify which populations are especially vulnerable to developing problematic SNS use. The present findings suggest that people who score high on neuroticism are at increased risk of developing problematic SNS use. This does not only enhance our fundamental understanding of user characteristics predicting problematic SNS use but also informs public health policy makers and counselors on which people are especially vulnerable towards developing problematic SNS use.

We also demonstrated that FoMO is a key mechanism connecting neuroticism to problematic SNS use. This finding increases our theoretical understanding of the mechanisms through which vulnerable populations may eventually develop problematic SNS use. Moreover, this finding may inform counselors how to help people high in neuroticism to engage with SNS in a healthy manner. Specifically, whereas interventions may not allow to fundamentally change someone's personality, public health policy makers and counselors could focus their efforts

on reducing FoMO to protect people from problematic SNS use. In this regard, the FoMO Reduction (FoMO-R) approach (Alutaybi et al., 2020) holds promising potential by offering specific strategies, such as using checklists and self-talk to reduce FoMO on SNS. Another promising avenue with regards to FoMO management pertains to mindfulness-based interventions (Weaver & Swank, 2021).

Limitations and Future Research

The present study extended our understanding of the relationship between neuroticism and problematic SNS but a number of limitations should be noted. First, due to the cross-sectional design of the study, it is not possible to make conclusions on causal effects. Second, we measured problematic SNS use via self-report measures. Future research should consider using objective measures as more ecologically valid alternatives for measuring problematic usage of SNS (Ryding & Kuss, 2020b). Third, the participant sample consisted mainly of young female SNS users. Given that female users are more inclined to engage in problematic SNS use (Su et al., 2020), research on problematic SNS use in women is highly important. However, future studies having a good gender balance are necessary, especially as males are typically underrepresented in social media research (Cheng et al., 2021). Moreover, future studies are needed to identify additional mechanisms which play a mediating role between neuroticism and problematic use of SNS. Lastly, our study focused on neuroticism which is associated with low social competence and negative emotions. However, Wegmann and colleagues (2019) suggest that socially integrated users are also at risk of developing problematic SNS usage patterns. These users can be reward-driven, and mechanisms such as positive feedback on SNS (e.g., likes) can positively reinforce excessive usage patterns. In this context, it would be relevant to investigate the predisposing role of extraversion because extraverted users are highly sociable and reward-seeking (Costa & McCrae, 1992), and often use SNS for pleasurable experiences (A. Chen & Roberts, 2019).

Conclusion

In the present study, we found that people high in neuroticism more often suffer from problematic SNS use. Moreover, neuroticism was found to be related to both high levels of FoMO and low levels of self-control but only FoMO was found to be a robust mediator of the relationship between neuroticism and problematic SNS use**.** This suggest that FoMO might be a good intervention target to protect people from engaging in problematic SNS use and associated negative consequences.

CHAPTER 7

Two dimensions of problematic smartphone use mediate the relationship between fear of missing out and emotional well-being

Based on: Gugushvili, N., Täht, K., Rozgonjuk, D., Raudlam, M., Ruiter, R.A.C., & Verduyn, P. (2020). Two dimensions of problematic smartphone use mediate the relationship between fear of missing out and emotional well-being. *Cyberpsychology: Journal of Psychosocial Research on Cyberspace*, *14*(2). https://doi.org/10.5817/CP2020-2-3

Abstract

It has been shown that both fear of missing out (FoMO) and problematic (i.e., excessive) smartphone use (PSU) are negatively associated with indicators of emotional well-being. Moreover, FoMO has been found to be a key predictor of PSU. This suggests that PSU may mediate the relation between FoMO and decreased emotional well-being but this pathway has never been tested. Moreover, in most studies on PSU, the multidimensional nature of this construct has been ignored. The aim of the present study was to address these gaps by directly testing the mediating role of (subdimensions of) PSU in the association between FoMO and emotional well-being. We conducted a cross-sectional study with Estonian participants (n = 426). Using a simple mediation analysis, we found that PSU partially mediated the relationship between FoMO and decreased emotional well-being. Using a parallel mediation analysis, we found that two specific dimensions of PSU were significant mediators of the relationship between FoMO and decreased emotional well-being: Cyberspace-oriented Relations and Physical Symptoms. This suggests that the negative relationship between FoMO and decreased emotional well-being is due to FoMO stimulating (a) online relationships at the cost of offline interactions and (b) Physical symptoms associated with excessive smartphone use. Overall, this study provides a fine-grained analysis of the relationship between FoMO, PSU and emotional well-being.

Keywords: fear of missing out, problematic smartphone use, emotional well-being, cyberspace-oriented relationships, physical symptoms

Shortly after the introduction of smartphones on the global market, their ownership has increased drastically (Pew Research Center, 2018). Currently, more than two billion people possess a smartphone (Takahasi, 2018) and they spend on average nearly three hours on their smartphone each day using it for accessing social network sites, watching videos, shopping and searching information amongst others (ComScore, 2017; Ofcom, 2018). These compact devices offer important benefits to users in various domains, including healthcare (Camacho et al., 2014), education (Godwin-Jones, 2011), and social communication (Chan, 2015).

However, smartphone usage may also have negative consequences. Specifically, excessive smartphone usage, often labeled in the literature as problematic smartphone use (PSU), is associated with negative outcomes such as decreased productivity (Duke & Montag, 2017), low academic achievement and distraction from the learning process (Lepp et al., 2014; Rozgonjuk, Kattago, et al., 2018; Rozgonjuk, Saal, et al., 2018; Samaha & Hawi, 2016), and low quality communication in social settings (Vanden Abeele et al., 2016). Perhaps most importantly, PSU has also been found to be associated with decreased mental health and emotional well-being (Elhai, Tiamiyu, et al., 2018; Elhai et al., 2019; Rozgonjuk, Levine, et al., 2018).

PSU is predicted by a wide range of individual characteristics including age and personality traits (Blackwell et al., 2017; Hussain et al., 2017). One person-characteristic that has consistently been found to be a predictor of PSU is fear of missing out (FoMO) (Alt, 2015; Błachnio & Przepiórka, 2018; Dhir et al., 2018; Scott & Woods, 2018). Moreover, both FoMO (Baker et al., 2016; Elhai, Rozgonjuk, et al., 2020; Milyavskaya et al., 2018; Reer et al., 2019; Tsai et al., 2019) and PSU are directly linked to decreased emotional well-being (Augner & Hacker, 2012; Demirci et al., 2015; Harwood et al., 2014; Smetaniuk, 2014).

This pattern of findings suggests that PSU may mediate the relationship between FoMO and emotional well-being. However, this mediation pathway has never been directly tested. Moreover, despite that PSU is well-known to be a multidimensional construct (Ching et al., 2015; Kwon et al., 2013; Rozgonjuk et al., 2016), it is typically studied as a one-dimensional construct. As such, it is not clear which subdimensions of PSU are the key mediators explaining the relationship between FoMO and emotional well-being.

The aim of the present study was to address these gaps by directly testing the mediating role of (subdimensions of) PSU in the association between FoMO and emotional well-being. This is important as this increases our understanding of person-level risk factors that drive problematic usage of smartphones and associated negative emotional consequences. Moreover, the present study is directly relevant for the growing public concern regarding FoMO and PSU (Barkan, 2019; Barker, 2016; Brueck & Lee, 2018; Twenge, 2019) which is addressed in national (Chassiakos et al., 2016; Davie & Firth, 2019; Ponti et al., 2017) and international guidelines (World Health Organization, 2019). As such, the present study is a

direct response to calls for "more and better research" to facilitate the development of evidence-based evaluation, prevention and intervention tools (Ashton & Beattie, 2019; Davie & Firth, 2019).

To realize our study aims, we conducted a cross-sectional study and ran simple and parallel mediation analyses to test whether (subdimensions of) PSU mediate the relationship between FoMO and emotional well-being. We tested this pathway in a sample of Estonian participants. It is notable that Estonia is one of the technologically most advanced and digitalized societies worldwide (Heller, 2017) with 88% of Estonian residents using the internet on a daily basis and 73% of them accessing the internet via smartphones (Statistics Estonia, 2018).

In the next sections, we will first define and discuss the three key constructs of the present manuscript in more detail: FoMO, PSU, and emotional well-being. Next, we will discuss the relationship between these constructs on a theoretical and empirical level. Finally, the specific goals and hypotheses of the present study will be described.

Key Constructs

Fear of Missing out (FoMO)

FoMO refers to the "pervasive apprehension that others might be having rewarding experiences from which one is absent" (Przybylski et al., 2013, p. 1841). FoMO has been predominantly explored in digital settings where it has been related to problematic usage of technologies including smartphones, social network sites, and the internet more generally (Chotpitayasunondh & Douglas, 2016; Oberst et al., 2017; Wolniewicz et al., 2018). It is assumed that one of the main characteristics of FoMO is the urge to constantly keep in touch and monitor what other friends are doing (Przybylski et al., 2013).

Browne and colleagues (2018) reported various socio-emotional correlates of FoMO including negative affect, rejection sensitivity, and high stress levels. Moreover, FoMO has been found to be associated with a wide range of unsatisfied psychological needs including basic needs such as autonomy (i.e., the intrinsic need for volition), competence (i.e., the intrinsic need to be efficient in one's environment), relatedness (i.e., the intrinsic need for interpersonal connections) (Przybylski et al., 2013; Xie et al., 2018), and need for approval (Browne et al., 2018; Lai et al., 2016).

Problematic Smartphone use (PSU)

PSU is defined as the excessive use of smartphone devices, which significantly disturbs and interferes with everyday life (Billieux, Maurage, et al., 2015). Moreover, PSU is often conceptualized within the frame of addiction models (Billieux et al., 2015). Specifically, it is assumed that it shares many similarities with other types of behavioral addictions but is less acute than addiction disorders (Panova & Carbonell, 2018).

It is notable that in addition to PSU, several other terms have been used to refer to excessive smartphone use including smartphone overuse (Ding & Li, 2017; Inal et al., 2015), smartphone addiction (Kwon et al., 2013; Y. H. Lin et al., 2014), smartphone addiction proneness (D. Kim et al., 2014) or simply excessive smartphone use (J. Chen et al., 2016). However, to avoid confusion, we will use the term *problematic smartphone use* (PSU) consistently throughout the paper as proposed by Panova and Carbonell (2018).

PSU consists of several dimensions (Ching et al., 2015; Kwon et al., 2013): (a) Tolerance – the constant need to use a smartphone and the inability to control usage of the device; (b) Positive Anticipation – the presence of overly positive expectations about smartphone use, such as having fun or alleviating boredom; (c) Cyberspace-oriented Relationships – the preference for online friendships over face-to-face friendships; (d) Withdrawal – states of impatience, irritation and negative affect when being interrupted during smartphone usage; (e) Physical Symptoms – also known as the daily-life disturbance dimension referring to feelings of exhaustion, lack of sleep and neck pain caused by the overuse of smartphones (Kwon et al., 2013; Rozgonjuk et al., 2016).

Emotional Well-Being

Emotional well-being is defined as "a composite of positive affect and negative affect that ebbs and flows and has a momentary character reflecting a person's emotional status quo at any given time" (Eid & Larsen, 2008, p. 259) High levels of emotional well-being consist of low levels of negative affective states, such as depressive mood, anger, sadness, or anxiety, and high levels of positive affective states, such as joy, fascination, happiness, optimism, or cheerfulness (Fredrickson & Joiner, 2002; Kahneman & Deaton, 2010). People also differ in trait-levels of emotional well-being as reflected by inter-individual differences in average levels of positive and negative affect (Fredrickson & Joiner, 2002; Larsen, 2009).

High levels of emotional well-being imply that people feel good, which in and of itself is an important outcome. However, emotional well-being is also associated with other crucial outcomes such as increased physical health (Lamers et al., 2012) or productivity (Oswald et al., 2015), which further underscores the importance of research on determinants of emotional well-being. Finally, it is notable that emotional well-being is a key component of the broader construct of subjective well-being (Larsen, 2009).

Recent research investigating the relation between digital communication and subjective well-being has increasingly focused on this emotional aspect of subjective well-being. For example, there is cross-sectional and longitudinal evidence indicating that emotional well-being is associated with and affected by usage of modern technologies, such as smartphones and social network sites and the nature of this association is negative (Contractor et al., 2017; H. J. Kim et al., 2019; Verduyn et al., 2015a). Psychological mechanisms such as negative social comparisons (Verduyn et al., 2017), envy (Tandoc et al., 2015), boredom (Elhai, Vasquez, et al., 2018) and sleep disturbance (Lemola et al., 2015) have been proposed to explain the negative associations between digital screen usage and emotional well-being.

The Relation Between the key Constructs

The I-PACE Model

In order to explain why some people engage in technology usage and why it sometimes further develops into problematic behavior, we make us of the Interaction of Person – Affect – Cognition – Execution (I–PACE) model of behavioral addictions (Brand et al., 2019). I–PACE was originally developed as a framework to understand the development and maintenance processes of specific internet-use addictions (Brand et al., 2016), but due to the similarities with problematic usage patterns of technologies, it has been extended to research on problematic social media use (Kircaburun et al., 2018) and problematic use of smartphones as well (Duke & Montag, 2017) such that nowadays the model is being used in the context of a wide range of modern technologies (Brand et al., 2019).

The I–PACE model assumes that the development of problematic smartphone use is a multileveled process, preceded by certain psychological and neurobiological factors that underlie and eventually drive individuals to problematic usage. Wegmann et al. (2017) have suggested that the trait FoMO is one of such antecedents. Moreover, the I–PACE model posits that consequences from heavy usage of technology include negative long-term impacts for global well-being, such as losing control over behavior, loneliness, isolation, and conflicts (Brand et al., 2016, 2019).

Empirical Findings

The path between FoMO and PSU as suggested by the I–PACE model is empirically well established. In cross-sectional and experimental studies, positive connections have been found between FoMO and general and problematic types of smartphone usage (Adelhardt et al., 2018; Elhai et al., 2016; Elhai, Levine, et al., 2018; Franchina et al., 2018). However, it is noteworthy that in all these studies

PSU was examined as a unidimensional construct. Moreover, there is ample evidence which indicates that FoMO is directly and significantly associated with many adverse outcomes, including diminished emotional well-being (Burnell et al., 2019; Wolniewicz et al., 2020), and life satisfaction (Błachnio & Przepiórka, 2018; Przybylski et al., 2013).

Similarly, a considerable body of literature has examined the path from PSU to negative psychological outcomes, as also hypothesized by the I–PACE model. Specifically, two recent systematic reviews demonstrate that PSU is consistently associated with diminished emotional well-being (Elhai, Dvorak, et al., 2017; Vahedi & Saiphoo, 2018). Moreover, PSU is related to social anxiety (E. B. Lee, 2015; Y.-K. Lee et al., 2014), sleep problems and stress as well (Lemola et al., 2015; Thomée et al., 2011). Thus, empirical findings are in accordance with the I–PACE model.

In most of these studies PSU was examined as a unidimensional construct but in a number of studies, the relation between specific dimensions of PSU and various indicators of subjective well-being, including emotional well-being, has also been examined. While social anxiety was found to be related to all dimensions of PSU (Darcin et al., 2015), other studies indicate that relationships may be dimension specific. Specifically, a study by Lee and colleagues (2018) demonstrated a positive relation between the dimension "Cyberspace-oriented Relationships" and interpersonal competence. In contrast, Darcin and colleagues (2015) found that this dimension was positively related to higher levels of loneliness. There is also evidence that there is a positive relation between the dimension "Positive Anticipation" of PSU and non-social usage of smartphones (Elhai, Hall, et al., 2017), which in turn is associated with decreased emotional well-being (Elhai, Levine, et al., 2017). As such, first evidence is available that the relation between PSU and outcome variables may differ across PSU dimensions.

The Present Study

Addressing the limitations of prior research, in the present study we examine whether (subdimensions of) PSU mediate the relation between FoMO and emotional well-being. First, we will investigate whether PSU mediates the relationship between FoMO and diminished emotional well-being, treating PSU as a unidimensional construct (see Figure 1). Second, we will employ a more fine-grained approach and examine which dimension(s) of PSU mediate the relation between FoMO and emotional well-being, treating PSU as a multidimensional construct (see Figure 2). It is notable that we will specifically focus on negative indicators of emotional well-being, as negative affective states impact overall emotional well-being more strongly than positive ones (Eid & Larsen, 2008). Based on the previous empirical findings and the theoretical assumptions of the I–PACE model we expect that:

H1: *FoMO positively predicts (subdimensions of) PSU*. This hypothesis is based on previous research indicating that FoMO is positively related to the overuse of social media (Franchina et al., 2018) and smartphones (Chotpitayasunondh & Douglas, 2016).

H2: *FoMO predicts diminished emotional well-being*. This hypothesis is based on prior studies demonstrating a significant negative relation between FoMO and various indicators of overall well-being (Błachnio & Przepiórka, 2018; Przybylski et al., 2013).

H3: *(Subdimensions of) PSU predicts diminished emotional well-being*. There is already substantial evidence that links PSU to decreased emotional well-being (Elhai, Dvorak, et al., 2017; Vahedi & Saiphoo, 2018).

H4: *(Subdimensions of) PSU mediate the association between FoMO and decreased emotional well-being*. This mediation path has never been tested directly before but, relatedly, Dhir and colleagues (2018) found that the relation between FoMO and negative affective outcomes, such as social media fatigue, was indirect and mediated by overuse of social media.

We will test the mediating role of specific dimensions of PSU in an exploratory manner as previous research on specific dimensions of PSU has yielded mixed results (Darcin et al., 2015; S. Lee et al., 2018). We, therefore, formulate the following research question:

RQ1: Which dimension(s) of PSU mediate the relationship between FoMO and emotional well-being?

To test our hypotheses, we conducted a cross-sectional study asking participants to complete standard questionnaires assessing our key constructs: FoMO, PSU, and emotional well-being.

Figure 1. Conceptual model of relation between FoMO and Emotional well-being mediated by PSU (unidimensional)

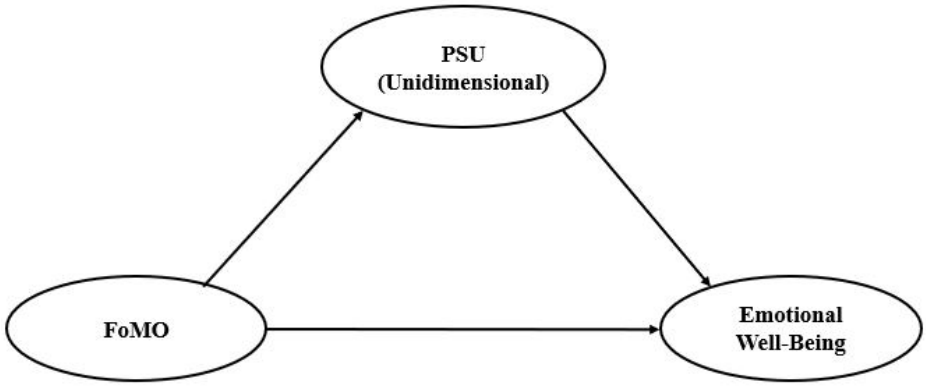
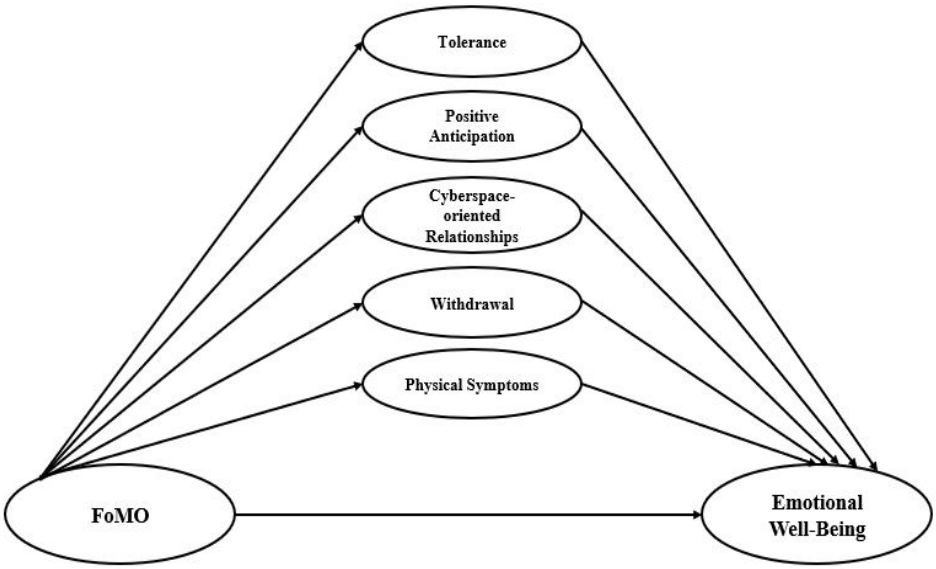


Figure 2. Conceptual model of relation between FoMO and Emotional well-being mediated by the five dimensions of PSU



Method

Participants

Our aim was to reach at least 300 participants as this number is common in research on PSU (Elhai, Vasquez, et al., 2018; Rozgonjuk, Kattago, et al., 2018; Rozgonjuk, Levine, et al., 2018; Rozgonjuk, Saal, et al., 2018; Wolniewicz et al., 2020) and ensures that our study has sufficient statistical power to detect small (r = .20) as well as larger effects (Cohen, 1988). Eventually, a sample of 426 Estonian participants volunteered and filled out the questionnaires. Most participants were female (77%). Age ranged from 18 to 56 years (M_{age} = 26.74, SD = 8.16). The majority of participants (93%) indicated Estonian as their native language, while 7% selected "other language". The majority of participants (47.7%) were student, 25.8% was employed and 26.3% were student and employed; one person (0,2%) did not to respond to this question. Finally, 52.5% of the participants held a high school diploma, 5.2% held an applied higher education diploma, 21.9% had obtained an undergraduate degree, 16.2% a master degree, and 4.2% a doctoral degree.

Procedure

We used convenience sampling technique to recruit the participants. Questionnaires were distributed online among Estonian employees and university students and included bachelor, master and doctoral students from a wide range of disciplines. They were contacted through the universities' mailing lists or through Facebook and were asked to fill out a series of questionnaires online. The survey period lasted from January 2018 to March 2018. Participants took part in the study on a voluntary basis and completed the questionnaires at home. All questionnaires were in the Estonian language. Participants completed the informed consent form online and were guaranteed permission to withdraw from the study at any time. To ensure anonymity, we replaced the emails of participants with a pseudo-identifier (code consisting of randomly generated characters). Moreover, all procedures were in compliance with the Declaration of Helsinki (World Medical Association, 2014) which outlines ethical principles and serves as a guideline for conducting research with human subjects.

Measures

Demographic Questions

The demographic questionnaire consisted of five questions assessing gender, age, highest attained level of education (secondary, professional, applied higher education, bachelor, master, doctoral levels), main occupational status (employed, unemployed, student, employed/student), and native language (Estonian/Other).

The Estonian Smartphone Addiction Proneness Scale

The Estonian Smartphone Addiction Proneness Scale, E–SAPS18 (Rozgonjuk et al., 2016) is based on the Smartphone Addiction Scale (SAS) by Kwon and colleagues (Kwon et al., 2013) and consists of 18 items. It can be used either as a unidimensional or a multidimensional scale and has been demonstrated to have sound psychometric properties (see table 1 for the dimensions, items, and Cronbach's alphas from the original study of E-SAPS 18).

When used as a multidimensional scale it encompasses five different dimensions of problematic smartphone usage: (a) Tolerance – referring to the inability to control smartphone usage (6 items, including "Having tried time and again to shorten my smartphone use time, but failing all the time"); (b) Positive Anticipation – referring to feelings of excitement when using a smartphone and feelings of emptiness when not being able to do so (3 items, including "There is nothing more fun to do than using my smartphone"); (c) Cyberspace-oriented Relationships – referring to a preference for online communication over face-to-face interactions (3 items, including "Feeling that my smartphone buddies understand

me better than my real life friends"); (d) Withdrawal – referring to states of impatience, intolerance and irritation that arise due to the inability to use a smartphone or when one is being interrupted while using a smartphone (3 items, including "Feeling impatient and fretful when I am not holding my smartphone"); and (e) Physical Symptoms – referring to smartphone related physical complaints such as pain in the wrists, neck, blurred vision, and disturbed sleep (3 items, including "Feeling tired and lacking adequate sleep due to excessive smartphone use"). The names of the dimensions are mainly based on the Smartphone Addiction Scale – SAS (Kwon et al., 2013).

All items were rated on a six-point Likert scale, ranging from 0 (*Strongly Disagree*) to 5 (*Strongly Agree*). Participants were instructed to indicate to what extent these statements currently apply to them. Cronbach's alpha for PSU as a unidimensional construct for the present study is equal to .89. Cronbach's alpha's for PSU as a multidimensional construct for the present study: Tolerance (.87); Positive Anticipation (.69); Cyberspace-oriented Relationships (.75); Withdrawal (.76); Physical Symptoms (.69).

Table 1. Dimensions, items and Cronbach's alphas from the original study of E-SAPS 18

Dimension		Cronbach's α
	Unidimensional	**.87**
	Tolerance dimension	**.82**
E1	Always thinking that I should shorten my smartphone use time	
E2	Having tried time and again to shorten my smartphone use time, but failing all the time	
E3	Feeling the urge to use my smartphone again right after I stopped using it	
E4	The people around me tell me that I use my smartphone too much	
E5	Missing planned work due to smartphone use	
E6	Using my smartphone longer than I had intended	
	Positive Anticipation dimension	**.71**
E7	There is nothing more fun to do than using my smartphone	
E8	My life would be empty without my smartphone	
E9	Using a smartphone is most fun thing to do	
	Cyberspace-oriented Relationships dimension	**.74**
E10	Feeling that my smartphone buddies understand me better than my real-life friends	
E11	Feeling that my relationships with my smartphone buddies are more intimate than my relationships with my real-life friends	
E12	Preferring talking with my smartphone buddies to hanging out with my real-life friends or with the members of my family	
	Withdrawal dimension	**.76**
E13	Won't be able to stand not having a smartphone	
E14	I will never give up using my smartphone even when my daily life is already greatly affected by it	
E15	Feeling impatient and fretful when I am not holding my smartphone	
	Physical Symptoms dimension	**.68**
E16	Feeling pain in wrists or at the back of the neck while using smartphone	
E17	Experiencing lightheadedness or blurred vision due to excessive smartphone use	
E18	Feeling tired and lacking adequate sleep due to excessive smartphone use	

The Fear of Missing out (FoMO) Questionnaire

The measure of FoMO is unidimensional and includes ten items. Example items are: "I get worried when I find out my friends are having fun without me" and "I fear others have more rewarding experiences than me". Respondents rate items on a five-point Likert scale, from 0 (*not at all true of me*) to 4 (*extremely true of me*). Participants were instructed to answer to what extent the statements generally apply to them. Cronbach's alpha for this measure in the present study is equal to .78. In order to translate and validate this scale in Estonian, the following steps were taken. First, forward and back-translation procedures were applied. Second, to validate the translation, a native speaker compared the original scale with the translated version and checked for possible incongruencies. Third, the final version of the Estonian FoMO questionnaire was tested for test-retest reliability and was administered twice (n=178). The one-month test-retest reliability in the original study reached .77 and Cronbach's alpha was .79 (Raudlam, 2018).

Emotional Well-Being Questionnaire

Emotional well-being was measured by the Emotional State Questionnaire (Aluoja et al., 1999; Ööpik et al., 2006) which assesses the experience of a range of negative emotional states including depressive mood, anxiety, social anxiety, panic, and fatigue. This scale was developed by Estonian researchers (Aluoja et al., 1999), is widely used in Estonia (Dobewall et al., 2018; Kaare et al., 2009; Karelson et al., 2013), and has been shown to have sound psychometric properties with Cronbach's alpha of .88 (Aluoja et al., 1999).

Participants were instructed to rate the intensity and frequency of disturbing experiences during the last month, such as "tension, or inability to relax", "sadness", "feeling of anxiety and fear", on a five-point scale, from 0 (*not at all*) to 4 (*constantly*). We reversed the scores on this scale such that higher scores reflect higher levels of emotional well-being and the absence of mood related problems. Cronbach's alpha for this scale in the present study is .94.

Data Analysis

RStudio version 3.2.3 (R Core Team, 2013) was used for analyzing the data. First, we calculated basic descriptive statistics for the assessed constructs. We applied Spearman's rank order correlation to compute bivariate relationships between the variables, as the items of PSU, FoMO and emotional well-being were not distributed normally and were positively skewed (see Table 2 for Skewness and Kurtosis values).

Next, we examined the factorial structure of the assessed variables. For this purpose, we conducted a confirmatory factor analysis using the R package Lavaan (Rosseel, 2012). We applied Diagonally Weighted Least Squares estimation

(DWLS), because it has been shown to be less biased and more accurate than similar estimation methods (e.g., robust maximum likelihood, or MLR) for the ordinary data type (Mîndrilă, 2010). Goodness of fit was judged by standard parameters: (a) Comparative Fit Index (CFI), (b) Tucker–Lewis Index (TLI), (c) root mean square error of approximation (RMSEA), d) Standardized Root Mean Square Residual (SRMR), and e) Chi-square test. The following cutoff values were used to assess the goodness of fit of the models: higher than .90 for TLI, higher than .95 for CFI, .06 or less for RMSEA, and .08 or less for SRMR (Brown, 2006; Hooper et al., 2008; Hu & Bentler, 1999; Schreiber et al., 2006).

Next, to test our hypotheses we ran simple and parallel mediation analyses using the R package Lavaan (Rosseel, 2012), where (a) the latent score of FoMO was supposed to predict the latent score of (subdimensions of) PSU (H1), (b) the latent score of FoMO was supposed to predict the latent score of emotional well-being (H2), (c) the latent score of (subdimensions of) PSU were supposed to predict the latent score of emotional well-being (H3), and (d) the latent score of (subdimensions of) PSU were supposed to mediate the relation between the latent score of FoMO and the latent score of emotional well-being (H4). We used bootstrapping technique across 1000 samples and applied the abovementioned standard indices and cutoff scores to judge the goodness of fit of the models.

Results

The descriptive statistics for the assessed variables are presented in Table 2. We found that all dimensions of PSU were significantly associated with both FoMO and emotional well-being. The effect size of these associations is medium (Cohen, 1988).

Table 2. Descriptive statistics and correlations between averaged scores of PSU (unidimensional), dimensions of PSU, FoMO and emotional well-being

	Mean	SD	Skewness	Kurtosis	2	3	4	5	6	7	8
1. PSU: Problematic Smartphone use	1.03	0.62	0.49	–0.21	.92	.79	.72	.87	.85	.42	–.47
2. PSU: Tolerance	1.79	1.04	0.38	–0.55		.59	.48	.40	.77	.34	–.39
3. PSU: Positive Anticipation	0.47	0.63	1.72	3.18			.82	.85	.63	.35	–.36
4. PSU: Cyberspace-oriented Relationships	0.58	0.74	1.42	1.96				.74	.57	.38	–.42
5. PSU: Withdrawal	1.33	0.96	0.57	–0.08					.65	.36	–.39
6. PSU: Physical Symptoms	1.00	0.92	0.82	–0.04						.39	–.46
7. Fear of Missing out	1.28	0.6	0.75	0.12							–.42
8. Emotional Well-Being	2.84	0.65	–0.77	0.60							

Note. All correlations are significant at $p < .001$ level.

The Structure of FoMO, PSU, and Emotional Well-Being

Before testing our hypotheses, we tested the measurement models of FoMO, PSU and emotional well-being to examine whether items loaded on their respective scales. For this purpose, we ran a series of confirmatory factor analyses (see Table 3 for fit indices of all measurement models).

First, we examined the structure of the FoMO questionnaire. Specifically, we built a model where FoMO was considered as a latent variable and 10 items as observed variables. This model, however, did not show adequate fit. The modification indices indicated that the first two items of the scale: "I fear that my friends have more rewarding experiences in their lives than me" and "I fear others are having more rewarding experiences than me" were highly correlated with each other. Therefore, we allowed an inter-correlation between these two items which improved the goodness of fit of the model (see top Table 3). It is notable that removing one of the two items (rather than allowing for an inter-correlation) let to the same results and does not modify any conclusion reported in the paper.

Second, we investigated the factorial structure of PSU. One item ("There is nothing more fun to do than using my smartphone") hardly showed any variance and this item was therefore excluded from all further analyses. We examined the fit of a five-dimension model where all items loaded on their respective scale, as well as a unidimensional model where the five factors loaded on one higher order factor. Both models fitted our data very well (see the middle section of Table 3), and is consistent with the five-dimensional structure of the PSU scale obtained in an earlier study in an Estonian sample (Rozgonjuk et al., 2016).

Finally, we examined the structure of the emotional well-being scale, where all items were expected to load on one latent variable. The model demonstrated also a good fit (see bottom Table 3).

Table 3. Fit indices of measurement models for FoMO, PSU, five-dimensional PSU and Emotional Well-being

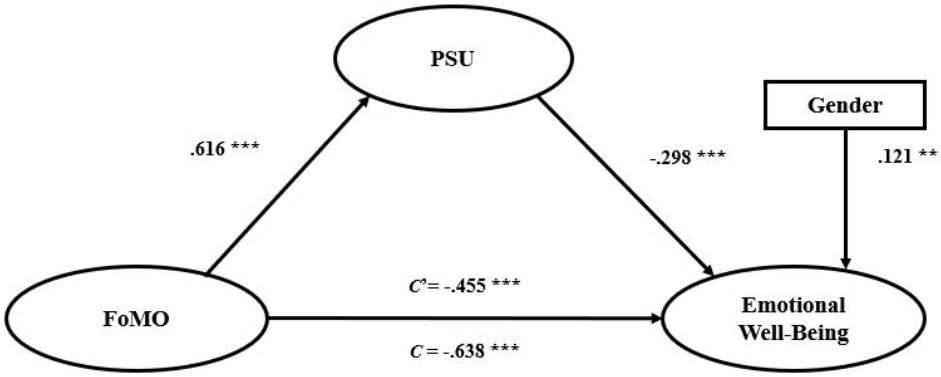
	Model	Dimensions	$\chi 2$	*p*	SRMR	TLI	CFI	RMSEA	90% CI	
									LL	UL
1	FoMO	One	80.437(34)	< .001	.065	.95	.96	.058	.042	.075
2	PSU	One	338.47(104)	< .001	.061	.98	.99	.04	.03	.05
		Five	118.36(109)	.25	.049	.99	.99	.015	.00	.03
3	EWB	One	532.528(350)	< .001	.072	.99	.99	.036	.030	.042

Note. PSU = Problematic smartphone use; EWB = Emotional well-being; CI = confidence interval; LL = lower limit; UL = upper limit.

The Relation Between Fomo, PSU, and Emotional Well-Being

To test our hypotheses and answer our research question, we ran two mediation analyses. First, we built a structural model where PSU was treated as a one-dimensional construct supposed to mediate the relation between FoMO and emotional well-being (see Figure 3). We added gender to the model to control for its effect on emotional well-being. We used a bootstrapping procedure across 1000 samples to test the indirect effects. Fit indices of the mediation model were very good: CFI = .98 and TLI = .98, SRMR = .066, RMSEA = .036, 90% CI [.032, .039]. FoMO significantly predicted PSU, B = .625, β =.616, SE = .110, $p < .001$. Further, FoMO significantly predicted diminished emotional well-being B = –.492, β = –.455, SE = .076, $p < .001$. PSU also significantly predicted decreased emotional well-being B = –.317, β = –.298, SE = .086, $p < .001$. Finally, PSU accounted for the association between FoMO and emotional well-being, when controlling for gender. The indirect effect of FoMO on emotional well-being through PSU was significant B = –.198; β = –.183, SE = .056, p =.001. The direct path (c') from FoMO to diminished emotional well-being also remained significant, reflecting a partial mediation effect B = –.492, β = –.455, SE = .076, p =.001.

Figure 3. PSU (unidimensional) as a significant mediator of the relationship between FoMO and emotional well-being (controlling for gender)

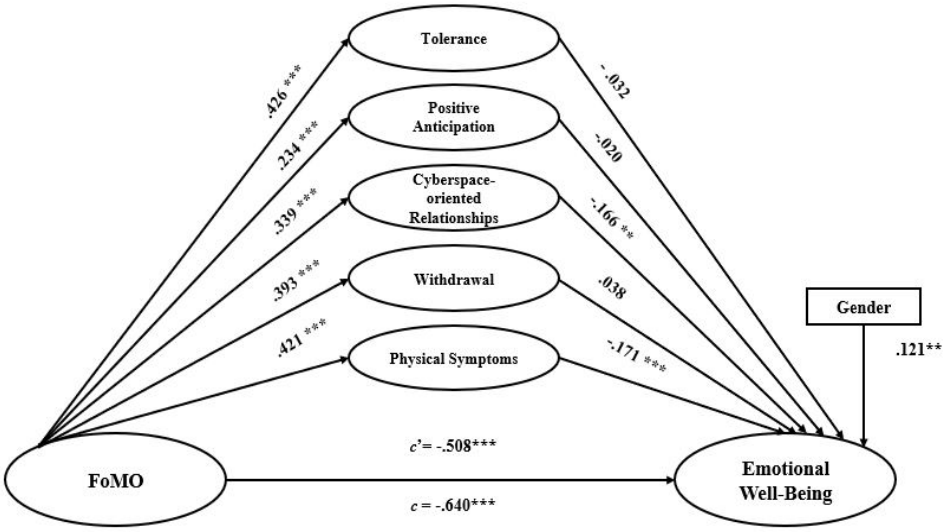


Note. Regression weights are standardized. C' is the direct effect of FoMO on emotional well-being; C is the total effect of FoMO on emotional well-being.

Next, we fitted a model where the five dimensions of PSU mediated the relationship between FoMO and emotional well-being (see Figure 4). We used again a bootstrapping procedure across 1000 samples to test the indirect effects. Gender was added in the model to control for its effect on emotional well-being. Fit indices of the model were good: CFI = .98 and TLI = .98, SRMR = .068, RMSEA = .038, 90% CI [.034, .042]. The relationship between FoMO and emotional well-being was mediated by two dimensions of PSU: Cyberspace-

oriented Relationships and Physical Symptoms. Other paths in this structural model were statistically non-significant (see Figure 4 and Table 4).

Figure 4. PSU (multidimensional: all five dimensions) as a mediator of the relationship between FoMO and emotional well-being (after controlling for gender)



Note. Regression weights are standardized. *C*' is the direct effect of FoMO on emotional well-being; *C* is the total effect of FoMO on emotional well-being.

Table 4. Direct and indirect effects of FoMO on emotional well-being (WB)

Mediating Relationships	**β**	***B***	***SE***	***p***
Total effect	–.640	–.670	.066	.000
Direct effect	–.508	–.532	.066	.000
FoMO–>Tolerance–>WB	–.014	–.014	.024	.556
FoMO–>Positive Anticipation–>WB	–.005	–.005	.013	.699
FoMO–>Cyberspace-oriented Relationships –>WB	–.056	–.059	.021	.005
FoMO–>Withdrawal–>WB	–.015	–.015	.023	.497
FoMO–>Physical Symptoms–>WB	–.072	–.075	.026	.003

A final structural model including only the two significant mediating PSU dimensions met the cutoff criteria for good fit: CFI = .98 and TLI = .98, SRMR = .062, RMSEA = .038, 90% CI [.034, .042]. Both Cyberspace-oriented Relationships and Physical Symptoms were positively predicted by FoMO. In their turn, both dimensions predicted diminished emotional well-being. The indirect effect for Cyberspace-oriented Relationships was *B* = –.059, β = –.056, *SE* = .021,

p =.005 and for Physical Symptoms B = –.075, β = –.072, SE = .026, p =.003. Moreover, the direct effect of FoMO on emotional well-being became smaller but remained significant B = –.532, β = –.508, SE = .066, p < .001, reflecting a partial mediation effect.

Discussion

The aim of the present study was to investigate whether (subdimensions of) PSU mediate the relationship between FoMO and emotional well-being among an Estonian sample. In the first set of analyses, we examined PSU as a one-dimensional construct. We found that FoMO predicted PSU and diminished emotional well-being. Moreover, PSU predicted decreased emotional well-being. Most importantly, PSU partially mediated the relation between FoMO and decreased emotional well-being.

At an empirical level, these findings are related to previous evidence showing that FoMO predicts overuse of social network sites (Franchina et al., 2018), which in turn predicts decreased well-being (Dhir et al., 2018). However, our results add to this research by showing that the mediating pathway might go beyond social network sites and extends to problematic smartphone use as well.

At a theoretical level, our findings lend support to the I–PACE model, which posits that various psychological factors, including person-level characteristics, such as FoMO, eventually drive individuals to overuse their smartphones (Brand et al., 2019). As smartphones give individuals unlimited online access to check what others are doing, excessive use of these devices can be seen as a maladaptive coping strategy or an end product of frequent, habitual checking to alleviate excessive worry arising from FoMO. According to the I–PACE model, such overuse would not help to cope with these worries but result in adverse outcomes. This claim is confirmed by the present study, showing the detrimental impact of smartphone overuse on emotional well-being.

In the second set of analyses, we examined PSU as a multidimensional construct. We found that two dimensions of PSU partially mediated the relation between FoMO and decreased emotional well-being: Cyberspace-oriented Relationships and Physical Symptoms. While FoMO predicted all dimensions of PSU, only the dimensions Cyberspace-oriented Relationships and Physical Symptoms predicted in turn diminished well-being. This indicates that not all dimensions of PSU are equally harmful to emotional well-being.

Why would those two dimensions negatively impact emotional well-being? The negative relation between the dimension Physical Symptoms and decreased emotional well-being is consistent with the broader literature on the connection between Physical Symptoms and decreased subjective well-being (Diener et al., 2017). Constant checking of one's smartphone may cause physical symptoms such as blurred vision or pain in the wrists, which then can lead to decreased levels of emotional well-being.

The negative impact of Cyberspace-oriented Relationships (i.e., preference for online friendship over real-life friendship) can be connected to the displacement hypothesis (Kraut et al., 1998). According to this hypothesis usage of online technologies displaces face-to-face interactions (Franchina et al., 2018; N. Guo et al., 2019; Lepp et al., 2016; Nie, 2001). Face-to-face interactions with family and friends have repeatedly been shown to be positive predictors of subjective well-being (Caunt et al., 2013; Diener & Seligman, 2002; Kross et al., 2013; Rotondi et al., 2017). The lack of face-to-face interactions following FoMO may then explain the negative impact of FoMO on emotional well-being. It is noteworthy that earlier findings regarding the consequences of the Cyberspace-oriented Relationships dimension are inconclusive. According to a study by Lee and colleagues (S. Lee et al., 2018), this dimension reflects a healthy aspect of smartphone use and is positively associated with interpersonal competence. In contrast, a study by Darcin and colleagues (2015) reported that the Cyberspace-oriented Relationship dimension was positively associated with loneliness. Our findings are more consistent with the latter study.

Theoretical and Practical Implications

Our findings have a number of implications at a theoretical and practical level. With regard to theoretical implications, the present study is the first to explicitly focus and investigate in detail the relation between FoMO, dimensions of PSU, and emotional well-being. In doing so, we have demonstrated that only the dimensions of Cyberspace-oriented Relationships and Physical Symptoms partially mediate the connection between FoMO and emotional well-being. As such, instead of focusing on PSU as a unidimensional construct, researchers might find value in paying attention to subdimensions of PSU. It is notable that by focusing on negative indicators of emotional well-being, we have shown that FoMO indirectly increases negative mood through (subdimensions of) PSU. Considering that negative emotions tend to last longer, have stronger effects and require more cognitive involvement than positive emotions (Larsen, 2009), these findings further advance our understanding of the detrimental impact of FoMO and PSU. Nevertheless, future research focusing on the experience of positive emotions are needed to further deepen our understanding of the impact of FoMO and PSU on emotional well-being.

With regard to practical implications, counselors could use this information when evaluating problematic smartphone usage patterns of their clients or when designing interventions to help clients' with high levels of FoMO. For instance, when noticing in clients that their FoMO results in a strong preference for online connections, counselors may stimulate their clients to engage more in face-to-face interactions. Since children and youth are ardent users of technology in general, and smartphones in particular (Orben, 2020) also parents could benefit from the present evidence. Specifically, parents could use the present evidence

when setting rules for healthy usage of smartphones. Finally, in conjunction with other findings, our results can be used by policy-makers for evidence-based decision making.

Limitations and Future Research

Like all studies, the present study has a number of limitations. First, due to the cross-sectional design, causal interpretations should be made with caution. Even though we constructed and tested a model where PSU mediates the relation between FoMO and emotional well-being, alternative models are also possible. Future studies using experimental and longitudinal designs are needed to further examine the temporal relation between these variables.

Second, PSU only partially mediated the relationship between FoMO and emotional well-being. This implies that additional mediating mechanisms may play a role which could be examined in future studies.

Third, we used a university student sample that consisted of mainly female participants. Considering the findings that females and males use smartphones differently (Andone et al., 2016) and that females are more prone to smartphone addiction (S. W. Choi et al., 2015), future studies may recruit more heterogeneous samples in terms of gender and explore its possibly moderating effect.

Conclusion

In this study, we investigated the relation between FoMO, PSU, and emotional well-being. We found that PSU partially mediated the relationship between FoMO and decreased emotional well-being. Treating PSU as a multidimensional construct, we specifically found that two specific dimensions of PSU were significant mediators: Cyberspace-oriented Relationships and Physical Symptoms. This suggests that the negative relationship between FoMO and emotional well-being is due to FoMO stimulating (a) online relationships at the cost of offline interactions and (b) Physical symptoms associated with excessive smartphone use.

CHAPTER 8

General discussion

Smartphones and SNS are popular and powerful tools. When used appropriately, these digital communication technologies can bring people together, create supportive communities and enhance mental health. However, when used inappropriately, these technologies can contribute to cyberbullying, create social divides, and undermine mental health.

The ever-increasing usage of smartphones and SNS has sparked substantial interest in the general public about the effects of these technologies on mental health, and also fueled a lot of debate among scholars examining this topic (Twenge et al., 2020; Valkenburg, 2022; Vuorre et al., 2021). A large volume of empirical studies has been conducted to examine the impact of time spent on smartphones and SNS on mental health. Undoubtedly, these studies advanced our understanding of the effects of digital communication technologies on mental health (Kross et al., 2021). However, these studies often resulted in mixed findings (for an overview, see Appel et al., 2020; Kross et al., 2021; Meier, 2022; Orben, 2020; Valkenburg et al., 2021). As argued in Chapter 1, this is mainly due to a predominant focus on aggregate effects of overall usage time which does not (1) make a distinction between usage types, (2) take user characteristics into account, and (3) distinguish between non-problematic and problematic engagement with SNS or smartphones.

It is of key importance to address these limitations of aggregate effects of overall usage time as doing so has broad scientific and societal implications. The initial arrival of (communication) technologies (e.g., printing press, radio, television) has often been accompanied by concerns that these technologies negatively impact mental health and society more broadly (BBC Future, 2016; Drotner, 1999). Smartphones and SNS are no exception (Orben, 2020). These worries are often based on a causationist, direct-effects standpoint according to which usage of technologies impacts all users similarly. This approach is often reflected in techno-deterministic headlines in mainstream media (e.g., Campbell, 2017; Haidt, 2022; Macmillan, 2017; O'Connell, 2018; Twenge, 2017), claiming that smartphones and SNS are solely responsible for myriad adverse outcomes. However, such headlines are often misleading or are based on a misinterpretation of research (e.g., Marshall, 2022)[1], and may contribute to fear or panic in society.

Techno-deterministic discourses inside and outside academia have overlooked the complexity of technology usage and tended to diminish the agency of users by portraying them as powerless victims of technology (Kline, 2001). This is troublesome because such a discourse, combined with societal panic is rarely informative or valuable for policymaking (Orben, 2019). Therefore, it is critical to examine the impact of digital communication technologies on mental health in

[1] The headline claims that smartphone screen exposure may lead to earlier onset of puberty. However, it is based on a study in which rats were exposed to pure blue light.

a more nuanced manner and clarify when, how and for whom usage of smartphones and SNS relates to mental health.

In line with this reasoning, this dissertation set out to answer six questions to provide a nuanced perspective on how usage patterns and user characteristics interact and impact mental health. The questions were: (1) How does usage of SNS and smartphones influence mental health? (2) Which user characteristics have been investigated as moderators of the relationship between (different types of) SNS use and mental health in prior research? (3) How do major personality traits (e.g., neuroticism) moderate the relationship between (different types of) smartphones use, SNS use and mental health? (4) How do demographic (e.g., age) and personality traits (e.g., neuroticism) moderate the relationship between non-problematic SNS use and problematic SNS use, and what are the associated consequences for mental health? (5) Why is neuroticism a vulnerability factor in the context of problematic SNS use? Do fear of missing out and self-control mediate the relationship between neuroticism and problematic SNS? (6) Why is FoMO a vulnerability factor in the context of problematic smartphone use? Do dimensions of problematic smartphone use mediate the relationship between fear of missing out and mental health?

The remainder of this chapter is organized as follows: First, we will discuss the main findings of the six chapters that constitute the core of this dissertation. Second, we will describe the theoretical and practical implications of the findings. Third, we will highlight limitations of the conducted studies and provide concrete recommendations for future research to further advance our knowledge about the relationship between usage of digital communication technologies and mental health.

Main Findings

In response to the first research question, we critically reviewed previous studies on the consequences of active and passive SNS use and formulated the extended active-passive model of SNS use in chapter 2. We explained that while the original active-passive model of SNS use has advanced our understanding of the impact of SNS on mental health, it needed further refinement. We proposed three specific extensions. First, we proposed to decompose passive SNS usage: the effects of passive SNS usage depend on content features such as self-relevance and achievement. Second, we proposed to decompose active SNS usage: the effects of active SNS usage depend on interaction features such as reciprocity and communion. Third, we proposed that it is essential to consider how usage types interact with users characteristics. The consequences of (subtypes of) active and passive SNS use differ across users depending on a range of vulnerability or protective user features. The extended active-passive model of SNS use provides a nuanced understanding by arguing that the consequences of active SNS use are not always beneficial and those of passive SNS use are not always detrimental.

In response to the second research question, and consistent with the third extension of the extended active-passive model, we reviewed in chapter 3 prior evidence on user characteristics that possibly moderate the relationship between (different types of) SNS use and mental health. For this purpose, we conducted a systematic review. We used a fine-grained approach by distinguishing between SNS usage types (overall, active, and passive) and mental health indicators (positive and negative indicators). In total, we identified 26 relevant journal articles, 15 unique moderators, and 76 tests of moderation. Most moderators (73%) were examined in a single journal article only, highlighting the need for a more systematic approach in this domain. Moreover, among the remaining 27% of moderators that were examined at least twice, social comparison orientation was the only moderator for which results were consistent. For those high on social comparison orientation, passive SNS usage was consistently found to be associated with decreases in mental health while this is not the case for users who score low on this trait.

In response to the third research question, and building on the findings of the third chapter, in Chapter 4 we conducted a *seven-day diary study* to investigate the moderating role of neuroticism and extraversion in the relationship between smartphones and Instagram use and mental health. We again opted for a fine-grained approach by distinguishing between smartphone usage types (overall, social, non-social), Instagram usage types (overall, active, passive) and mental health indicators (positive and negative indicators). We found that non-social use of smartphones and passive use of Instagram is predictive of negative affect. This finding suggests that when usage of digital technologies is not aimed at fostering meaningful social connections, it can have negative consequences for mental health. Moreover, we found that neuroticism is a significant moderator of the relationship between time spent on smartphones and negative affect, as well as between passive use of Instagram and negative affect. These (negative) relationships were detrimental for people high in neuroticism. As such, neuroticism may act as a vulnerability factor in these relationships. Some evidence suggested that this may also be the case for extravert SNS users. Extraversion was found to moderate the relationship between the amount of time spent on smartphones and positive affect in the sense that for extraverted users, spending time on smartphones was related to decreases in positive affect.

In response to the fourth research question, in Chapter 5 we describe the findings of a cross-sectional study on how non-problematic SNS use may turn into problematic use and negatively impact mental health. We tested this mediation pathway and examined whether age, neuroticism, and extraversion act as moderators of this indirect relationship. We found that problematic usage of Facebook fully mediated the relationship between Facebook use intensity and depressive symptoms. Moreover, we also found that this indirect relationship was especially strong for young users and neurotic users. However, this relationship was not moderated by extraversion. This suggests that young users and neurotic users are more vulnerable to end up using SNS in a problematic manner.

In response to the fifth research question, in chapter 6 we zoomed into on the role of neuroticism and examined why neuroticism is a vulnerability factor in the context of problematic SNS use. We tested this in a cross-sectional study and using structural equation modelling, we examined the parallel mediating roles of FoMO and self-control in the relationship between neuroticism and problematic SNS use. We found that neuroticism was predictive of both FoMO and self-control. However, only FoMO was predictive of increases in problematic SNS use. Tests of indirect effects revealed that FoMO was a robust mediator while self-control did not mediate the relationship between neuroticism and problematic SNS use.

In response to the sixth research question, in chapter 7 we zoomed into on the role of FoMO as a vulnerability factor in the context of problematic smartphone use. We conducted a cross-sectional study and using structural equation modelling, we tested the parallel mediating roles of five dimensions of problematic smartphone use in the relationship between FoMO and emotional well-being. We found that among the five dimensions of problematic smartphone use, cyberspace-oriented relationships and physical symptoms were the only significant mediators of this relationship. This study adds to our understanding of the consequences of FoMO and the value of decomposing problematic smartphone use in subdimensions.

Implications

This dissertation has many theoretical and practical implications. We will first discuss the theoretical implications by discussing how the present findings advance our understanding of the relationships between digital communication technologies and mental health. Next, we will turn to practical implications by describing how the present findings may ultimately contribute to happier societies.

Theoretical Implications

The Importance of Usage Types. A large number of studies have combined smartphone and SNS usage into the overall monolithic measure of "screen time" (Meier & Reinecke, 2021), or examined the overall amount of time spent on smartphones or SNS (Kross et al., 2021). However, such approaches are increasingly often being criticized. First, lumping together higher-level units of analysis (e.g., smartphones) with lower-level units (e.g. SNS) may confound effects of technologies (Meier & Reinecke, 2021). Second, overall measures of smartphone and SNS usage time do not tell us how people actually use these technologies (van Deursen et al., 2015; Verduyn et al., 2017). Throughout chapters 2, 3, and 4, we demonstrated the value of making a distinction between usage types by showing that the relationship between digital communication

technologies and mental health is complex and depends on how users engage with these technologies. As such, our findings underscore the value of decomposing smartphone and SNS usage, and measuring usage of these technologies in a fine-grained manner.

The Importance of User Characteristics. The second main contribution of this dissertation is a demonstration of the importance to take the interplay between usage types and user characteristics into account. Throughout Chapters 2, 3, 4, and 5, we have proposed and empirically tested a range of user characteristics as moderators of the relationship between (different types of) smartphone and SNS use and mental health. In doing so, we moved away from the direct-effects paradigm (Bryan et al., 2021; Johannes et al., 2021) and attempted to identify user characteristics that act as robust moderators. In Chapters 2 and 3, we provided an overview of what already has been done and what research is still needed. In Chapter 4 and 5, we made a contribution at an empirical level by studying the role of demographic characteristics and personality traits. We demonstrated that both types of user characteristics are important to take into account in research on the relationship between digital communication technologies and mental health.

The Importance of Separating Non-Problematic from Problematic Usage. The third main contribution of the present dissertation is an analysis of problematic usage of SNS and smartphones by taking into account a dynamic interplay between non-problematic usage, user characteristics, and lower-level mechanisms. Specifically, Chapter 5 revealed that SNS use can turn into problematic patterns, especially for younger and neurotic users. Building on this finding, in chapter 6, we explored in-depth why neuroticism would be a vulnerability factor for problematic SNS use and identified FoMO as a robust mechanism linking neuroticism with problematic usage patterns. Finally, in Chapter 7, we zoomed in further and explored why FoMO would be a risk factor in the context of problematic usage of these technologies. In doing so, we identified two specific dimensions of problematic usage of smartphones which linked high levels of FoMO with decreased emotional well-being: cyberspace-oriented relationships and physical symptoms. Taken together, our findings provide a nuanced overview of precursors and underlying mechanisms of problematic SNS and smartphone use and underscore the value of integrating mediating and moderating mechanisms.

Practical implications

The findings of the present dissertation are relevant for a wide range of stakeholders.

Policymakers

The present findings are relevant for policymakers who wish to protect users of digital communication technologies from negative consequences. Our findings do not support a techno-deterministic and dystopian causationist point of view (Orben, 2019) according to which usage of smartphones and SNS universally cause harm to all users. As such, policy aimed at preventing access to digital communication tools likely constitutes a suboptimal approach. In the present dissertation, we illustrated that the outcomes of digital communication technologies depend on an interaction between user and usage characteristics. Policymakers could (1) target vulnerable groups via information campaigns to raise awareness regarding the potential adverse effects of SNS and smartphone use, (2) encourage transparent and rigorous research using nuanced approaches on the consequences of digital communication technologies, and (3) create policies aimed at SNS developers to stimulate them sharing anonymized large-scale behavioural data of users with independent researchers such that the nature of interactions between usage and user characteristics can be optimally studied.

Counsellors

Our findings suggest that specific sub-populations (e.g., users with high neuroticism) are at a higher risk of developing problematic usage patterns and diminished mental health. Two implications follow from these findings. First, it may be difficult to amend stable personality traits such as neuroticism but it may be possible to impact mechanisms underlying the negative effects of neuroticism such as FoMO. Indeed, FoMO can be successfully targeted by intervention strategies such as the FoMO-R method which includes awareness and resilience-building activities (Alutaybi et al., 2020). Second, counsellors should also focus on the self-regulatory processes (i.e., the goals that problematic users try to achieve when using SNS and smartphones) (Ozimek & Förster, 2021) and offer healthier alternatives. For example, when neurotic clients use these technologies to cope with loneliness in order to feel better, counsellors could design specific interventions to address such regulatory attempts.

SNS users

The findings of the present dissertation suggest that the average SNS user should not be overly concerned about the impact of the time spent on smartphones and SNS if this usage does not trigger damaging psychological mechanisms or becomes addictive. Rather than focusing on time spent on digital communication tools, SNS users may profit from examining how they use these tools. Most users will likely benefit when using SNS to engage in warm, targeted interactions as

these interaction types are most likely to elicit feelings of connectedness and enhance mental health. Moreover, most users will likely profit when avoiding frequent exposure to self-relevant success stories posted by others on SNS, and stay mindful of the content they are exposed to. For instance, they should be aware that people mainly engage in positive self-presentation on SNS and primarily share positive aspects of their lives (e.g., picture-perfect photos of themselves), which does not necessarily match reality.

Platform developers

The findings of the present dissertation clearly illustrate the damage associated with problematic usage and the need to protect vulnerable groups of users. However, to understand the full scale of the issue and efficiently tackle it, transparency from SNS platform developers and access to anonymized data are essential. Therefore, we strongly encourage developers to actively cooperate with independent researchers to identify key features of their platforms, usage patterns, and risk groups among their users. We are fully aware that this may not always be in the immediate economics interest of profit-oriented companies, as they directly benefit from users' spending large amounts of time on their platforms. However, we believe it is the responsibility of social media companies to protect users by taking action and ensuring that their tools are designed to be optimally helpful.

Limitations and Future Studies

The present dissertation contributed to our understanding of the impact of digital communication technologies on mental health. However, a number of limitations should be mentioned that could be addressed in future studies. First, in most empirical studies we exclusively relied on self-report measures for assessing technology usage. However, self-report measures do not correlate strongly with non-obtrusive log data of smartphones and SNS (Boyle et al., 2022; Ernala et al., 2020; P. H. Lee et al., 2021; Marengo et al., 2021; Parry et al., 2021; Rozgonjuk, Pruunsild, et al., 2020). As such, future research should consider including objective measures as a more ecologically valid option for capturing (problematic) use of smartphones and SNS when replicating our findings (Dissing et al., 2021; Ryding & Kuss, 2020b).

Second, in Chapters 4–7 we relied on a convenience sampling technique to recruit participants due to which samples consisted predominantly of female white users with higher education degrees. Moreover, the mean age across our empirical studies ranged from 26 to 30 years. Future research is necessary to replicate our findings using more diverse participant samples to examine the generalizability of our findings.

Third, in Chapters 5–7 we made use of cross-sectional research designs. Recent studies suggest that the relationship between digital communication technologies and mental health may be reciprocal (Frison & Eggermont, 2017; Jun, 2016; Orben, 2020; Rousseau et al., 2017; Stanković et al., 2021). Therefore, experimental studies are needed to clarify the temporal direction of the relationships described in chapters 5–7.

Fourth, this dissertation focused on SNS usage either without specifying the platforms (Chapter 3) or on specific platforms such as Instagram and Facebook (Chapter 4, Chapter 5). However, we did not investigate other popular SNS platforms such as TikTok and WeChat (for overviews, see Montag et al., 2018, 2021). Future research needs to examine the cross-platform validity of our findings. Existing evidence indicates that users engage differently with various platforms (Rozgonjuk et al., 2021a) and different SNSs may impact users' mental health differently (Pittman & Reich, 2016; Rozgonjuk, Sindermann, et al., 2020).

Fifth, while the empirical chapters presented in this dissertation advance our understanding of problematic usage of SNS and smartphones, the observation of partial mediation in Chapter 6 and Chapter 7 suggests that there may be additional mechanisms which underlie the relationships between user characteristics, problematic usage, and mental health. Such factors may include negative reinforcement mechanisms (e.g., fear of social isolation) and positive reinforcement mechanisms, (e.g., experience of gratification) (Wegmann & Brand, 2019). Future research is needed to identify potential additional robust mediators of these relationships.

Sixth, in the present dissertation, we mainly focused on personality traits characterized by social deficiencies, as antecedents of problematic usage of smartphones and SNS (e.g., Chapter 6, Chapter 7). However, *the Reward-driven Hypothesis* (Wegmann & Brand, 2019) argues that socially competent individuals may also be at risk of developing problematic usage patterns through positive reinforcing mechanisms. Future research needs to thoroughly identify and test such predisposing characteristics, as well as underlying mechanisms.

Seventh, Montag and colleagues (2019; 2021; 2020) highlight the data business model's importance in understanding why users become hooked to SNS. Simply put, this business model relies on collecting and selling personal data to marketing companies. This, in turn, compels SNS engineers to introduce specific features, such as likes and personalized and frictionless newsfeeds, which lead to problematic usage of SNS. In Chapter 5, we have demonstrated that intense usage of Facebook indeed is predictive of problematic Facebook use. However, we did not investigate specific features of SNS that may be responsible for this relationship. As such, future studies are necessary to identify such features and cross them with personality traits to gain better understanding of the antecedents of problematic usage patterns.

Finally, in Chapter 3, we conducted a systematic review. However, due to the limited number of studies, we were unable to conduct a meta-analysis. As a result, we relied on a procedure known as "vote counting" to distinguish between robust

and non-robust effects. However, such a procedure has its drawbacks, as it does not consider factors such as differences in sample size (Suri, 1998), data dependencies, and multiple testing practices, which may lead to accumulation of type I error (Bender et al., 2008; Cheung, 2019). We suggest that once the necessary amount of evidence is accumulated, this systematic review should be followed by a meta-analysis.

Conclusion

The present dissertation addressed three key limitations of research that focused on the relationship between usage time of digital communication technologies and mental health. First, we showed that different usage types of SNS and smartphones are differentially related to mental health. Second, we demonstrated that these relationships differ systematically across users and identified vulnerability factors in these relationships. Third, we clarified the complex direct and indirect relationships between these vulnerability factors, problematic usage of digital communication technologies, and mental health outcomes. Overall, this dissertation demonstrates that the impact of digital communication technologies on mental health is complex and depends on an interaction between usage types and user characteristics.

APPENDIX

Summary

In the 21st century, smartphones and social networking sites (SNS) have become essential tools for billions of people for a wide range of purposes including connecting and collaborating with others, accessing information, shopping online, or passing time. Due to the popularity and prevalence of smartphones and SNS, much work has been done in the past two decades to understand how these digital communication technologies impact mental health.

Past research predominantly focused on the amount of time people spend using smartphones and SNS. This yielded mixed findings and meta-analyses revealed that, on average, the effect of smartphone and SNS usage on mental health is negative but small. However, focusing on overall usage time does not take into account (1) usage types, (2) user characteristics, and (3) the distinction between non-problematic and problematic usage of digital communication technologies, and how the interplay between these three aspects impacts mental health.

In this dissertation, we addressed these three key limitations and answered six major research questions: (1) How does usage of SNS and smartphones influence mental health? (2) Which user characteristics have been investigated as moderators of the relationship between (different types of) SNS use and mental health in prior research? (3) How do major personality traits (e.g., neuroticism) moderate the relationship between (different types of) smartphones use, SNS use and mental health? (4) How do demographic (e.g., age) and personality traits (e.g., neuroticism) moderate the relationship between non-problematic SNS use and problematic SNS use, and what are the associated consequences for mental health? (5) Why is neuroticism a vulnerability factor in the context of problematic SNS use? Do fear of missing out and self-control mediate the relationship between neuroticism and problematic SNS? (6) Why is FoMO a vulnerability factor in the context of problematic smartphone use? Do dimensions of problematic smartphone use mediate the relationship between fear of missing out and mental health?

Chapter 1 provides a comprehensive overview of past research, identifies three key limitations, and explains how the present dissertation will address these limitations.

Chapter 2 critically reviews past research on the impact of active and passive use of SNS on mental health and formulates the extended active-passive model of SNS use. In this model, we decompose active SNS use in four subtypes by crossing two fundamental interaction dimensions: reciprocity and communion. Moreover, we decompose passive SNS use in four subtypes by crossing two fundamental content dimensions: self-relevance and achievement. Finally, we propose to cross usage types and user characteristics in the prediction of mental health as the effect of different types of SNS use differs across users.

Building on Chapter 2, **Chapter 3** systematically reviews existing evidence on user characteristics that have been tested as moderators of the relationship between (types of) SNS use and mental health. We demonstrate that out of 15 unique moderators distributed across 26 manuscripts, the majority of moderators (73%) were studied in a single journal article only. We also demonstrate that findings were largely mixed for those moderators that were studied at least in two journal articles. The only exception was social comparison orientation which has been found to robustly moderate the relationship between passive SNS use and mental health. For users scoring high on social comparison orientation, passive SNS usage was associated with diminished mental health. On the other hand, the relationship between passive use of SNS and mental health was not significant for those who scored low on this trait.

Chapter 4 presents findings from a seven-day diary study that we conducted to empirically test the moderating role of neuroticism and extraversion in the relationship between digital communication technologies and mental health. Specifically, we used a fine-grained approach and distinguished between different types of smartphone use (overall time spent, social use, non-social use), Instagram use (overall time spent, active use, passive use) and indicators of mental health (positive affect, negative affect). We found that non-social use of smartphones and passive use of Instagram predicts negative affect. We also found that neuroticism moderates the relationship between time spent on smartphones and negative affect and between passive Instagram use and negative affect, such that these effects are detrimental for those who score high on this trait but are non-significant for those with a low score. Finally, we also found that extraversion is a risk factor in the relationship between time spent on smartphones and positive affect. Those who scored high on extraversion experienced declines in positive affect. However, this was not the case for those users who scored low on extraversion.

Chapter 5 presents findings from a cross-sectional study where we examined whether the relationship between Facebook use intensity and depressive symptoms is mediated by problematic Facebook use and moderated by age, neuroticism, and extraversion. We found that problematic Facebook use fully mediated the relationship between Facebook use intensity and depressive symptoms. Furthermore, our findings demonstrated that this indirect relationship was stronger for young users and users scoring high on neuroticism.

Chapter 6 explores further why neuroticism is a vulnerability factor in the context of problematic use of SNS. For this purpose, we conducted a cross-sectional study and tested whether the relationship between neuroticism and problematic SNS use was parallelly mediated by fear of missing out and self-control. We found that only fear of missing out was a robust mediator of this relationship.

Chapter 7 builts on the findings of Chapter 6. In a cross-sectional study, we examined whether the relationship between fear of missing out and emotional well-being was parallelly mediated by five dimensions of problematic smart-

phone use (tolerance, positive anticipation, cyberspace-oriented relationships, withdrawal, and physical symptoms). Our findings demonstrated that only two dimensions: cyberspace-oriented relationships and physical symptoms, were robust mediators of this relationship.

Chapter 8 presents an overview of the main findings of the dissertation. It also discusses the theoretical and practical implications of these findings, acknowledges the limitations, and provides recommendations for future research. For instance, the empirical studies presented in the dissertation are correlational and therefore future studies should replicate these findings in experimental studies to clarify the causal nature of the relationship between usage of digital communication technologies and mental health.

Samenvatting

In de 21e eeuw zijn smartphones en sociale netwerksites (SNS) essentiële hulpmiddelen geworden voor miljarden mensen voor een breed scala aan doeleinden, waaronder connecteren en samenwerken met anderen, toegang krijgen tot informatie, online shoppen of tijdverdrijf. Vanwege de populariteit en prevalentie van smartphones en SNS is er de afgelopen twee decennia veel onderzoek gedaan om te begrijpen hoe deze digitale communicatietechnologieën de mentale gezondheid beïnvloeden.

Eerder onderzoek richtte zich voornamelijk op de hoeveelheid tijd die mensen besteden aan het gebruik van smartphones en SNS. Dit leidde tot tegenstrijdige bevindingen en uit meta-analyses bleek dat het effect van smartphone- en SNS-gebruik op mentale gezondheid gemiddeld genomen negatief maar klein is. Echter, wanneer men focust op de totale gebruikstijd wordt geen rekening gehouden met (1) gebruikstypes, (2) gebruikerskenmerken, en (3) het onderscheid tussen niet-problematisch en problematisch gebruik van digitale communicatietechnologieën, en hoe de wisselwerking tussen deze drie aspecten invloed heeft op de mentale gezondheid.

In dit proefschrift hebben we deze drie belangrijke beperkingen aangepakt en zes belangrijke onderzoeksvragen beantwoord: (1) Hoe beïnvloedt het gebruik van SNS en smartphones de mentale gezondheid? (2) Welke gebruikerskenmerken zijn in eerdere studies onderzocht als moderatoren van de relatie tussen (verschillende soorten) SNS-gebruik en mentale gezondheid? (3) Hoe modereren belangrijke persoonlijkheidskenmerken (bv. neuroticisme) de relatie tussen (verschillende soorten) smartphonegebruik, SNS-gebruik en mentale gezondheid? (4) Hoe modereren demografische (bv. leeftijd) en persoonlijkheidskenmerken (bv. neuroticisme) de relatie tussen niet-problematisch SNS-gebruik en problematisch SNS-gebruik, en wat zijn de bijbehorende gevolgen voor de mentale gezondheid? (5) Waarom is neuroticisme een kwetsbaarheidsfactor in de context van problematisch SNS-gebruik? Mediëren FoMO en zelfcontrole de relatie tussen neuroticisme en problematisch SNS gebruik? (6) Waarom is FoMO een kwetsbaarheidsfactor in de context van problematisch smartphonegebruik? Mediëren dimensies van problematisch smartphonegebruik de relatie tussen FoMO en mentale gezondheid?

Hoofdstuk 1 geeft een uitgebreid overzicht van eerder onderzoek, identificeert drie belangrijke beperkingen en legt uit hoe dit proefschrift deze beperkingen zal aanpakken.

Hoofdstuk 2 geeft een kritisch overzicht van eerder onderzoek naar de impact van actief en passief gebruik van SNS op mentale gezondheid en formuleert het uitgebreide actief-passief model van SNS-gebruik. In dit model splitsen we actief SNS-gebruik op in vier subtypen door twee fundamentele interactiedimensies te kruisen: wederkerigheid en “communion”. Bovendien ontleden we passief SNS-

gebruik in vier subtypen door twee fundamentele inhoudsdimensies te kruisen: zelfrelevantie en prestatie. Ten slotte stellen we voor om gebruikstypes en gebruikerskenmerken te kruisen bij het voorspellen van mentale gezondheid, aangezien het effect van verschillende soorten SNS-gebruik verschilt tussen gebruikers.

Voortbouwend op Hoofdstuk 2, geeft **Hoofdstuk 3** een systematisch overzicht van gebruikerskenmerken die in eerder onderzoek zijn getest als moderatoren van de relatie tussen (soorten) SNS-gebruik en mentale gezondheid. We laten zien dat van de 15 unieke moderatoren verdeeld over 26 manuscripten, de meerderheid van de moderatoren (73%) slechts in één tijdschriftartikel werd bestudeerd. We tonen ook aan dat de bevindingen grotendeels tegenstrijdig waren voor die moderatoren die in ten minste twee tijdschriftartikelen werden bestudeerd. De enige uitzondering was de neiging tot sociale vergelijking aangezien deze neiging consistent de relatie tussen passief SNS-gebruik en mentale gezondheid modereert. Voor gebruikers die een sterke neiging hebben om zich met anderen te vergelijken, werd gevonden dat passief SNS-gebruik geassocieerd is met verminderde mentale gezondheid. Echter, de relatie tussen passief gebruik van SNS en mentale gezondheid was niet significant voor diegenen die laag scoorden op deze eigenschap.

Hoofdstuk 4 presenteert de bevindingen van een zevendaags dagboekonderzoek dat we hebben uitgevoerd om de modererende rol van neuroticisme en extraversie in de relatie tussen digitale communicatietechnologieën en mentale gezondheid empirisch te testen. Concreet gebruikten we een fijnmazige benadering en maakten we onderscheid tussen verschillende soorten smartphonegebruik (totale tijdsbesteding, sociaal gebruik, niet-sociaal gebruik), Instagramgebruik (totale tijdsbesteding, actief gebruik, passief gebruik) en indicatoren van mentale gezondheid (positief affect, negatief affect). We vonden dat niet-sociaal gebruik van smartphones en passief gebruik van Instagram negatief affect voorspellen. We vonden ook dat neuroticisme een modererende rol speelt in de relatie tussen tijdbesteding op smartphones en negatief affect en tussen passief Instagram-gebruik en negatief affect, in de zin dat deze effecten nadelig zijn voor diegenen die hoog scoren op deze eigenschap, maar niet-significant zijn voor mensen met een lage score. Ten slotte vonden we ook dat extraversie een risicofactor is in de relatie tussen tijd doorgebracht op smartphones en positief affect. Diegenen die hoog scoorden op extraversie, ervoeren een afname in positief affect. Dit was echter niet het geval voor de gebruikers die laag scoorden op extraversie.

Hoofdstuk 5 presenteert de bevindingen van een cross-sectionele studie waarin we onderzochten of de relatie tussen de intensiteit van Facebook-gebruik en depressieve symptomen wordt gemedieerd door problematisch Facebookgebruik en gemodereerd door leeftijd, neuroticisme en extraversie. We vonden dat problematisch Facebook-gebruik de relatie tussen de intensiteit van Facebook-gebruik en depressieve symptomen volledig medieerde. Bovendien toonden

onze bevindingen aan dat deze indirecte relatie sterker was voor jonge gebruikers en gebruikers die hoog scoorden op neuroticisme.

Hoofdstuk 6 onderzoekt verder waarom neuroticisme een kwetsbaarheidsfactor is in de context van problematisch gebruik van SNS. Hiervoor hebben we een cross-sectionele studie uitgevoerd en getest of de relatie tussen neuroticisme en problematisch SNS-gebruik parallel werd gemedieerd door FoMO en zelfcontrole. We vonden dat alleen FoMO een robuuste mediator was in deze relatie.

Hoofdstuk 7 bouwt voort op de bevindingen van Hoofdstuk 6. In een cross-sectionele studie onderzochten we of de relatie tussen FoMO en emotioneel welzijn parallel werd gemedieerd door vijf dimensies van problematisch smartphonegebruik (tolerantie, positieve anticipatie, cyberspace-georiënteerde relaties, afkickverschijnselen en lichamelijke symptomen). Onze bevindingen toonden aan dat slechts twee dimensies: cyberspace-georiënteerde relaties en lichamelijke symptomen, robuuste mediatoren waren van deze relatie.

Hoofdstuk 8 geeft een overzicht van de belangrijkste bevindingen van het proefschrift. Het bespreekt ook de theoretische en praktische implicaties van deze bevindingen, erkent de beperkingen en doet aanbevelingen voor toekomstig onderzoek. Bijvoorbeeld, de empirische studies die in het proefschrift worden beschreven zijn correlationeel en daarom zouden toekomstige experimentele studies deze bevindingen moeten repliceren om de aard van de causaliteit tussen het gebruik van digitale communicatietechnologieën en mentale gezondheid te verduidelijken.

Kokkuvõte

Erinevad digitaalsed kommunikatsioonitehnoloogiad nagu nutitelefonid ja sotisaalmeediaplatvormid (SMP) on 21. sajandil muutunud miljardite inimeste jaoks olulisteks tööriistadeks. Neid kasutatakse erinevatel eesmärkidel, muuhulgas teiste inimestega ühenduse loomiseks, koostööks, teabele ligipääsuks, veebis ostlemiseks ja aja veetmiseks. Nutitelefonide ja SMP-e populaarsuse ja laia leviku tõttu on teadlased viimase kahe aastakümne jooksul uurinud, kuidas need digitaalsed kommunikatsioonitehnoloogiad mõjutavad inimeste vaimset tervist. Need uuringud on keskendunud peamiselt üldisele ajale, mille inimesed veedavad nutitelefone ja SMP-e kasutades ning on andnud erinevaid tulemusi. Uuringuid kokkuvõtvate metanalüüside tulemused on näidanud, et on nutitelefonide ja SMP-e kasutamise kasutamise keskmine mõju vaimsele tervisele on negatiivne, aga samas väike. Üldisele kasutusajale keskendumine ei võta aga arvesse (1) erinevaid kasutustüüpe, (2) kasutajate omadusi ega (3) digikommunikatsioonitehnoloogiate mitteprobleemse ja probleemse kasutuse eristamist. Samuti ei ole siiani olnud teada kuidas eelnevalt mainitud kolm faktorit koos toimivad inimeste vaimst tervise kujunemisele digitehnoloogiate rikkas keskkonnas.

Käesolevas väitekirjas seega keskendusin neile kolmele faktorile ning vastasin kuuele peamisele uurimisküsimusele: (1) Kuidas mõjutab SMP-e ja nutitelefonide kasutamine vaimset tervist? (2) Milliseid kasutajate karakteristikuid on varasemates uuringutes SMP-e kasutamise ja vaimse tervise vaheliste seoste moderaatoritena vaadeldud? (3) Kuidas mõjutavad peamised isiksuseomadused (nt neurootilisus) nutitelefonide kasutamise ja vaimse tervise ning SMP-e kasutamise ja vaimse tervise vahelist seost? (4) Kuidas demograafilised näitajad (nt vanus) ja isiksuseomadused (nt neurootilisus) modereerivad seost mitteprobleemse SMP-e kasutamise ja probleemse SMP-e kasutamise vahel ning millised on sellega seotud tagajärjed vaimsele tervisele? (5) Miks on neurootilisus probleemse SMP-e kasutamise kontekstis riskitegur? Kas eemalejäämise hirm (ingl. keeles *Fear of Missing Out* (FoMO)) ja enesekontroll vahendavad seost neurootilisuse ja probleemse SMP-e vahel? (6) Miks on FoMO probleemse nutitelefonikasutuse kontekstis riskifaktor? Kas probleemse nutitelefoni kasutamise eri dimensioonid vahendavad seost FoMO ja vaimse tervise vahel? Väitekiri jaguneb kaheksaks peatükiks.

1. peatükk annab põhjaliku ülevaate varasematest uuringutest, toob välja nende kolm põhilist puudust ja selgitab, kuidas käesolev doktoritöö neid puudusi käsitleb.

2. peatükis vaadeldakse kriitiliselt varasemaid uuringuid SMP-e erinevate (aktiivse ja passiivse) kasutamistüüpide mõju kohta vaimsele tervisele. Lisaks sõnastatakse SMP-e kasutamise mudel, mille nimetasime laiendatud aktiivne-passiivne mudel. Selles mudelis vaadeldakse aktiivset SMP-e kasutamist neljas

modulatsioonis põhinedes kahel näitajal: vastastikkus ja ühendus. Need neli modulatsiooni moodustuvad siis kahe näitaja madalatest ja kõrgetest tasemetest. Sarnaselt vaatasime passiivset SMP-e kasutamist neljaks jaotatuna, põhinedes kahel põhilisel näitajal: enesekohasus ja saavutused. Kokkuvõtvalt tegime ettepaneku vaimse tervise prognoosimisel vaadata koos nii kasutustüüpe kui ka kasutaja omadusi, kuna eri isemoomuga SMP-de kasutamise mõju on erinevate kasutajate lõikes erinev.

3. peatükis antakse süstemaatiline ülevaade (2. peatükile tuginedes) SMP-e kasutajate karakteristikutest, mida on varasemates uuringutes testitud SMP-e kasutamise (tüüpide) ja vaimse tervise vahelise seose moderaatoritena. Tuuakse välja 15 erinevat moderaatorist 26-st käsikirjast, kusjuures enamik moderaatoritest (73%) olid vaatluse all ainult ühes ajakirjaartiklis. Paraku olid tulemused nende moderaatorite kohta, mida uuriti vähemalt kahes teadusartiklis, üsnagi erinevad. Ainsana näitas sotsiaalse võrdluse orientatsioon püsivaid tulemusi. Nimelt on leitud, et indiviididel, kellel on tugevam orienteeritus sotsiaalsele võrdlusele, on SPM-de aktiivne kasutamine seotud kehvema vaimse tervisega. Teisest küljest ei olnud seos SMP-e passiivse kasutamise ja vaimse tervise vahel statistiliselt oluline nende jaoks, kelle sotsiaalse võrdluse näitaja oli madalam.

4. peatükk põhineb seitse päeva kestnud päevikuuuringu tulemustel. Selle uuringu eesmärk oli empiiriliselt testida kahe isiksuse omaduse, neurootilisuse ja ekstravertsuse, modereerivat rolli digikommunikatsioonitehnoloogiate ja vaimse tervise seose puhul. Digi-kommunikatsioonitehnoloogiate puhul eristasime erinevaid nutitelefoni kasutamise tüüpe (üldine kulutatud aeg, sotsiaalne kasutus, mittesotsiaalne kasutus), Instagrami kasutamise eri võimalusi (üldine kulutatud aeg, aktiivne kasutamine, passiivne kasutamine) ning vaimse tervise puhul eristasime negatiivset ja positiivset afekti. Leidsime, et nutitelefonide mittesotsiaalne kasutamine ja Instagrami passiivne kasutamine ennustab pigem negatiivset afektiivsust. Samuti leidsime, et neurootilisus modereerib seost nutitelefonides veedetud aja ja kasutaja negatiivse emotsionaalsuse vahel, samuti seost passiivse Instagrami kasutamise ja negatiivse emotsionaalsuse vahel. Täpsemalt neorootilisemate kasutajate puhul näeme negatiivseid mõjusid, aga neid kelle neorootilisuse näitajad on madalad, ei ole neid mõjusid. Lõpuks leidsime ka, et ekstravertsus on nutitelefonides veedetud aja ja positiivse emotisonaalsuse vahelise seose riskitegur. Need, kel on ekstravertsuse skaalal kõrge tulemus, kogesid vähem positiivseid emotsioonet. Kuid see ei kehtinud nende kasutajate puhul, kes said ekstravertsuse näitajal madala tulemuse.

5. peatükis esitatakse läbilõikeuuringu tulemused. Uuringus on vaatluse all Facebooki kasutamise intensiivsuse ja depressiivsete sümptomite vaheline seos ning uurimisküsimuseks on, kas probleemne Facebooki kasutamine vahendab nimetatud seost ning kas rolli omavad kasutaja vanus ja isikuseomadused (neurootilisus ja ekstravertsus). Tulemused näitasid, et probleemne Facebooki kasutamine vahendas täielikult Facebooki kasutamise intensiivsuse ja depressiivsete sümptomite vahelist seost. Lisaks näitasid tulemused, et see vahendatud seos oli tugevam nooremate ja kõrgema neurootilisusega kasutajate puhul.

6. peatükis uurisime lähemalt, miks neurootilisus on SMP-e probleemse kasutamise kontekstis riskitegur. Selleks viisime läbi läbilõikeuuringu ja testisime, kas neurootilisuse ja probleemse SMP-e kasutamise vahelist seost vahendavad FoMO ja enesekontroll. Leidsime, et ainult FoMO oli selle suhte tugev vahendaja.

7. peatükk tugineb omakorda 6. peatüki järeldustele. Läbilõikeuuringu abil uurimiti, kas FoMO ja emotsionaalse heaolu vahelist seost vahendavad samaaegselt viis probleemse nutitelefonikasutuse dimensiooni (suurenenud kasutus, positiivne ootus, küberruumile orienteeritud suhted, võõrutusnähud ja füüsilised sümptomid). Tulemused näitasid, et ainult kaks dimensiooni (küberruumile orienteeritud suhted ja füüsilised sümptomid) eelloetletud viiest nutitelefoni kasutamise alamdimensioonist vahendasid seost FoMO ja emotsionaalse heaolu vahel.

8. peatükis antakse ülevaade kogu väitekirja peamistest leidudest. Samuti arutlatakse leidude teoreetiliste ja praktiliste järelmite ja piirangute üle. Samuti antakse soovitusi tulevaste uuringute jaoks. Näiteks doktoritöös esitatud empiirilised uuringud on korrelatiivsed ja seetõttu on vajalik tulemusi tulevastes eksperimentaalsetes uuringutes korrata, et selgitada digitaalsete kommunikatsioonitehnoloogiate kasutamise ja vaimse tervise vahelise seose põhjuslikku olemust.

Impact paragraph

The rise of smartphones and social networking sites (SNS) has been accompanied by concerns inside and outside academia that these digital communication technologies negatively influence mental health. The present dissertation enhances our understanding of this pressing matter. Here, I will discuss three ways the findings from the present dissertation may contribute to this debate in the academic and public domain.

A first key message is that what we do on smartphones and SNS may be more important than the amount of time we invest in them. Researchers can benefit from this insight by decomposing aggregate usage metrics of digital technologies into meaningful subcategories such as (subtypes of) active versus passive use or social vs. non-social use. Smartphone owners and SNS users can profit from this insight by engaging in those usage types that benefit most users such as warm reciprocal interactions while avoiding exposure to self-relevant achievement-focused content of others. Counsellors should also be aware of the differential effects of different usage types and use this knowledge when designing interventions for clients who experience negative mental health consequences due to their usage of digital communication tools. Rather than exclusively preventing (or strongly limiting) clients to use smartphones or SNS, a valuable alternative may be to nudge clients towards healthier usage styles. Finally, policymakers could launch information campaigns to make the general public aware of which usage types are most beneficial for most people. However, such endeavors are complicated due to the role of individual differences, which we discuss next.

A second key message is that user characteristics matter in the context of SNS and smartphone use. This implies that scholars should pay more attention to moderators such as age, gender, and personality traits to systematically explain for whom usage of smartphones and SNS is beneficial versus detrimental. Moreover, smartphone owners and SNS users can benefit from this insight by being aware of their own vulnerability factors. For example, when SNS users realize they have neurotic tendencies or tend to compare themselves with others, they should exercise extra caution when using smartphones and SNS. This insight is also important for counsellors as assessing their clients' proneness to engage in social comparisons and neurotic thoughts may help them to evaluate their clients' risk of suffering adverse outcomes when using smartphones and SNS. Finally, policymakers can use these insights to make the public aware of which user populations are at increased risks when using digital communication tools.

The third key message is that it is critical to make a distinction between non-problematic and problematic usage of digital communication technologies. Researchers may benefit from this insight by assessing both engagement types and identifying mechanisms that turn regular usage into problematic usage. Smartphone owners and SNS users may benefit from this insight by critically

reflecting on the degree to which they have control over these communication tools rather than exclusively focusing on the amount of time spent on these devices. Counsellors could examine whether their clients have user characteristics that make them especially vulnerable for problematic usage styles and can implement interventions targeting amendable, lower-level mechanisms (e.g., fear of missing out) to reduce addiction-like symptoms in their clients. Finally, policymakers can make use of this insight to raise awareness about specific risks associated with problematic usage of digital communication technologies. Somewhat ironically, smartphones and SNS can be used as practical tools for such information dissemination and educational campaigns.

Finally, each of the three key messages obviously also has consequences for smartphone and SNS developers but this is a complex matter. Whereas certain recommendations do not necessary clash with profit maximization (e.g., nudging warm reciprocal interactions) others may do (e.g., avoiding problematic engagement and associated usage time). However, we believe that smartphone and SNS developers should take their responsibility by, at least, providing independent researchers access to anonymized usage data such that the complex interaction between user characteristics and usage types can be even better understood.

Acknowledgements

Doing a PhD across two different countries, universities, and departments has been, at times, tough, but in general, a remarkable experience. This journey enabled me to meet wonderful people and significantly contributed to my professional and personal growth. Here, I would like to thank everyone who directly or indirectly supported me in one way or another and made this journey possible and enjoyable.

First, I want to thank my supervisors: Philippe Verduyn, Karin Täht, and Rob Ruiter. I feel incredibly fortunate to have worked with the three of you, as I could not have wished for better guides on this journey. You have allowed me to pursue my dream research project, provided me with excellent guidance and unwavering support, yet challenged me to grow as a scientist.

Philippe, I have always admired your work and feel so privileged to have been mentored by you. You have been a key source of invaluable guidance, expertise, trust, inspiration, and enthusiasm throughout these years. I will forever be thankful for your generosity. **Karin**, I am incredibly grateful for your enormous support, for allowing me to explore and learn from my mistakes and for gently guiding and assisting me with your expertise whenever I was lost. **Rob**, a huge thank you for your always spot-on comments, helpful advice anytime I needed it and for constantly bringing a fresh perspective and insights into the research project.

I want to extend a huge thanks to my (past and present) colleagues at WSP (UM) and the Institute of Psychology (UT). My dear paranymphs, **Tuğçe** and **Dārta**, thank you so much for having my back! **Tuğçe**, you always brighten up my workdays with lovely chats and jokes, and I feel blessed to share the office with you. Thank you for the camaraderie, priceless support, and advice, but also for your genius idea of setting up a snack corner in the office and your social event planning skills 😊. **Dārta**, back in the day, your support and friendliness made me feel very welcome at UM and made my transition from Estonia to the Netherlands much easier. Thank you for your kindness and the many interesting and fun conversations we had (and for always switching the lights on 😊). **Merve**, my heartfelt thanks for always offering a helping hand when I needed it and for sharing your wisdom and experience on thesis writing. Your sense of humour and our insightful discussions (not least) on the similarities and differences between Turkey and Georgia are much appreciated 😊. **Bram**, my fellow dragon 😊 you hands-down are a great colleague to have around. I am so thankful for all the invaluable help you've provided me with during times of need (both in stats and outside academia), but no less for all the fun and pleasant interactions we've had. **Bona**, your compassion and encouragement always found me at the right time. Thank you so much! **Rosine**, your welcoming attitude, supportiveness, and

friendliness are much appreciated, as is your love of Khachapuri! **Gerda**, I will always be grateful for your approachability and support. **Hanne**, thank you for creating a pleasant and relaxed atmosphere in our office. **Louk**, I greatly appreciate our small chats 😊.

In addition, I want to thank **Alicia**, **Vera**, **Paco**, **Kennedy**, **Tari**, **Wilken**, **Thomas**, **Gemma**, **Fatemeh**, **Khalid**, **James**, **Eka**, **Alexandra**, **Tamika**, **and Pascalle**, as well as the rest of WSP, for creating a very welcoming and inspiring working environment. Furthermore, I am sincerely grateful to the Institute of Psychology for welcoming me to Tartu. **Hedvig**, **Martin**, and **Siqi**, thank you for being wonderful officemates.

This double-degree project has been quite a challenge from an administrative perspective. I want to express my sheer gratitude to **Rense Hoekstra** and **Reet Marits** for designing and executing this difficult task and**,** to **Kertu Saar**, **Marju Tammiste**, **Mariëlla Muermans-Ummels**, and **Trudy Micheels** for being super helpful and taking care of the administrative issues.

Next, I am incredibly grateful to my external co-authors, **Dmitri Rozgonjuk**, **Ethan Kross** and **Eva-Maria Schruff-Lim**, for their excellent scientific input and for improving the quality of the papers presented in this thesis. My gratitude is extended to all participants who volunteered and took part in our studies and to the master students who collected the data. I should also thank **Michiel Vestjens** for always kindly helping me with Qualtrics issues and **Wim Van Den Noortgate** for generously answering my questions on the meta-analytic approach.

I want to give my most profound appreciation to **Marine Chitashvili** for always believing in me, actively encouraging me to follow the research path and being one of the biggest supporters and inspirations in my life. A special thanks to **Bela Arutinova** for opening the doors to quantitative research, which has, since then, never ceased to fascinate me. I am incredibly grateful to **Diana Lezhava** for all her support, trust, and encouragement throughout the years and for being a caring and approachable human being.

My co-workers at the **Center of Social Sciences (CSS)** have contributed significantly to my development as a researcher. I still cherish our excellent times together. I want to thank the whole staff for being amazingly supportive, lovely colleagues.

I want to thank **Mom & Dad** for encouraging me to follow my passion and pursue research and my brother **Dimitri** for inspiring me to become a researcher and for thoroughly supporting me on this path. My heartfelt thanks go to my sister-in-law **Anna** for her unwavering kindness and to my awesome nephews, **Ilia** and **Gabriel**, who always mange to put a smile on my face and make me happier.

I cannot thank my friends **Tusiko** (and her adorable floofer **Chewbacca**), **Kri**, **Marika**, **Merry**, **Dakota** (+ her magnificent doggo **Windy**), **Irina**, **Kusa**, **Bariam**, **Tekle**, **Aniko**, **Mariam**, **Ana**, **Kristina**, **Nukri** and **Sandro** enough. You are a constant source of meaningful connection, honesty, trust, insights, joy, silliness, and laughter. Thank you so much for being there for me.

Last but not least, **Medea**, I owe you so much. You are my rock.

Curriculum Vitae

Nino Gugushvili was born in Georgia on January 25, 1989. She received her Bachelor of Arts in Psychology from Ivane Javakhishvili Tbilisi State University in 2012. Afterwards, Nino obtained her Master of Science degree in Counseling Psychology at Ivane Javakhishvili Tbilisi State University in 2014. From 2014 to 2018, Nino worked as a researcher at the Center for Social Sciences in Tbilisi, Georgia. Furthermore, from 2015 to 2016, she worked as a researcher at the Ministry of Defense of Georgia. In 2018, Nino started her PhD project: “Digital communication technologies and mental health: An interplay between usage types and user characteristics”, at Maastricht University and the University of Tartu. As of December 2022, Nino is a post-doctoral researcher in the Work and Social Psychology department at Maastricht University.

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