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Two Dimensions of Problematic Smartphone Use Mediate the Relationship Between Fear of Missing Out and Emotional Well-Being

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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

Please note: Article updated on May 28, 2020. The figures 3 and 4 were updated. The figures incorrectly displayed positive direct (c') and total effect (c) of FoMO on emotional well-being. The effects should have been negative and were now corrected. In Figure 3, „c' = .455” and „c = .638” was changed to „c' = -.455” and „c = -.638”. In Figure 4, „c' = .508” and „c = .640” was changed to „c' = -.508” and „c = -.640”. The error occurred during formatting of the figures by the journal.

Introduction

Shortly after the introduction of smartphones on the global market, their ownership has increased drastically (Poushter et al., 2018). Currently, more than two billion people possess a smartphone (Takahashi, 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 et al., 2019; Elhai, Tiamiyu, et al., 2018; 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 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 & S. Lee, 2018; Twenge, 2019) which is addressed in national (Canadian Paediatric Society, 2017; Chassiakos et al., 2016; Davie & Firth, 2019) 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, Philippot, 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; Lin et al., 2014), smartphone addiction proneness (D. Kim et al., 2014) or simply excessive smartphone use (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., 2015). 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 use 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., 2020) 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 S. 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).*

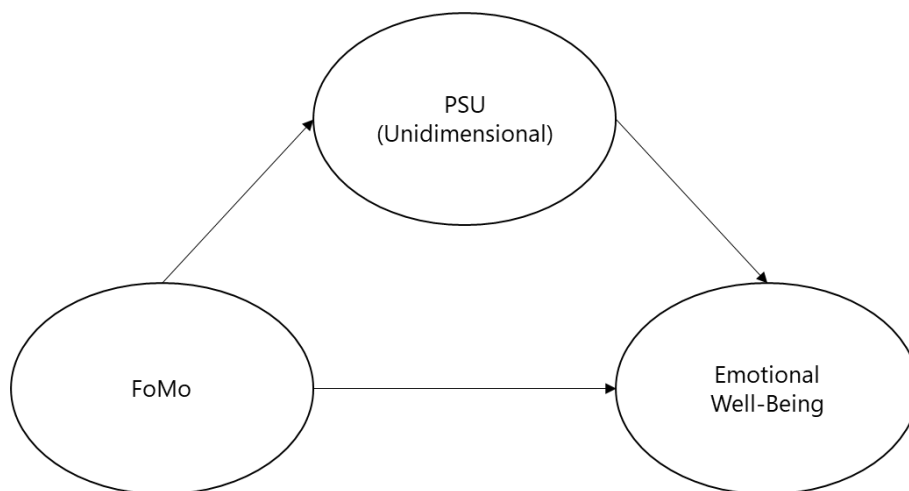
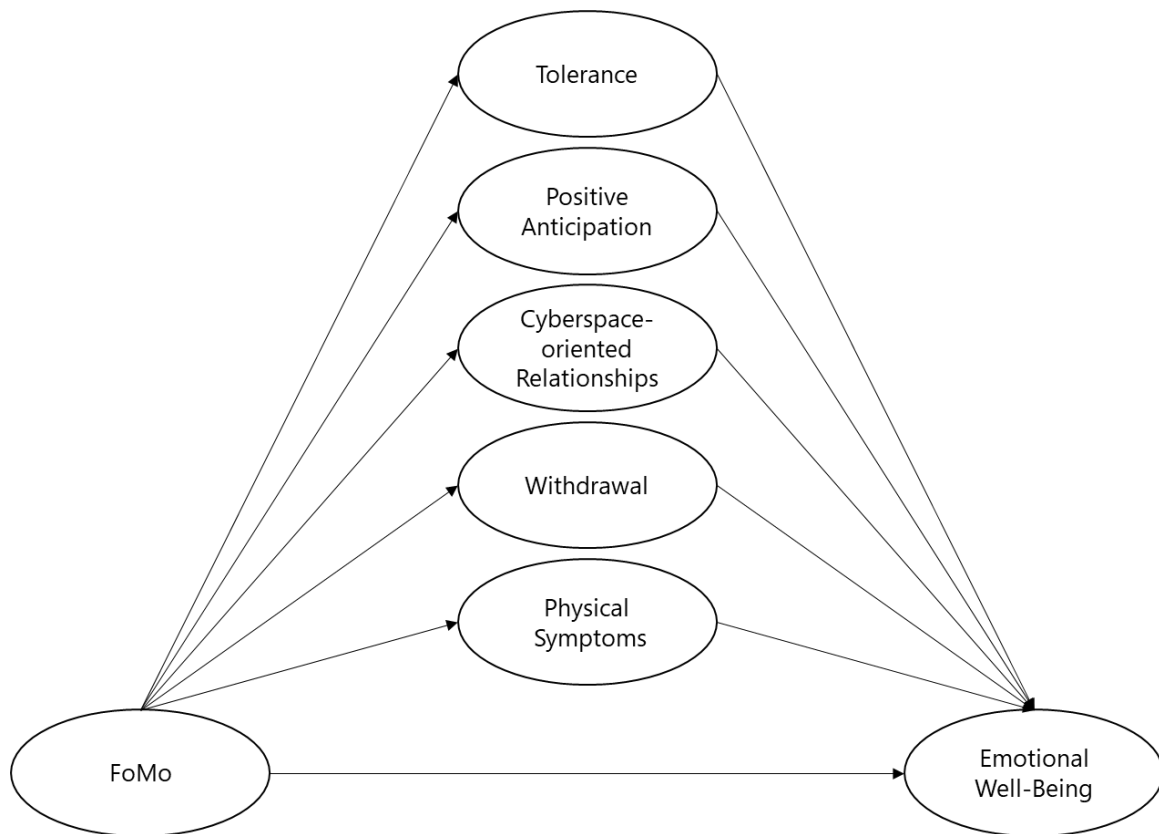


Figure 2. Conceptual Model of Relation Between FoMO and Emotional Well-Being Mediated by the Five Dimensions of PSU.



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 ($M_{\text{age}} = 26.74$, $SD = 8.16$). 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, 2013) 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).

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	

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).

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 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 (Míndrilă, 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

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 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).

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).

Table 3. *Fit Indices of Measurement Models for FoMO, PSU, Five-Dimensional PSU and Emotional Well-Being.*

Model	Dimensions	χ^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.

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) led to the same results and does not modify any conclusion reported in the paper.

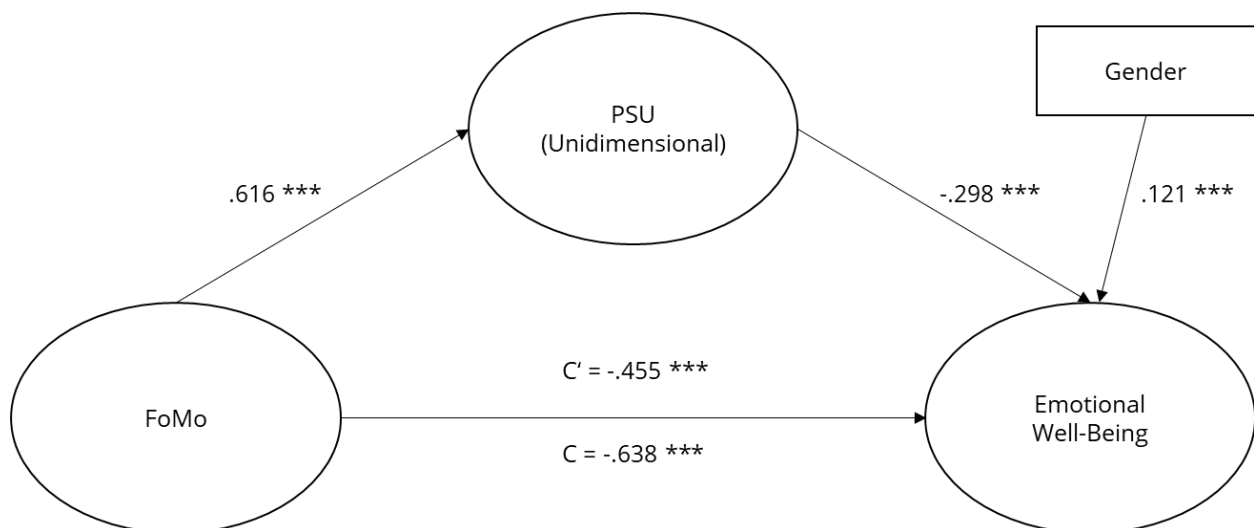
Second, we investigated the factorial structure of PSU. One item (“There is nothing more fun to do than using my smartphone”) hardly showed any variance and this item was therefore excluded from all further analyses. We examined the fit of a five-dimension model where all items loaded on their respective 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).

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, $B = 0.625$, $\beta = .616$, $SE = .110$, $p < .001$. Further, FoMO significantly predicted diminished emotional well-being $B = -0.492$, $\beta = -.455$, $SE = .076$, $p < .001$. PSU also significantly predicted decreased emotional well-being $B = -0.317$, $\beta = -.298$, $SE = .086$, $p < .001$. 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 $B = -0.198$; $\beta = -.183$, $SE = .056$, $p = .001$. The direct path (c') from FoMO to diminished emotional well-being also remained significant, reflecting a partial mediation effect $B = -0.492$, $\beta = -.455$, $SE = .076$, $p = .001$.

Figure 3. PSU (Unidimensional) as a Significant Mediator of the Relationship Between FoMO and Emotional Well-Being (Controlling for Gender).

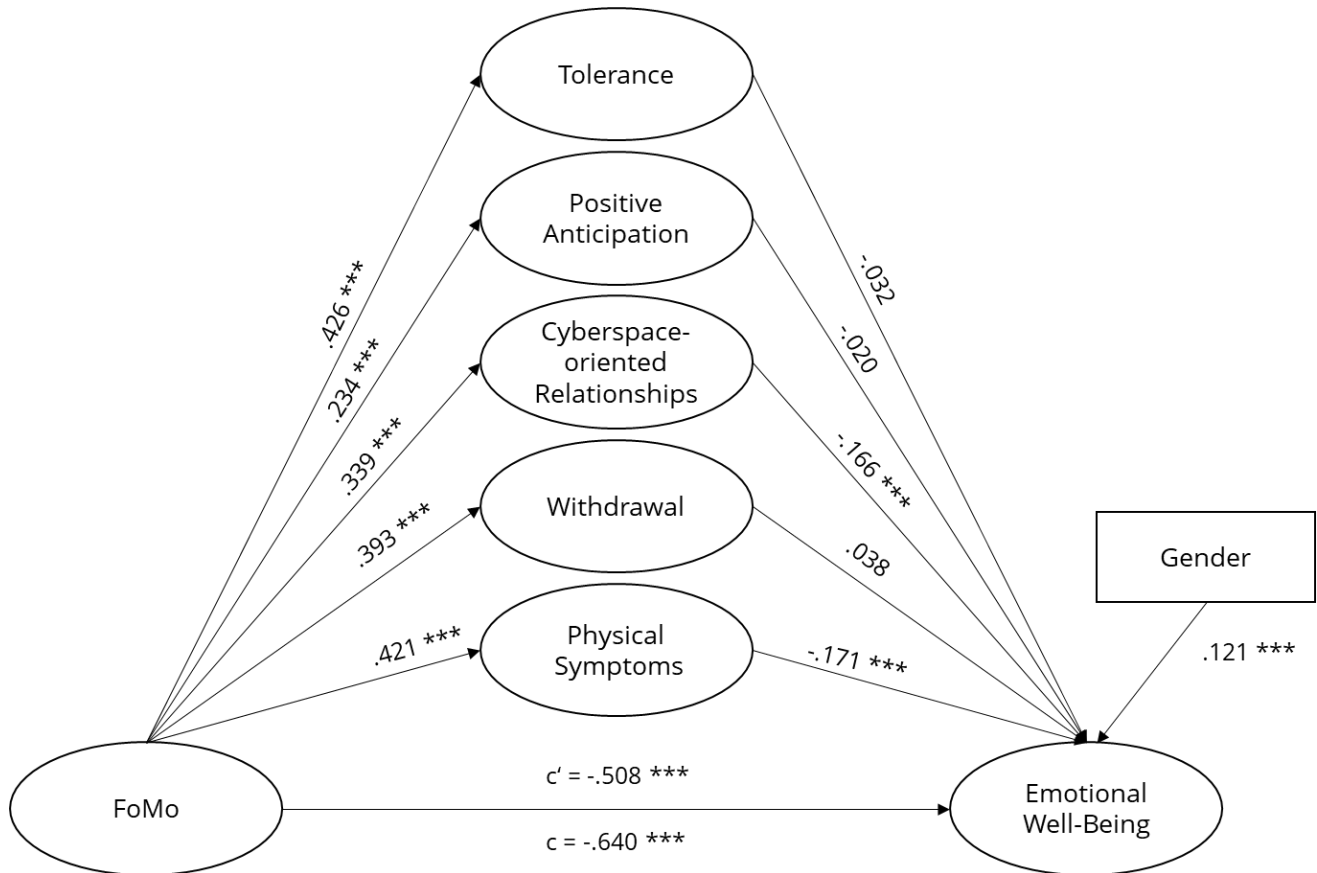


Note. Regression weights are standardized. C' is the direct effect of FoMO on emotional well-being; C is the total effect of FoMO on emotional well-being.

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	-0.670	.066	.000
Direct effect	-.508	-0.532	.066	.000
FoMO->Tolerance->WB	-.014	-0.014	.024	.556
FoMO->Positive Anticipation->WB	-.005	-0.005	.013	.699
FoMO->Cyberspace-oriented Relationships ->WB	-.056	-0.059	.021	.005
FoMO->Withdrawal->WB	-.015	-0.015	.023	.497
FoMO->Physical Symptoms->WB	-.072	-0.075	.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 $B = -0.059$, $\beta = -.056$, $SE = .021$, $p = .005$ and for Physical Symptoms $B = -0.075$, $\beta = -.072$, $SE = .026$, $p = .003$. Moreover, the direct effect of FoMO on emotional well-being became smaller but remained significant $B = -0.532$, $\beta = -.508$, $SE = .066$, $p < .001$, 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; 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 S. Lee and colleagues (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 (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.

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