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A Structural Equation Modeling Approach to Understand the Dynamics of Smartphone Attachment and Problematic Smartphone use

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Abstract
Problematic smartphone use (PSU), conceptualized as the overuse of one's smartphone, has received much attention in the empirical literature. One specific lens that has been used to study smartphone use is attachment theory. The current study evaluated the tenets of attachment to smartphones to further understand the relationship of smartphone attachment with problematic use. A total of 761 adults, who were primarily female and White, from the United States of America, completed a variety of measures. Structural Equation Modeling (SEM) was used to test a theoretical model, and it was revealed that the extent someone viewed their smartphone as a refuge (i.e., secure base) predicted PSU. Moreover, refuge mediated the relations between Fear of Missing Out (FoMO) and PSU. The current research contributes to the literature a better understanding of the dynamics between smartphone attachment and PSU. Theoretical basis for the findings are discussed and suggestions for future research are proposed.

Keywords Attachment theory · Problematic smartphone use · Fear of missing out · Technology

Introduction

If you are reading this, you likely have used a smartphone today. The modern smartphone is a ubiquitous entity that can be seamlessly used to accomplish most tasks. To put it simply, if there is something you need to complete, ranging from paying bills, connecting with friends, playing a video game, and more, there likely is an app for that. In the United States of America, it is estimated that 85% of its population owns a smartphone, while 97% owns a cellphone of some type (Pew Research Center, 2021). Not only are smartphones large in numbers, but they also tend to be used heavily. For example, Howarth (2023) suggests the average American spends three and a half hours a day on their smartphone. Smartphone use estimates for young adults are typically higher, with Holte et al. (2023) reporting an average slightly over 4 h a day. In light of these statistics, it is reasonable that the empirical literature has taken an interest in studying smartphone use and conceptualizing smartphone overuse as problematic smartphone use (PSU; Billieux et al., 2015).

Existing smartphone research has found PSU to be related to musculoskeletal pain (Inal et al., 2015; Xie et al., 2016), anxiety (Elhai et al., 2019, 2020; Gao et al., 2020) and depression (Wolniewicz et al., 2020). Moreover, PSU severity has been related to deficits with school (Przepiorka et al., 2021), sleep (Demirci et al., 2015; Lemola et al., 2015), and work (Bian & Leung, 2015; Duke & Montag, 2017). Collectively, problematic smartphone use is linked with numerous maladaptive outcomes. While these are just a few associations of PSU, they underline the importance of studying smartphone use. The current study, like others before it, will evaluate smartphone use with the tenets of attachment theory. In particular, this work will conceptualize one's smartphone as a compensatory attachment figure and describe smartphone uses as an interaction with such attachment figure. By understanding how individual differences in attachment relate to smartphone use, it is viable we can better understand why not all individuals are susceptible to maladaptive outcomes due to their smartphone use.

Although research has demonstrated smartphones can serve as an attachment figure (Holte & Ferraro, 2021; Eichenberg et al., 2019; Keefer et al., 2012; Konok et al., 2016; Parent, 2019; Parent & Shapka, 2020; Trub & Barbot, 2016; Nie et al., 2020) and individual's attachment dimensions can influence their technology use, namely

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how attachment anxiety predicts problematic smartphone use (Parent et al., 2021, 2022; Sun & Miller, 2023); more research is needed to understand the mechanisms involved with this relationship. That is, it is important to evaluate additional factors which may play a role in this structural relationship. Thus, the current study proposes a structural equation model (Fig. 1) of behavior to better understand the dynamics involved with attachment and problematic smartphone use.

Attachment Theory

Attachment can be described as the bond between two people which persists regardless of time or location (Ainsworth, 1973; Bowlby, 1969). While over the years, numerous attachment styles have been conceptualized, a growing trend in the attachment literature is to quantify attachment as continuous values of attachment anxiety and avoidance (Cameron et al., 2012; Fraley, 2019). By studying attachment as continuous dimensions across these concepts, important individual differences in attachment are not lost as they are in categorical approaches (Fraley et al., 2015). Individuals with high levels of attachment anxiety report desiring intense closeness with others (Hazan & Shaver, 1990) and routinely have fearful thoughts close others will abandon or reject them (Bartholomew & Horowitz, 1991; Brennan et al., 1998). While individuals with higher attachment anxiety scores tend to prefer closeness with their partners (Hazan & Shaver, 1990), higher levels of attachment avoidance are associated with the need for space (Brennan et al., 1998). As it pertains to smartphone use, prior research has found attachment anxiety to be associated with problematic smartphone use (Holte, 2023; Parent et al., 2021; Sun & Miller, 2023). Provided attachment avoidance has not regularly been associated with PSU, the current study will primarily focus on the role of attachment anxiety with PSU.

Telepressure

Telepressure can be described as the anxiety caused by having technology-based messages to respond to (Barber & Santuzzi, 2017). In particular, Barber and Santuzzi's (2017) General Telepressure (GTP) measure identified two main factors: preoccupation and urge to respond. Preoccupation describes the extent to which an individual has difficulty focusing on things until they have responded to their messages and their desire to respond. The preoccupation factor of the GTP measure at its core highlights the extent to which an individual ruminates about responding to messages. Prior research has demonstrated rumination thought style, how prone someone is to ruminate, is positively associated with PSU (Arrivillaga et al., 2022; Elhai et al., 2020). Thus, it is reasonable to expect GTP-Preoccupied to predict the extent someone has PSU. Likewise, attachment anxiety is related with tendency to ruminate (Garrison et al., 2014; Lanciano et al., 2012; Liu et al., 2021). Therefore, it is viable that individuals who are concerned about communications they have not responded to would also be concerned about potential rejection or abandonment of close others.

Hypothesis 1: GTP-Preoccupied Will Predict PSU and Attachment Anxiety

The urge to respond factor describes the extent an individual feels compelled to respond to messages promptly. There is an initial support that it could reliably predict attachment anxiety and FoMO. Namely, it is expected that individuals desire for prompt communication could be driven by a need to maintain close relationships (Baumeister & Leary, 1995) and a fear that by not responding promptly, they may have their relationships severed. Both attachment anxiety and FoMO in their own way have a fear of rejection, with attachment anxiety by definition, reflecting a concern of abandonment (Brennan et al., 1998) and recent FoMO works

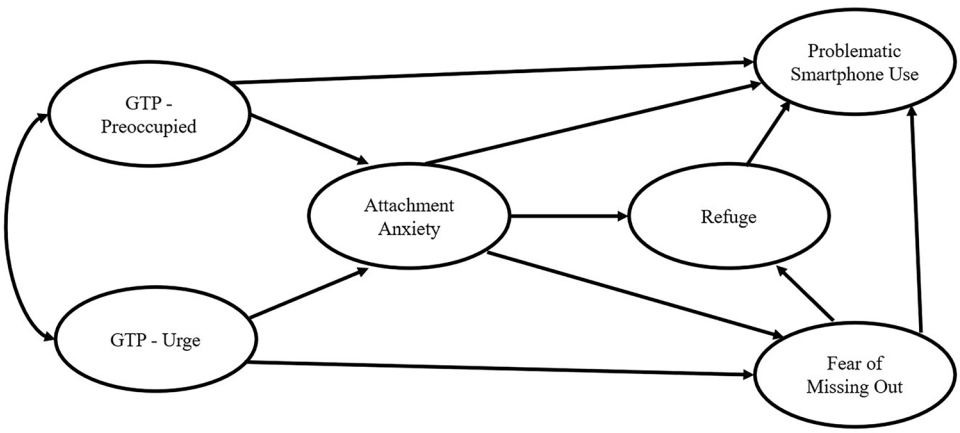

Fig. 1 Structural equation model of behavior

suggesting it is largely related to a fear of social exclusion (Holte et al., 2022; Marengo et al., 2021; Wang et al., 2023). Research by Forgays et al. (2016) found that individuals have a general expectation to receive text messages in response to their messages promptly. Thus, it is reasonable to contend that individuals with higher propensity of attachment anxiety and FoMO are more inclined to have a desire to respond promptly, to ensure they remain in the good graces of others.

Hypothesis 2: GTP-Urge Will Predict Attachment Anxiety and FoMO

Attachment Anxiety in the Digital World

As described earlier, attachment anxiety is a dimension of attachment that pertains to the extent an individual is concerned of potential rejection or abandonment (Brennan et al., 1998). As such, research has demonstrated to offset these fears, individuals scoring high in attachment anxiety are more inclined to monitor the Social Networking Site (SNS) pages of their close others (Reed et al., 2016; Marshall et al., 2013) to ensure they are not going to leave them. Checking the behavior of this variety makes it reasonable that attachment anxiety has been correlated with problematic social media use (PSMU; Marino et al., 2023; Worsley et al., 2018) and PSU (Parent et al., 2021, 2022; Sun & Miller, 2023). Thus the following hypothesis is proposed:

Hypothesis 3a: Attachment Anxiety Will Predict PSU

Moreover, research has suggested higher levels of attachment anxiety is related to stronger likelihood to develop an attachment to their smartphone (Konok et al., 2016; Parent, 2019), and prior research by Trub and Barbot (2016) and Pezzella (2018) showed attachment anxiety is associated with the use of one's smartphone for refuge, which in essence, is the degree someone feels safe while relying on one's smartphone as a secure base. To this end, the following hypothesis is proposed:

Hypothesis 3b: Attachment Anxiety Will Predict Smartphone Refuge

The relationship between attachment anxiety and FoMO has recently gained much focus in the empirical literature. For example, correlational research has found these variables to be moderately related with correlational coefficients ranging from 0.29 (Alfasi, 2022) to 0.73 (Holte & Ferraro, 2020). One reason for this relationship could rest in the knowledge that both concepts, to an extent, worry about their social relationships. Przybylski et al. (2013) conceptualized FoMO as a feeling that is experienced when an individual feels deficits in basic psychological needs of autonomy, competence, and relatedness. It is possible that individuals with higher attachment anxiety have deficits in the relatedness psychological need as they feel less secure about their relationships (Cassidy & Berlin, 1994; Collins, 1996). Provided relatedness is a key component to social relationships (Byrne, 1961), this may be one reason why attachment anxiety has shown to be associated with FoMO (Alfasi, 2022; Blackwell et al., 2016; Holte & Ferraro, 2020; Holte, 2023; Liu & Ma, 2019).

Thus, the following hypothesis is proposed:

Hypothesis 3c: Attachment Anxiety Will Predict FoMO

Interaction of Person-Affect-Cognition-Execution Model (I-PACE)

The I-PACE model is a theoretical prospective which can explain why some individuals develop problematic technological use (Brand et al., 2016, 2019). The general idea of this model of behavior is that it considers the interaction of individual aspects of the individual, their current affect, and thoughts which all tie into together for the execution of a specific behavior. Within the perspective of the I-PACE model, it would be anticipated that as a result of resorting to one's smartphone as a secure base, individuals will gradually develop PSU. That is, according to the I-PACE model, individuals would develop the behavioral response to resort to their smartphone anytime they need support, and this learned association will gradually progress to PSU.

Hypothesis 4: Refuge Will Predict PSU

In addition, it is anticipated that one's sense of their smartphone being a secure base will be a mediational factor between the relationship of attachment anxiety at PSU. That is, if an individual scores high in attachment anxiety and uses their smartphone as a secure base, the extent their smartphone is a refuge should mediate the extent they develop PSU. Individuals who do not see their smartphone as a secure base may resort to other entities when they are distressed which in turn, based on the I-PACE model, would make them less inclined to experience PSU.

Hypothesis 5: Refuge Will Mediate the Relations of Attachment Anxiety and PSU

Fear of Missing Out (FoMO)

Fear of Missing Out (FoMO), the concern one is missing out on an enjoyable experience (Przybylski et al., 2013). When people experience FoMO, it is not uncommon for individuals to have the desire to alleviate the concern of missing out. Thus, it is often considered to be an antecedent of technology use. In particular, research has demonstrated FoMO to be related to PSMU (Dempsey et al., 2019; Holte,

2023; Liu & Ma, 2019) and PSU (Chotpitayasunondh & Douglas, 2016; Holte, 2023; Elhai et al., 2018a). Within the I-PACE model, FoMO would be a form of negative affect that prompts people to log onto SNS sites, via smartphone or computer, to verify or dismiss their concern that others are having a more enjoyable time than themselves. Thus, when people have deficits in the psychological needs of autonomy, competence or relatedness, individuals then experience FoMO as suggested by Przybylski et al. (2013), and this negative emotional state drives individuals to resort to their smartphone as a secure base, and repeated cycles of the I-PACE model causes the individual to develop PSU. Thus, the following hypothesis is proposed:

Hypothesis 6: Fear of Missing Out Will Predict Refuge and PSU

Moreover, the extent to which an individual views their smartphone as a refuge should ultimately determine the extent to which one's FoMO predicts PSU. If an individual does not resort to their smartphone when they are distressed by the apprehension others are having a rewarding experience, according to the I-PACE model, they would not be as prone to PSU compared to those who do. Thus, the following hypothesis is proposed:

Hypothesis 7: Refuge Will Mediate the Relations of FoMO and PSU

In addition, it is expected that FoMO would mediate the relationship between attachment anxiety and refuge. Simply put, the extent to which someone resorts to their smartphone as a secure base likely could be influenced by the extent to which they experience FoMO. People who have a stronger propensity to experience FoMO mixed in with their dispositional attachment anxiety likely should predict the extent someone views their smartphone as a refuge. Based on the I-PACE Model (Brand et al., 2016, 2019), FoMO would be a type of negative affectivity which would prompt individuals to use their smartphone to ameliorate the FoMO they experience. Provided young adults view their smartphone as a secure base (Fowler & Noyes, 2015), it is viable one of the affordances used to gain a sense of security is information that can support or refute their concern they are missing out. Taken together, it is reasonable that FoMO will also mediate the relations proposed below.

Hypothesis 8: Fear of Missing Out Will Mediate the Relations of Attachment Anxiety and Refuge

Current Study

The aims of the current study are to further understand the relationship between attachment and PSU. While prior work has demonstrated attachment anxiety and PSU are associated with each other (Parent et al., 2021, 2022; Sun & Miller, 2023), more work is needed to understand the dynamics of this relationship. Moreover, it is important for research to consider the role of telepressure as a predictor of attachment anxiety, as it is feasible both GTP-Preoccupied and GTP-Urge predict attachment anxiety, and the extant literature has yet to identify if telepressure is a predictor of attachment anxiety.

Methods and Materials

Participants

The initial sample of this study consisted of 776 individuals, but this number was revised to 761 after dropping 15 participants who got an attention check question wrong. Participants were recruited from Cloud Research, an online research participant recruitment site (Litman et al., 2017). The average age of the sample was 42.29 (SD = 14.656, range 18–80) years old, and it was mostly female (64.8%), White (79.1%), indicated a bachelor's degree was their highest level of education (36.8%), and resided in the Southeast of the United States (30.1%). The demographics of this sample is depicted on Table 1.

Materials

The materials used for the current study are outlined in Table 2.

Procedure

All procedures and protocols designed for the current study were approved by the Institutional Review Board prior to data collection. The research study was listed on Cloud Research (Litman et al., 2017), a commonly used research participant recruitment site. Those interested in participating clicked a link which took them to Qualtrics where the study was hosted. Participants who consented to participate completed the following questionnaires in counterbalanced order: General Telepressure Scale (Barber & Santuizz, 2017), Young Adult Attachment to Phone Scale (Trub & Barbot, 2016), Experiences in Close Relationships—Relationships Structures Global (Fraley et al., 2015), Fear of Missing Out Scale (Przybylski et al., 2013), and the Smartphone Addiction Scale—Short Version (Kwon et al., 2013). Lastly, participants were compensated financially ($0.50 USD) for their time spent completing the research study.

Analyses

Both AMOS Structural Equation Modeling (IBM Corp, 2021a) and SPSS (IBM Corp, 2021b) software platforms were used for our statistical analyses. Structural Equation

Table 1 Demographic information

	Total	Percentage
Sex		
Male	264	34.69%
Female	493	64.78%
Prefer to not respond	4	0.53%
Race/ethnicity		
White	602	79.11 %
Black or African American	71	9.33%
Asian or Pacific Islander	64	8.41%
Hispanic or Latino	48	6.31%
Native American or American Indian	12	1.58%
Other – Did not Specify	4	0.53%
Middle Easterner	1	0.13%
Education		
High School/GED	205	26.94%
Associate's	138	18.13%
Bachelor's	280	36.79%
Master's	122	16.03%
Doctorate	16	2.10%
Geographic region of residence		
Southeast – USA	229	30.09%
Northeast – USA	181	23.78%
Midwest – USA	163	21.42%
West – USA	113	14.85%
Southwest – USA	75	9.86%

USA United States of America, provided individuals were able to endorse multiple races and ethnicities, these values may exceed 100%

Modeling (SEM) is a multivariate statistical technique that allows researchers to examine how variables are causally connected (Byrne, 2016). By using SEM, researchers are able to estimate the causal pathways between multiple variables simultaneously, which is a key strength of its use. The Indirect Effects plugin (Gaskin & Lim, 2018) was used with the AMOS software to calculate the effects of multiple mediators. Missing data ranged from 0 to 0.8%, and Littles MCAR test revealed the data was missing completely at random. Thus, missing values were imputed with expectation maximization (Dempster et al., 1977) procedures. The recommended values of skewness and kurtosis while using SEM are—3 to 3 for skewness and—10 to 10 for kurtosis (Brown, 2006). For the current study, our values were within reasonable ranges as they varied from −0.918 to 1.849 for skewness and −1.346 to 2.748 for kurtosis. To analyze the SEM model, Confirmatory Factor Analysis with maximum likelihood was used to assess model fit. Bootstrapping with 95% confident interval was used to test the mediational analyses with 2000 bootstrapped samples.

Model fit was assessed with use of model chi square, Tucker Lewis Index (TLI), root-mean-square-error-of-approximation (RMSEA), comparative fit index (CFI), and standardized root mean square residual (SRMR). The values obtained within these metrics were compared with standard benchmarks in the field. This includes having an SRMR value ≤ 0.08, RMSEA ≤ 0.06 (Hu & Bentler, 1999), CFI ≥ 0.90 (Byrne, 1994) and TLI values ≥ 0.90 (Marsh et al., 2004a). Moreover, ideally model chi square should be ≥ 0.05, but sample size tends to implicate this index (Byrne, 2016). Model fit was improved by adding covariance paths to the error terms of items. The placement of these paths were based on modification indices (MI) greater than 30, with the paths being placed in stepwise order from largest to smallest MI. Prior to adding each new covariance path, model fit was examined. The placement of these covariance paths was guided by the suggestions of Marsh et al. (2004b), which outlines that only covariance paths that are the largest and theoretically justifiable should be applied.

Results

Descriptive and correlational statistics are depicted on Table 3. The initial SEM model depicted poor fit across the indices of CFI (0.876), TLI (0.865), SRMR (0.081), RMSEA (0.080) and had a statistically significant Chi

Table 2 Measures

Measure	Description	α
Demographics	5 items regarding sex, age, race/ethnicity, education, and region of country where they live	N/A
General Telepressure Scale	3 items per factor for a total of 6 items, 1 to 5 (Strongly Disagree to Strongly Agree)	Urge– .93; Preoccupation– .86.
Young Adult Attachment to Phone Scale – Refuge Factor	3 items, 1 to 5 (Disagree Strongly to Agree Strongly)	.75
Experiences in Close Relationships – Relationships Structures Global – Attachment Anxiety Subscale	3 items, 1 to 7 (Strongly Disagree to Strongly Agree)	.92
Fear of Missing Out Scale	10 items, 1 to 5 (Not at all true of me to Extremely true of me)	.92
Smartphone Addiction Scale – Short Version	10 items, 1 to 7 (Strongly Disagree to Strongly Agree)	.91

Table 3 Descriptive and correlational statistics

	Mean	SD	Range	2	3	4	5	6
1. Attachment anxiety	10.42	5.34	3-21	.579 ***	.385 ***	.336 ***	.448 ***	.331 ***
2. Fear of Missing Out	20.44	9.20	10-50		.470 ***	.458 ***	.571 ***	.413 ***
3. GTS – Preoccupation	8.62	3.46	3-15			.792 ***	.554 ***	.527 ***
4. GTS – Urge	8.44	3.83	3-15				.521 ***	.548 ***
5. PSU	23.78	10.58	10-60					.659 ***
6. Refuge	8.95	2.91	3-15					

GTS General Telepressure Scale, *PSU* Problematic Smartphone Use

***$p < .001$

Square ($p < .001$). As depicted on Table 4, modification indices were used and resulted in improved psychometric fit. The final SEM model depicted acceptable fit in TLI (0.928), SRMR (0.073), CFI (0.935), and RMSEA (0.058) Table 4. As expected with a large sample, model chi square was statistically significant ($p < .001$). Figure 2 depicts the SEM model without error terms or individual items to improve visual simplicity. As indicated in Fig. 2, with the exception that Telepressure-Urge would predict attachment anxiety (H2a) and attachment anxiety would predict PSU (H3a), each of the hypotheses pertaining to a direct path was supported. In addition, as depicted in Table 5, refuge mediated the relationship of attachment anxiety and PSU (H5), refuge mediated the relationship of FoMO with PSU (H7), and FoMO mediated the relationship of attachment anxiety and refuge (H8).

Discussion

Smartphones are everywhere in modern society. We rely on them for a myriad of activities. Based on this reliance towards smartphones, it is reasonable people may develop an attachment to them. As a result of this bond humans have formed with their smartphones, research has taken an interest in this relationship. Though research has demonstrated humans develop attachment to their smartphone (Holte & Ferraro, 2021; Keefer et al., 2012; Konok et al., 2016; Trub & Barbot, 2016; Nie et al., 2020; Parent et al., 2021), more work is needed to understand the dynamics of smartphone attachment and problematic smartphone use. By identifying these mechanisms, important individual differences may be discovered. The current study aimed at increasing awareness in smartphone attachment as it relates to problematic smartphone use. This research builds upon the findings of other research, by including significant relations of constructs previously found in the empirical literature such as attachment anxiety and FoMO (Alfasi, 2022; Blackwell et al., 2016; Holte & Ferraro, 2020; Holte, 2023; Liu & Ma, 2019), attachment anxiety and PSU (Parent et al., 2021, 2022; Sun & Miller, 2023), FoMO and PSU (Chotpitayasunondh & Douglas, 2016; Holte, 2023; Elhai et al., 2018a), as well as variables previously not studied within the smartphone attachment literature (e.g., telepressure and Smartphone Refuge), within one structural equation model to examine if these findings remain significant while including other variables within the same model. After testing out hypothesized model, numerous key findings were replicated and identified.

First, it was discovered that Telepressure-Preoccupied predicted both problematic smartphone use (H1a) and attachment anxiety (H1b). Based on the I-PACE model, it

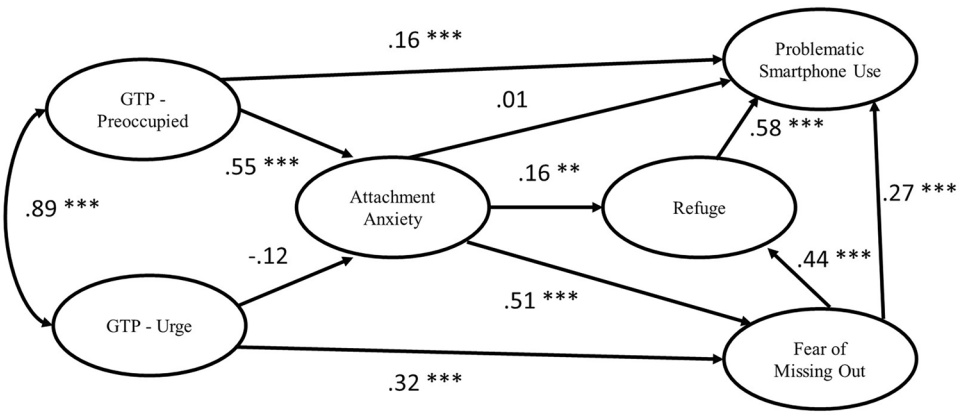

Fig. 2 SEM model without error terms or individual items to improve visual simplicity. Note: ** $p < .01$, *** $p < .001$

Table 4 Fit indices of each iteration of the structural equation model after the addition of covariance paths

Path added	MI	X^2 (df)	CFI	TLI	SRMR	RMSEA	RMSEA 90% CI
None	None	2644.190 * (453)	.876	.865	.081	.080	.077 to .083
FoMOS 1 to FoMOS 2	354.404	2224.394 * (452)	.900	.890	.078	.072	.069 to .075
FoMOS 7 to FoMOS 9	220.722	1975.655 * (451)	.914	.905	.077	.067	.064 to .070
SAS 1 to SAS 2	204.255	1746.743 * (450)	.927	.919	.076	.062	.059 to .065
SAS 4 to SAS 7	69.277	1674.574 * (449)	.931	.924	.075	.060	.057 to .063
FoMOS 3 to FoMOS 4	35.586	1624.845 * (448)	.934	.927	.073	.059	.056 to .062
SAS 1 to SAS 3	31.287	1592.247 * (447)	.935	.928	.073	.058	.055 to .06

MI Modification Index for the path

*$p < .001$

was reasonable that individuals who have messages they need to respond to on their mind are more prone to developing problematic smartphone use. In this example, the preoccupation thought of one's messages they need to attend to is the negative affectivity, which after repeated cycles of the model, problematic smartphone use is possible. Similarly, the relation with attachment anxiety is not surprising, given attachment anxiety is related with a preoccupation about the whereabouts of others (Hazan & Shaver, 1987) and in general, a stronger propensity to ruminate (Garrison et al., 2014; Lanciano et al., 2012; Liu et al., 2021). Moreover, it was found that Telepressure-Urge was not a predictor of attachment anxiety (H2a). This suggests that though individuals having preoccupied thoughts tend to have higher attachment anxiety, individuals who feel the desire to respond quickly appear to not have this association. It was, however, discovered that Telepressure-Urge predicted FoMO (H2b). One interpretation of this is that FoMO is related to the fear of social exclusion (Holte et al., 2022; Marengo et al., 2021; Wang et al., 2023), and individuals have an expectation for responses to their text messages to be delivered promptly (Forgays et al., 2016). Thus, in an effort to mitigate the chance one's slow responses severs these friendships, people respond to messages promptly.

Though prior work had demonstrated attachment anxiety and PSU had a relationship (Parent et al., 2021, 2022; Sun & Miller, 2023), in the current study, attachment anxiety was not a significant predictor of PSU (H3a). One explanation for this is the possibility that refuge was a better predictor of PSU, provided it specifies attachment anxiety behaviors with the use of one's smartphone (IE: feeling uncomfortable being separated from one's smartphone). As a result of being a better predictor, it is possible that variance that attachment anxiety would normally explain was allotted to refuge instead. While attachment anxiety was not a predictor of PSU, it was a predictor of refuge (H3b). This suggests individuals who score high in attachment anxiety are more prone to view their smartphone as a secure base. This finding replicates similar outcomes which suggest high attachment anxiety individuals tend to become attached to their smartphones more than those who score lower in attachment anxiety (Konok et al., 2016; Parent, 2019). Likewise, attachment anxiety was a significant predictor of FoMO (H3c), which replicates numerous prior works (Alfasi, 2022; Blackwell et al., 2016; Holte & Ferraro, 2020; Holte, 2023; Liu & Ma, 2019).

One of the more notable findings in the current study involved the role of refuge. In particular, the extent to which someone viewed their smartphone as a secure base appears to predict how prone someone is to have higher PSU severity (H4). This provides further support to how viewing smartphone use through the lens of attachment theory can explain problematic use. Moreover, it was found that refuge mediated the relationship of both attachment anxiety and PSU (H5) and the relationship of FoMO and PSU (H7). These findings establish that individuals are more prone to developing PSU based on the extent to which they view their smartphone as a secure base. This is an important contribution to the literature as it is among the first to empirically evaluate the role of refuge as a mediator between these relationships.

As expected, FoMO predicted the degree people viewed their smartphone as a secure base (H6a). Prior research suggested FoMO develops as a result of feeling one's psychological needs are not being me (Przybylski et al. 2013). Moreover, Keefer et al. (2012) found that individuals have higher object attachment as a manner to compensate for the inaccessibility of close others. Taking these findings into account, it is viable individuals who experience deficits in psychological needs (e.g., autonomy, relatedness,

Table 5 Statistics of indirect effects in the structural equation model

Predictor	Mediator	DV	β	S.E	95% CI
AA	Refuge	PSU	.09 **	.04	.01 to .06
FoMO	Refuge	PSU	.26 ***	.04	.16 to .26
AA	FoMO	Refuge	.23 **	.03	.10 to .16

DV dependent variable, *AA* attachment anxiety, *FoMO* Fear of Missing Out

**$p < .01$; ***$p < .001$

competence) will resort to their smartphone to comfort themselves. Moreover, provided individuals have complete control over their smartphone, they know it will be there for them and they can use it to exercise the psychological need they may have a deficit in. Based on the finding that refuge predicts PSU severity, more work is needed in understanding other maladaptive outcomes of resorting to one's smartphone as a secure base. Alternatively, understanding potential factors which can mitigate the presence of negative symptoms such as PSU need to be studied to encourage the health of others.

It was also revealed that FoMO predicted PSU (H6b). This finding has been established in the literature (Chotpitayasunondh & Douglas, 2016; Holte, 2023; Elhai et al., 2018a). With the framework of the I-PACE model (Brand et al., 2016, 2019), FoMO is a form of negative affectivity which prompts individuals to use digital technologies, such as smartphones. Thus, when individuals have the apprehension others are having a rewarding experience without them, it is viable people may resort to their smartphone to check SNS to confirm or deny this concern. Likewise, FoMO mediated the relation of attachment anxiety and refuge (H8). Based on what has been discussed about FoMO being a feeling that is experienced with deficits to psychological needs are present (Przybylski et al. 2013), the propensity to which an individual feels the need to resort to their smartphone appears to be related to the degree they experience FoMO. Individuals with lower FoMO may be less inclined to resort to their smartphone as a secure base, which those with higher amount would likely be more inclined (Table 5).

Practical Implications

There is an important practical implication that need to be addressed within the current research. Namely, the finding that smartphone refuge predicts PSU suggests when individuals seek treatment for their overuse of their smartphone, there is an emotional connection between the individual and their smartphone that the clinician needs to keep account of when trying to help the patient. Therefore, when trying to treat PSU, interventions that result in separating the individual from their smartphone likely will cause emotional distress. One intervention that appears to be effective in the empirical literature is the Grayscale Screen Display paradigm (Holte, 2023). This intervention consists of switching an individual's smartphone to the grayscale screen display setting, which removes the bright saturated colors that have shown to be stimulating to the brain (Mikellides, 1990). A benefit of using this paradigm in treating PSU is that it would allow the user to continue to use their smartphone, without separating them from it, which in turn could prevent emotional distress that may be caused by separation. By applying this finding that smartphone refuge predicts PSU, clinicians in turn can best treat their patients and help them live a better life.

Managerial Implications

There are numerous managerial implications and next steps for future research that can be addressed. First, it was revealed that attachment anxiety was not a significant predictor of PSU with the inclusion of Smartphone Refuge in the model. While prior work has found PSU and attachment anxiety to be associated with each other (Parent et al., 2021, 2022; Sun & Miller, 2023), the current research found that other variables appear to be better predictors of PSU and may have taken away variance that attachment anxiety normally explained. That is, the extent an individual views their smartphone as a secure base appears to be more influential when predicting PSU. While this is a key finding of the research, it is important to address that more research is needed to evaluate the findings of the current study. Namely, longitudinal research could further provide more understanding of the temporal relationship of these variables. By using longitudinal frameworks, future research will be able to detect if smartphone refuge at Time 1 predicts PSU at Time 2. This type of research will improve our understanding that smartphone attachment causes individuals to use their smartphone in problematic ways.

Limitations

Though this study featured numerous strengths such as having a large enough sample to use SEM analyses, there are limitations to address. The first major limitation of this work is it did not use a true experimental research design; thus, causality cannot be implied. Future research would need to use such a framework to have a better understanding of how viewing one's smartphone as a secure base can result in higher PSU severity. Second, this research was a cross-sectional research design, which does not allow for the study of longitudinal effects of study variables. Third, this research was conducted while the global COVID-19 pandemic was still taking place. Perhaps, the findings of the current study were impacted by the timing of data collection? Future research is encouraged to reexamine the structural model now that COVID-19 is no longer considered a global health emergency by the World Health Organization. Fourth, the proportion of females who participated in the research was higher than the proportion of females in the United States, suggesting our sample was skewed as it pertains to sex. Though sex differences in smartphone use are limited, this is an important consideration to make when critiquing the current research. Fifth, while the use of Cloud Research to recruit a nationwide sample of participants allowed for a diverse sample of participants to be recruited, it is important to note that individuals who participate in online research studies may differ

in some ways in comparison to people who do not spend their free time participating in such research. Sixth, though a nationwide recruitment method was used to recruit the sample, it was primarily White which is not generalizable to the US population. Though to current knowledge, there are no major demographic differences in smartphone use; this is an important consideration to consider. Lastly, the current research did not specify participants to differentiate between work and personal smartphone use. Future research is encouraged to see if PSU differs based on specific uses (IE: personal or work).

Conclusion

Aside from these limitations, the current study contributes more knowledge about the relationship between smartphone attachment and PSU. Namely, how refuge mediated the relationship of both attachment anxiety and PSU as well as the relationship of FoMO and PSU. Thus, the current study further fortified the viewpoint of smartphone use being studied through the lens of attachment theory. This paper also contributes to the FoMO literature by underlining how FoMO predicts the extent someone views their smartphone as a secure base, as well as mediates the relationship between attachment anxiety and refuge. Taken together, the current work identified numerous structural relationships and fosters further knowledge of problematic smartphone use. This work is valuable as smartphone use continues to be a dominant theme in the lives of many, research is needed to understand the behavior.

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Data Availability The data which supported the findings of the research are available by contacting the corresponding author.

Declarations

Ethics Approval and Consent to Participate All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all participants.

Conflict of Interest The author declares no competing interests.

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