Addictive Behaviors 105 (2020) 106335

Contents lists available at ScienceDirect

Addictive Behaviors

journal homepage: www.elsevier.com/locate/addictbeh

Depression, anxiety and fear of missing out as correlates of social, non-social and problematic smartphone use

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HIGHLIGHTS

- Non-social smartphone use (NSSU) related to fear of missing out (FOMO).
- NSSU related to problematic smartphone use (PSU) severity.
- FOMO mediated relations between depression severity and NSSU.
- FOMO mediated relations between both depression and anxiety with PSU severity.

ARTICLE INFO

Keywords:
Problematic smartphone use
Fear of missing out
Depression
Anxiety
Social networking

ABSTRACT

Few studies have examined mental health variables in relation to social vs. non-social smartphone use, and how such types of use relate to problematic smartphone use (PSU). We conducted a web survey of 316 American undergraduate students about severity of depression, anxiety, fear of missing out (FOMO), social and non-social smartphone use, and PSU. Using structural equation modeling, we found that compared to social smartphone use, non-social use was more strongly linked with severity of PSU ($\beta = 0.18$, $p < .05$) and FOMO ($\beta = 0.24$, $p < .05$). FOMO mediated relations between depression severity and non-social smartphone use ($\beta = 0.09$, $p = .04$). Furthermore, FOMO mediated relations between both depression ($\beta = 0.23$, $p < .001$) and anxiety ($\beta = 0.16$, $p = .04$) with PSU severity. We discuss non-social smartphone use as a possible avoidance strategy among anxious individuals, and the role of FOMO in individuals desiring social connectedness but also feeling socially anxious. Results are discussed in the context of a comprehensive theoretical model on pathways toward excessive internet use.

1. Introduction

Problematic smartphone use (PSU) is defined in the scientific literature as excessive frequency of smartphone use with impairment in academic, occupational and/or social functioning (Billieux, Maurage, Lopez-Fernandez, Kuss, & Griffiths, 2015). PSU involves symptoms observed in behavioral addictions, such as psychological withdrawal (when unable to use one's phone), tolerance (increased use to obtain the same level of satisfaction), and hazardous use (e.g., when driving) (De-Sola Gutierrez, Rodriguez de Fonseca, & Rubio, 2016). However, we should emphasize that PSU is not classified as a disorder, unlike arguably more severe addictive behaviors - namely, substance use disorders (Billieux et al., 2015; Panova & Carbonell, 2018). Despite the literature base on PSU, little research has examined influences of mental health variables on different types of smartphone use (i.e., social vs. non-social), and how such use may contribute to PSU.

Many pathways can influence PSU (Billieux et al., 2015). One line of research focuses on psychopathology or mental health pathways. Recent studies find PSU severity mildly to moderately correlated with anxiety and depression severity in participants from the U.S. (Wolniewicz, Rozgonjuk, & Elhai, 2020), Turkey (Gül et al., 2019), Korea (Kim & Koh, 2018), and China (Elhai, Yang, Fang, Bai, & Hall, 2020). Although conceivable that PSU can cause psychopathology (Lemola, Perkinson-Gloor, Brand, Dewald-Kaufmann, & Grob, 2015;

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https://doi.org/10.1016/j.addbeh.2020.106335
Received 28 September 2019; Received in revised form 31 January 2020; Accepted 1 February 2020
Available online 07 February 2020
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Thomée, Härenstam, & Hagberg, 2011), below we discuss the more accepted theoretical conceptualization that psychopathology contributes to PSU (Brand et al., 2019).

In addition to examining PSU's relationship with depression and anxiety severity, more recent studies examined PSU in relation to other negative affect-related variables. Specifically, PSU severity is related to rumination (Elhai et al., in press; Elhai, Tiamiyu, & Weeks, 2018; Liu et al., 2017) and worry (Elhai, Rozgonjuk, Yildirim, Alghraibeh, & Alafnan, 2019). PSU is also related to emotion dysregulation and distress intolerance (Elhai, Levine, O'Brien, & Armour, 2018; Fırat et al., 2018; Gül et al., 2019).

An additional relevant variable is fear of missing out (FOMO) - apprehension of missing rewarding experiences, and a corresponding need to stay persistently connected with one's social network (Przybylski, Murayama, DeHaan, & Gladwell, 2013). FOMO involves negative affectivity from unmet social connectedness needs (Przybylski et al., 2013), and relates to depression/anxiety severity (e.g., Dempsey, O'Brien, Tiamiyu, & Elhai, 2019; Elhai et al., 2018; Oberst, Wegmann, Stodt, Brand, & Chamarro, 2017). In fact, FOMO has correlated with negative affectivity prospectively over one week (Elhai, Rozgonjuk, Liu, & Yang, 2020; Milyavskaya, Saffran, Hope, & Koestner, 2018). FOMO correlates with excessive social network site (SNS) use (Błachnio & Przepiórka, 2018; Dempsey et al., 2019; James, Lowry, Wallace, & Warkentin, 2017), and PSU severity (Elhai, Yang, et al., 2020; Oberst et al., 2017; Wolniewicz, Tiamiyu, Weeks, & Elhai, 2018). One study found FOMO related to increased social smartphone use (Wolniewicz et al., 2018), while another found FOMO more strongly related to non-social smartphone use (Elhai, Levine, Alghraibeh, et al., 2018).

In fact, distinguishing social from non-social internet use is a prominent categorization in research (Song, LaRose, Eastin, & Lin, 2004). Social smartphone use involves primarily social purposes, such as SNS, messaging, phone calls, and relationship maintenance. In contrast, non-social, often labeled "process" smartphone use, involves primarily non-social motivations, including news consumption, entertainment, and relaxation (Elhai, Hall, Levine, & Dvorak, 2017; van Deursen, Bolle, Hegner, & Kommers, 2015). We emphasize that there can be overlap between social and process use. For example, news articles could be consumed on social media (process use) and simultaneously shared/discussed online (social use).

Research finds lower depression severity related to increased social smartphone use such as social networking (Elhai, Levine, Dvorak, & Hall, 2017; Panova, Carbonell, Chamarro, & Puerta-Cortés, in press), while increased anxiety-related psychopathology relates only to process use (Elhai, Levine, et al., 2017; Panova et al., in press; Rozgonjuk et al., 2019). Additionally, van Deursen et al. (2015) found social stress more related to process use. Furthermore, FOMO relates to increased social use (Wolniewicz et al., 2018), but with stronger associations with process use (Elhai, Levine, Alghraibeh, et al., 2018). Burke and Kraut (2016) discovered that while personalized SNS communication associated with greater psychological well-being, one-click interactions involving little online socialization (e.g., liking/sharing content) were not. Overall, in contrast to direct social use, process smartphone use seems more highly associated with psychopathology symptoms.

Finally, several studies examined whether social or process smartphone use correlates more with PSU severity, though finding mixed results. PSU severity related more to process use in four studies (Elhai, Hall, et al., 2017; Elhai, Levine, et al., 2017; Rozgonjuk et al., 2019; van Deursen et al., 2015). Other studies, however, found PSU severity related more to social use (Panova et al., in press; Zhitomirsky-Geffet & Blau, 2016). One study discovered PSU severity equivalently related to social and process use (Wolniewicz et al., 2018). Investigating social and process smartphone use in the present study, and their mediating role in accounting for relations between psychopathology symptoms and PSU severity, may provide a more comprehensive understanding of the relationships among these variables.

1.1. Aims

We examined how psychopathology symptoms (depression, anxiety and FOMO) associate with social and process smartphone use, and how such use correlates with PSU severity. We were particularly interested in FOMO as a possible intermediary variable between both depression and anxiety with PSU severity, as recent work supports such mediating relationships (Elhai, Levine, Alghraibeh, et al., 2018; Elhai, Yang, et al., 2020; Oberst et al., 2017). This study is important in increasing understanding of pathways to PSU, such as FOMO, and the role of how people use their phones.

1.2. Theory

A relevant theory to understanding determinants of PSU is the Interaction of Person-Affect-Cognitive-Execution model (I-PACE) (Brand et al., 2019; Brand, Young, Laier, Wolfling, & Potenza, 2016). I-PACE is a comprehensive theoretical framework that first proposes predispositional variables contributing to excessive internet use, including genetic, biological, personality, cognition, psychopathology, and internet use motives. Second, I-PACE proposes additional determinants involving affective and cognitive responses such as cognitive and attention bias, coping strategies, internet use expectancies, disinhibition, and craving. I-PACE suggests that these determinants can influence decisions to use specific internet features, in turn influencing excessive use. Importantly, affective and cognitive responses are conceptualized as mechanistic variables that account for relationships between predisposition and both Internet application and excessive use. Since its development, numerous studies have supported I-PACE in modeling excessive internet use (e.g., Dempsey et al., 2019; Lemenager et al., 2018; Oberst et al., 2017). We focus on depression and anxiety severity as predisposing psychopathology variables, and FOMO as an intermediate affective/cognitive response variable leading to types of smartphone use (social and process), and PSU.

1.3. Hypotheses

While both social and process smartphone use relate to PSU, process use is typically more strongly associated (Elhai, Hall, et al., 2017; Elhai, Levine, et al., 2017; Rozgonjuk et al., 2019; van Deursen et al., 2015). PSU can involve social-related functional impairments (Billieux et al., 2015), and greater process use may facilitate maladaptive or impaired socialization in PSU. In I-PACE, process use would serve as a type of internet use leading to excessive use. Therefore, we propose the following hypothesis:

H1) *Process smartphone use should be positively related to PSU severity*.

FOMO is thought to drive excessive internet use, such as PSU, to satisfy unmet social needs (Przybylski et al., 2013). Prior studies support FOMO's relationship with PSU severity (e.g., Elhai, Yang, et al., 2020; Fuster, Chamarro, & Oberst, 2017; Oberst et al., 2017; Wolniewicz et al., 2018). In I-PACE, FOMO can represent a cognitive bias and affective response contributing to PSU (Brand et al., 2016; Wegmann, Oberst, Stodt, & Brand, 2017). We propose:

H2) *FOMO should be positively related to PSU severity*.

FOMO is conceptualized to result from unmet social needs, and consequently drive social internet use (Przybylski et al., 2013). FOMO relates to excessive SNS use (Błachnio & Przepiórka, 2018; Dempsey et al., 2019; James et al., 2017), and increased social smartphone use (Wolniewicz et al., 2018). However, one study unexpectedly, but empirically, found FOMO more strongly related to process use (Elhai, Levine, Alghraibeh, et al., 2018). Based on evidence for FOMO's relationship with both social and process smartphone use, we

hypothesize:

H3) *FOMO should be positively related to social and process smartphone use*.

FOMO relates to both depression and anxiety severity (e.g., Dempsey et al., 2019; Elhai, Levine, Alghraibeh, et al., 2018; Oberst et al., 2017). FOMO is conceptualized to involve negative affectivity resulting from unmet social needs (Przybylski et al., 2013). While it is possible that FOMO leads to negative affectivity, here we conceptualize negative affectivity as a precursor to FOMO, guided by the I-PACE framework.

H4) *FOMO should positively correlate with depression and anxiety severity*.

Depression and anxiety severity are associated with greater FOMO (see H4). FOMO in turn correlates with increased social smartphone use and excessive SNS use to meet social needs, and FOMO has also unexpectedly correlated with process smartphone use (see H3). FOMO should be a mechanism mediating between depression/anxiety severity with social and process smartphone use, based on these prior findings. In I-PACE, FOMO would represent an intermediary cognitive bias or affective response between psychopathology (e.g., depression/anxiety) with specific internet feature use, such as social and process smartphone use (Brand et al., 2016; Wegmann et al., 2017).

H5) *FOMO should fully mediate relations between both depression (H5a) and anxiety (H5b) with social and process smartphone use*.

FOMO relates to higher depression/anxiety severity (reviewed in H4). FOMO also relates to higher PSU severity (see H2). FOMO mediated relations between depression- and anxiety-related psychopathology with PSU severity (Elhai, Levine, Alghraibeh, et al., 2018; Elhai, Yang, et al., 2020; Oberst et al., 2017). FOMO is a cognitive or affective response variable (in I-PACE) driven by psychopathology (depression/anxiety), in turn contributing to PSU (Brand et al., 2016; Wegmann et al., 2017).

H6) *FOMO should fully mediate relations between both depression (H6a) and anxiety (H6b) with PSU severity*.

1.4. Research model

Our research model is depicted in Fig. 1. Depression and anxiety are specified to predict FOMO (testing H4); in turn, FOMO predicts social and process smartphone use (H3). Social and process use (H1) predict PSU severity. Fig. 1 notes PSU's modeling as a latent variable, discussed below. We adjusted for sex as a covariate, because of greater smartphone use among women (Jeong, Kim, Yum, & Hwang, 2016; Wang, Wang, Gaskin, & Wang, 2015).

2. Method

2.1. Participants and procedure

In Fall 2018, we recruited undergraduate research participants (age 18–25) from the psychology research pool of a large university in midwestern United States. Students signed up for course research points, through the department's Sona Systems web portal. Enrollees were routed online to a consent statement, and for those consenting, to a web survey on psychdata.com.

Of 329 individuals enrolling in the study, 13 participants did not continue past initial demographic questions, and were excluded (resulting effective $N = 316$). Mean age was 19.21 years ($SD = 1.74$). A majority were women ($n = 211$, 66.8%). Most identified as Caucasian ($n = 238$, 75.3%), with racial/ethnic minority representation (not mutually exclusive) from African American ($n = 60$, 19.0%), Asian ($n = 15$, 4.7%), and Hispanic ($n = 15$, 4.7%) backgrounds. The sample mostly included freshman ($n = 188$, 59.5%) and sophomores ($n = 79$, 25.0%), with a majority working part-time ($n = 164$, 51.9%), or full-time ($n = 32$, 10.1%).

2.2. Instruments

In addition to querying demographics, we distributed the following measures.

2.2.1. Depression anxiety stress Scale-21 (DASS-21)

The DASS-21 is a shorter version of the original DASS (Lovibond & Lovibond, 1995), measuring symptoms over the past week. Response options range from "0 = did not apply to me at all" to "3 = applied to me very much or most of the time." We used only the depression and anxiety subscales (seven items each), because stress has only mild associations with PSU severity across the literature (Elhai, Dvorak, Levine, & Hall, 2017). The depression and anxiety subscales have reliability and validity (Antony, Bieling, Cox, Enns, & Swinson, 1998; Brown, Chorpita, Korotitsch, & Barlow, 1997). Sample items include "I felt downhearted and blue" (depression), and "I felt I was close to panic" (anxiety). Our internal consistency (coefficient alpha) was 0.91 for depression, and 0.84 for anxiety.

2.2.2. FOMO scale

The FOMO Scale (Przybylski et al., 2013) contains 10 items involving anxiety from missing rewarding, social events. Item content includes "I fear others have more rewarding experiences than me," and "I get anxious when I don't know what my friends are up to." Response options range from "1 = Not at all true of me" to "5 = Extremely true of me." Reliability and validity are evidenced (Elhai, Levine, Alghraibeh, et al., 2018; Przybylski et al., 2013). Our sample's alpha

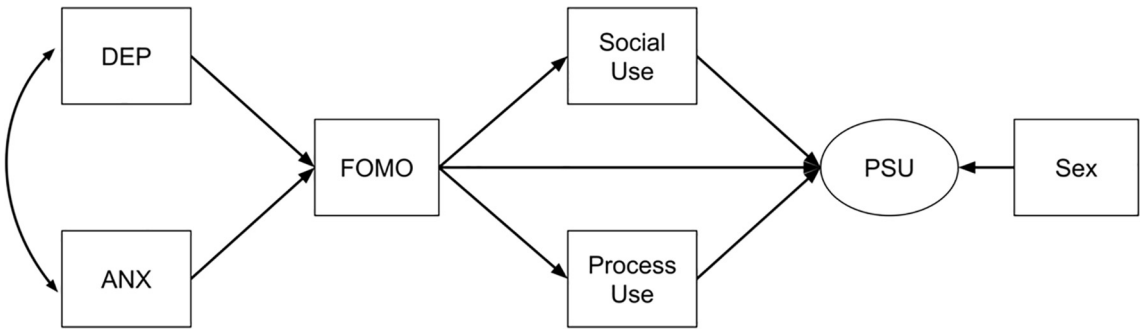

Fig. 1. Hypothesized model. Note: DEP = Depression; ANX = Anxiety; FOMO = Fear of missing out; PSU = Problematic smartphone use. The oval represents a latent variable, while rectangles indicate observed variables. For visual simplicity, factor loading paths from the latent variable are not displayed.

Table 1
Means, standard deviations, and bivariate correlations among psychological summed scores.

Variable	*M*	*SD*	1	2	3	4	5
1. PSU	27.41	9.41					
2. Social Use	21.60	2.91	0.20**				
3. Process Use	26.72	3.74	0.31**	0.43**			
4. FOMO	22.59	8.57	0.51**	0.13*	0.27**		
5. DEP	4.13	4.83	0.40**	−0.04	0.08	0.44**	
6. ANX	3.77	4.14	0.38**	−0.06	0.02	0.40**	0.74**

Note: DEP = Depression; ANX = Anxiety; FOMO = Fear of missing out; PSU = Problematic smartphone use.
*indicates $p < .05$. **indicates $p < .01$.

coefficient was 0.89.

2.2.3. Process and social smartphone use

We used the 12-item scale by van Deursen et al. (2015), comprising seven process and five social smartphone use items. The process use subscale taps relaxing, informational, and entertainment-based use; social use taps online social interaction and maintenance. Response options range from "1 = Strongly disagree" to "5 = Strongly agree." Sample items include "I use my smartphone because it is entertaining" (process use), and "I use my smartphone to maintain relationships" (social use). The subscales are reliable and valid (Elhai, Levine, et al., 2017; van Deursen et al., 2015). Our coefficient alphas were 0.72 (process) and 0.76 (social use).

2.2.4. Smartphone addiction scale-short version (SAS-SV)

The SAS-SV (Kwon, Kim, Cho, & Yang, 2013) includes 10 items, measuring PSU severity from "1 = Strongly disagree" to "6 = Strongly agree." Reliability and validity are adequate (Elhai et al., 2018; Lopez-Fernandez, 2017). We slightly reworded items for a consistent first-person voice, consistency and accessibility (Duke & Montag, 2017). Sample items include "I miss planned work due to smartphone use" and "I use my smartphone longer than I had intended." Our sample's coefficient alpha was 0.86.

2.3. Analysis

We used R software version 3.5.2 (R Core Team, 2019) for descriptive/correlational analyses and analyses of variance (ANOVA). We used R's *mice* package to impute small amounts (< 5%) of missing item-level data (with maximum likelihood estimation) before summing scale scores. We used R's *fmsb* (internal consistency), *pastecs* (descriptives), *ez* (ANOVA effects), and *apatables* (correlations) packages.

We used Mplus version 8.2 (Muthén & Muthén, 2019) for confirmatory factor analysis (CFA) and structural equation modeling (SEM). We first modeled separate CFAs for Fig. 1's scales. Despite using different estimators and treating items as continuous vs. ordinal, FOMO, process and social use CFAs did not fit well. While depression and anxiety CFAs fit well, including these latent variables in SEMs resulted in model non-convergence, likely because of the large number of model parameters and power/sample size required for such a complex model. We therefore treated PSU as a latent variable, using observed summed scores for remaining scales.

For the PSU CFA, we treated SAS-SV items as ordinal, using a polychoric covariance matrix, probit factor loadings, and weighted least squares estimation with a mean-adjusted chi-square (DiStefano & Morgan, 2014). Residual covariances were fixed to zero. We judged good model fit based on benchmarks of ≥ 0.95 for the comparative fit index (CFI) and Tucker-Lewis Index (TLI), ≤ 0.06 for root mean square error of approximation (RMSEA), and ≤ 0.08 for standardized root mean residual (SRMR) (Hu & Bentler, 1999); however, we rely less on RMSEA as it often mistakenly judges poor fit when using ordinal data (Shi, Maydeu-Olivares, & Rosseel, 2020). The PSU CFA fit well (except based on RMSEA), robust $\chi^2(35, N = 316) = 243.64$, $p < .001$, CFI = 0.96, TLI = 0.95, RMSEA = 0.14 (90% CI: 0.12 to 0.15), SRMR = 0.05. Standardized factor loadings were uniformly high, mostly in the 0.70-0.80 range (available upon request).

We tested Fig. 1's model using SEM, including sex as a covariate of PSU severity (1 = men, 2 = women). We used the same statistical approach as above. We tested model variations using Mplus' DIFFTEST command. We tested mediation, computing cross-products of direct path coefficients, estimating standard errors using the Delta method, with 1000 non-parametric bootstrapped replications (Hayes, 2017).

2.4. Ethics

The university's institutional review board (IRB) approved the project. Informed consent was obtained from each participant prior to participation. The Declaration of Helsinki principles were used in conduct of the study.

3. Results

Descriptive statistics and bivariate correlations for summed scores appear in Table 1. First, we analyzed sex differences on the study variables from Table 1. Using ANOVA, only social smartphone use differed by sex, $F(1, 314) = 11.57$, $p = .001$, $\eta_p^2 = 0.04$, with higher scores among women (M = 21.99, SD = 2.53) than men (M = 20.83, SD = 3.43). Next, PSU severity was related to process smartphone use; using a *t*-test for dependent correlations (Meng, Rosenthal, & Rubin, 1992), PSU severity was not less related to social use, $t(313) = 1.92$, $p = .06$. FOMO positively correlated with PSU severity. FOMO correlated with social use, but more strongly with process use, $t(313) = 2.40$, $p = .02$. FOMO was associated with higher depression and anxiety severity. While we tested bivariate correlations for data exploration, our main focus was SEM, discussed next.

Fig. 1's model demonstrated some evidence for adequate (but not good) fit (again, primarily because of RMSEA, discussed above), robust $\chi^2(101, N = 316) = 650.58$, $p < .001$, CFI = 0.93, TLI = 0.91, RMSEA = 0.13 (90% CI: 0.12 to 0.14), SRMR = 0.10. Standardized path coefficients are displayed in Fig. 2. Controlling for sex and FOMO, PSU severity related to process but not social smartphone use (testing H1). FOMO was associated with PSU severity (controlling for sex, social and process use; testing H2). FOMO was positively related to process but not social use (testing H3). FOMO was related to both higher depression and anxiety severity (testing H4).

We tested variations of Fig. 1's model. For example, we removed the FOMO-PSU path, but this model worsened model fit, robust $\chi^2_{diff}(1, N = 316) = 138.32$, $p < .001$. We also added age as a covariate of PSU, which did not improve fit, robust $\chi^2(115, N = 316) = 619.71$, $p < .001$, CFI = 0.93, TLI = 0.92, RMSEA = 0.12 (90% CI: 0.11 to 0.13), SRMR = 0.14 (note: this model is not nested within Fig. 1's model, and thus cannot be compared using chi-square difference testing).

Mediation results are in Table 2. Results indicate that FOMO mediated relations between depression severity and process (but not social) smartphone use (testing H5a). FOMO mediated relations between depression and PSU severity (H6a); and between anxiety and PSU severity (testing H6b).

4. Discussion

We first discovered in SEM that process (but not social) use related to PSU severity, partially supporting H1. This finding corroborates prior work finding PSU severity more related to process use (Elhai, Hall, et al., 2017; Elhai, Levine, et al., 2017; Rozgonjuk et al., 2019; van Deursen et al., 2015), but does not support other work finding PSU more related to social use (Panova et al., in press; Zhitomirsky-Geffet &

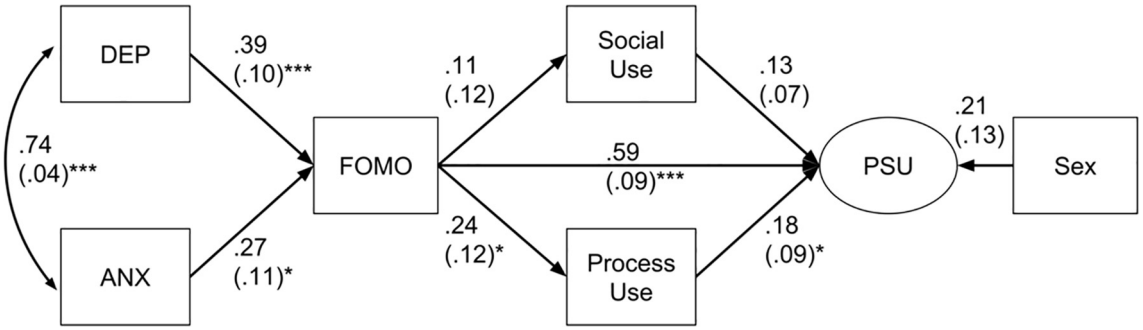

Fig. 2. Standardized path coefficients for the SEM model. *Note*: DEP = Depression; ANX = Anxiety; FOMO = Fear of missing out; PSU = Problematic smartphone use. The oval represents a latent variable, while rectangles indicate observed variables. For visual simplicity, factor loading paths from the latent variable are not displayed. Standard errors are displayed in parentheses. *p < 0.05, **p < 0.01, ***p < 0.001.

Table 2
Mediation tests.

Mediation tests (relevant hypothesis in parentheses)	β	SE	z	p
Depression- > FOMO- > Process Use (H5a)	0.09	0.05	2.04	0.04
Depression- > FOMO- > Social Use (H5a)	0.05	0.05	1.00	0.32
Anxiety- > FOMO- > Process Use (H5b)	0.06	0.04	1.56	0.12
Anxiety- > FOMO- > Social Use (H5b)	0.03	0.04	0.86	0.39
Depression- > FOMO- > PSU (H6a)	0.23	0.06	4.01	< 0.001
Anxiety- > FOMO- > PSU (H6b)	0.16	0.07	2.08	0.04

Note: FOMO = Fear of missing out; PSU = Problematic smartphone use.

Blau, 2016). In fact, the former studies specifically assessed process motivations that are more passive (e.g., to relax, to be entertained) and social motivations that are more active (e.g., to interact with others, to maintain relationships) for smartphone use. However, the latter studies assessed social and process use by inquiring about specific features and applications on one's phone, rather than motivations for use. This difference in measurement strategy may account for the prior mixed findings. In the context of I-PACE, process smartphone use may be a type of use leading to problematic use (Brand et al., 2019; Brand et al., 2016).

Supporting H2, FOMO related to PSU severity, corroborating prior work (e.g., Elhai, Yang, et al., 2020; Fuster et al., 2017; Oberst et al., 2017). FOMO has been conceptualized as a cognitive/affective bias that can influence PSU (Brand et al., 2019; Brand et al., 2016), for example, to feel more socially connected through a smartphone's social features (Przybylski et al., 2013). In fact, FOMO not only demonstrates relations with PSU severity, but also excessive SNS severity (Błachnio & Przepiórka, 2018; Dempsey et al., 2019; James et al., 2017).

Regarding H3, in our bivariate analyses FOMO correlated with social smartphone use, but FOMO was more associated with process use. Furthermore, in SEM after covariate adjustment FOMO was related to process but not social use, supporting one prior study (Elhai, Levine, Alghraibeh, et al., 2018). It may seem most intuitive that the socialization desires involved with FOMO would drive greater social than process smartphone use. However, despite FOMO involving a desire to socialize, it may have a social anxiety component if such socialization becomes stressful. Socially anxious individuals desire social connection, but fear social engagement, therefore often avoiding or decreasing social interaction because of perceived difficulty and challenge (reviewed in Hofmann, 2007). Such social avoidance can manifest offline through physical social avoidance, or online by engaging in process rather than social internet use (Prizant-Passal, Shechner, & Aderka, 2016). In fact, FOMO demonstrates moderate-to-large relationships with social anxiety (Dempsey et al., 2019; Wolniewicz et al., 2018). Thus FOMO may drive social smartphone use to satisfy social relatedness needs, but FOMO may be more related to process smartphone use as a means of avoiding or decreasing the stressful nature of in-person social engagement for socially-anxious individuals.

Supporting H4, FOMO related to depression and anxiety severity, expected based on prior research (Dempsey et al., 2019; Elhai, Levine, Alghraibeh, et al., 2018; Oberst et al., 2017). In some support of H5, FOMO did not mediate relations between depression/anxiety with social smartphone use, but did with process use. Depression and anxiety especially relate to process use (Elhai, Levine, Alghraibeh, et al., 2018; Rozgonjuk et al., 2019; Wolniewicz et al., 2018). Because depression/anxiety correlate with FOMO, and FOMO related to process use, FOMO may represent an interpersonal coping mechanism (in I-PACE) in response to negative affectivity and loneliness (Przybylski et al., 2013), but when subsequent social engagement becomes fear-inducing, the individual may consequently engage in excessive internet use (process use in particular) to regulate such negative emotion.

Finally, supporting H6 FOMO mediated relations between both depression and anxiety with PSU severity, supporting prior work (Elhai, Levine, Alghraibeh, et al., 2018; Elhai, Yang, et al., 2020; Oberst et al., 2017). As previously discussed, FOMO can be a cognitive/affective response (in I-PACE) to negative affectivity, consequently leading to excessive internet/smartphone use to alleviate negative emotion. Thus while depression and anxiety alone may not cause PSU, FOMO may be a mediating variable.

We acknowledge several limitations. First, we used a convenience sample of students, unlikely representative of the general population. Second, psychopathology measures were self-administered, without diagnostic interview-based data for depression and anxiety. Additionally, our smartphone use and PSU measures involved self-report methodology; objective smartphone data are more accurate (Montag et al., 2015; Rozgonjuk, Levine, Hall, & Elhai, 2018). Our study design was cross-sectional, and causal conclusions cannot be made; in fact, our directionality tested (though theory-driven) could occur in reverse in longitudinal designs. Additionally, we acknowledge that social and process smartphone use may overlap; for example, reading a Facebook news post and sharing/discussing it involves both social and process use. Furthermore, the only latent variable we used in CFA was for modeling PSU. And our primary CFA and SEM models demonstrated mixed evidence for good fit, with RMSEA values in particular demonstrating the worst fit. In fact, recent research demonstrates bias in RMSEA values when analyzing ordinal data, with more confidence placed in SRMR values (Shi et al., 2020). We would therefore place somewhat more confidence in our direct and indirect effects, rather than the integrated structural model. Nonetheless, these findings provide insight into the role of psychopathology-related variables, including FOMO, on types of smartphone use and excessive use. Future research should further examine differential relations between FOMO and social vs. process internet/smartphone use in order to further understand how people use internet technology both to satisfy relatedness needs but also to alleviate negative emotion and distress.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

N/A.

Role of funding sources

This work was supported by Tianjin Philosophy and Social Science Project (TJJX15-002). The funding source did not have a role in the writing of this paper.

Contributors

JE led the project. DR and JE designed the study protocol. EG and JE conducted data analyses. JE and EG wrote the initial manuscript, and JE and HY revised the manuscript. JE, EG and DR had full access to the data.

Notes

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.addbeh.2020.106335.

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