

Hallauer, C. J., Rooney, E. A., Billieux, J., Hall, B. J., & Elhai, J. D. (2022). Mindfulness mediates relations between anxiety with problematic smartphone use severity. *Cyberpsychology: Journal of Psychosocial Research on Cyberspace*, 16(1), Article 4. <https://doi.org/10.5817/CP2022-1-4>

Mindfulness Mediates Relations Between Anxiety With Problematic Smartphone Use Severity

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Abstract

A growing body of literature has demonstrated relations between mood- and anxiety-related psychopathology with problematic smartphone use (PSU) symptom severity. However, there has been little empirical inquiry of potential mediators of these relationships. The current study examined trait mindfulness and smartphone use expectancies as mediators of the relation between depression/anxiety and PSU severity in 352 undergraduate students. Participants completed an online survey that measured depression, anxiety, smartphone use expectancies, and PSU severity. Structural equation modeling demonstrated that trait mindfulness was inversely associated, and smartphone use expectancies were positively associated, with PSU severity. Trait mindfulness significantly mediated relations between anxiety and PSU severity. Results provide implications for understanding PSU within the context of theoretical models of PSU's development, and highlight the role of mindfulness as an emotion regulation strategy and potential treatment for PSU.

Keywords: mindfulness; problematic smartphone use; depression; anxiety; structural equation modeling

Editorial Record

First submission received:
January 8, 2021

Revision received:
June 12, 2021

Accepted for publication:
November 18, 2021

Editor in charge:
David Smahel

Introduction

Smartphones are a prominent mainstay of the modern world, with an estimated 3 billion users worldwide in 2019 (O'Dea, 2020). Concurrent with the rise in smartphone ownership is concern about excessive smartphone engagement that results in functional impairment of daily life (Busch & McCarthy, 2021; Elhai, Levine, et al., 2019). Smartphone overuse is associated with increased mental health symptoms – especially depression and anxiety (Elhai, Levine, et al., 2019). However, only recently have researchers examined mediating variables explaining relations between depression/anxiety and excessive smartphone use.

Excessive smartphone use is often referred to in the literature as problematic smartphone use (PSU), but also “smartphone use disorder,” “smartphone addiction” and similar terms (Montag, 2019; Thomée, 2018). It is important to note that PSU is not currently recognized as a diagnosable disorder. Although similarities in presenting symptoms (e.g., loss of control, withdrawal-like symptoms), and psychosocial risk factors (Billieux, 2012; Billieux et al., 2015; Montag, 2019; Montag et al., 2016; Ryding & Kaye, 2018) exist between PSU and addictive disorders, Panova & Carbonell (2018, see also Starcevic et al., 2020) clarify one does not become addicted to the

internet itself and, in the context of smartphone use, the term “addiction” is perhaps best applied to disordered use of internet channels/content accessed via the smartphone. Yet, it has also been suggested that the smartphone itself can become a learned cue related to aforementioned channels/content and, on its own, may elicit cue-reactivity, complicating the term “addiction” in the context of a smartphone (Duke & Montag, 2017a). Moreover, recognizing that the smartphone is a medium that may fuel specific problematic behaviors fits with current research aimed at identifying general risk factors that promote smartphone-mediated problematic behaviors (Billieux et al., 2015; Canale et al., 2021).

To date, no consensus has been reached on relevant criteria to speak of addictive behavior or a “Use Disorder” associated with the smartphone or with the internet, and concerns of over-pathologizing normal behavior remain (e.g., Billieux et al., 2019; Starcevic et al., 2020). Theoretical frameworks describing PSU and problematic internet use (PIU) have generally been developed on the framework of substance use disorders (e.g., Brand et al., 2016; Elhai et al., 2019b; Kardefelt-Winther, 2014), which accounts for conceptual overlap between both PSU and PIU models and dominant substance use disorder models (James & Tunney, 2017; Kardefelt-Winther et al., 2017). Moreover, models of PSU and PIU themselves present important conceptual overlap, yet important differences exist and the uniqueness of each medium has been too often overlooked in past research (Duke & Montag, 2017a; Lachmann et al., 2017). For example, the smartphone’s portability and convenience may contribute to overuse by enabling constant internet access (Elhai et al., 2017), highlighting ease of access as an important factor distinguishing PSU from PIU (Anderson et al., 2017). Differential context of use, such as accessing social networking sites (SNS) only via a smartphone, and preference of use, meaning preference to access certain apps via a smartphone and others through a computer, may also differentiate PSU from PIU (Tankovska, 2021). Montag et al. (2021) concluded that smartphones are the current pre-eminent method for accessing the internet and thus potentially represent the driving force behind PIU, suggesting that investigation of PSU is important and necessary even if questions about taxonomy, construct overlap, and potential diagnostic criteria remain.

Consistent with above information and recommendations by Montag et al. (2021), we use the term “PSU” to capture the predominantly mobile form of PIU and to account for an uncontrolled and excessive use of the smartphone engendering tangible negative consequences, such as interpersonal and school/work impairment (Billieux, 2012; Busch & McCarthy, 2021; Elhai, Levine, et al., 2019; Lee et al., 2019). PSU severity is generally associated with psychopathology, primarily depression (with medium effect sizes) and anxiety severity (with small-to-medium effects) (Busch & McCarthy, 2021; Elhai, Levine, et al., 2019; Elhai, Tiamiyu, & Weeks, 2018; Lewis & Martin, 2020; Porter et al., 2020). PSU is associated with other adverse consequences, such as sleep problems from late night overuse (Yang et al., 2020), and academic interference (Busch & McCarthy, 2021). Additionally, PSU is related to greater distractibility while driving, leading to poorer reaction times and increased risk of driving accidents (Li et al., 2019) and pedestrian accidents (e.g., falls, bumps, collisions; Kim et al., 2017). The predominant view is that mental health problems drive PSU as self-medication, rather than the reverse (Brand et al., 2019). Recent work has considered additional contributing influences on PSU, involving internet-related cognitive biases, and cognitive- and emotion-related coping strategies (see Elhai, Yang, et al., 2019 for a review). The current paper considers two such influences: mindfulness and smartphone use expectancies.

Internet use expectancies represent an internet-related cognitive bias that may contribute to PSU (Brand et al., 2019). Like other areas of overlap between SUDs and PIU/PSU, expectancies are grounded in theoretical frameworks of SUDs and involve beliefs about the positive and negative affective, behavioral, and cognitive effects of using a substance (Cooper et al., 2016) or the internet (e.g., Brand et al., 2016). Expectancies have been consistently associated with SUDs (Montes et al., 2019) and PIU and can be either positive or negative in valence. Positive expectancies reflect the belief that using a substance or the internet results in positive outcomes and/or experiencing positive emotion. However, the definition of negative expectancies depends on the situation. In the context of substance use, negative expectancies refer to perceived negative consequences of using a substance, such as using tobacco results in feeling sick (Rohsenow et al., 2003). By contrast, negative expectancies in the context of smartphone use reflect using a smartphone to avoid negative emotions and experiences (Brand et al., 2014; Elhai, Yang, Dempsey, et al., 2020). Further, positive and negative use expectancies correlate with PIU severity (Brand et al., 2014; Wegmann et al., 2015; Wegmann & Brand, 2016, 2019) and are reinforcing if associated with desired effects of internet use (Brand et al., 2016). Little work has examined relations between smartphone use expectancies with PSU, with one study finding an especially strong relationship between negative smartphone use expectancies (NSE) and PSU severity (Elhai, Yang, Dempsey, et al., 2020). Given the previous discussion on

overlap between PIU and PSU, it can be supposed that similar reinforcement processes implicated in PIU can lead to habitual smartphone use (Brand et al., 2019) and consequential PSU (Chen et al., 2019).

An additional emotion-related coping strategy is mindfulness, or mindful attention, involving being open, attentive to, and aware of the present moment and serves as an emotion regulation strategy (Leyland et al., 2019). Mindfulness is conceptualized as regulating emotion through engagement with, rather than suppression or avoidance of, emotional experience (Brown & Ryan, 2003). Further, mindfulness is reduced when an individual engages with automatic or habitual behaviors, such as phone checking (van Deursen et al., 2015). Prior research suggests mindfulness is inversely related to PIU severity (Arslan, 2017; Owen et al., 2018) and overuse of specific online activities such as online games and SNS (Kircaburun et al., 2019) but little work has examined its relationship with PSU (Arapaci, 2021; Elhai, Levine, O'Brien, et al., 2018; Regan et al., 2020). Because emotional avoidance strategies such as rumination and emotional dysregulation are related to PSU severity (Elhai, Tiamiyu, Weeks, et al., 2018; Elhai, Yang, Dempsey, et al., 2020), increased mindful awareness (an emotional regulation skill) should serve as a buffer against the impact of PSU (i.e., decrease the severity of PSU; see Elhai, Levine, O'Brien, et al., 2018) consistent with the overlap between PIU and PSU and emotion regulation theory (Gross, 1998).

Given the prevalence of smartphone use and corresponding benefits (i.e., utility, portability), and consequences of misuse/overuse (e.g., accidents due to distractibility, sleep problems, etc.), it is pertinent to examine potential contributors to PSU. The evidence thus far suggests maladaptive cognitive and emotional coping strategies are associated with increased PSU (Elhai, Yang, et al., 2019). In particular, areas in the literature that warrant additional attention are smartphone use expectancies and mindfulness. Understanding how these variables relate to existing psychopathology within the context of a theoretical framework can provide evidence for the underpinnings of PSU.

Aims

Although the relationship between depression/anxiety and PSU severity has been established (Busch & McCarthy, 2021; Elhai, Levine, et al., 2019), less is known about variables that mediate this relationship – especially cognitions, and cognitive- and emotion-related processes mediating relations between depression/anxiety and PSU severity (see Elhai, Yang, et al., 2019 for a review). We examined relationships between mindfulness (an emotion coping process) and smartphone use expectancies (internet-related cognitions) with PSU severity. We also explored how mindfulness and smartphone use expectancies may mediate relations between depression/anxiety with PSU severity.

Theory

Relevant to this study is Brand et al.'s (2016, 2019) Interaction of Person-Affect-Cognition-Execution (I-PACE) model of PIU. I-PACE describes psychological and neurobiological processes and risk factors underlying development and maintenance of PIU. In fact, Brand et al. (2016, 2019) highlighted I-PACE's application to several behaviors, including excessive use of communications applications, unspecified internet use disorder, and others. First, personal components consist of one's core characteristics that may predispose an individual to PIU, such as genetic contributions, negative childhood experiences, and psychopathology variables (e.g., depression and social anxiety). Second, I-PACE proposes responses to personal components that involve risk and resilience factors, such as cognitive and attention bias, use expectancies, inhibitory control and craving, and coping strategies. These response variables are conceptualized to moderate or mediate relationships between personal components and PIU (Brand et al., 2019). Finally, I-PACE assumes these response variables influence decisions about using specific internet features or applications, which can lead to maladaptive/problematic use or adaptive use. Although Brand et al. (2016) developed I-PACE specifically to account for specific types of PIU, recent research supports I-PACE in modeling PSU severity (Dempsey et al., 2019; Elhai, Yang, Dempsey, et al., 2020; Elhai, Yang, Fang, et al., 2020; Lemenager et al., 2018; Oberst et al., 2017; Yuan et al., 2021).

Hypotheses

The following hypotheses are posed based on theory and literature presented. The general trend in these hypotheses is that mindfulness and smartphone expectancies represent resilience and risk factors (respectively) from I-PACE, associated with PSU severity, and mediating relations between depression/anxiety and PSU severity.

H1: Mindfulness will be inversely related to PSU severity.

H2: Positive smartphone use expectancies (PSE) will be positively related to PSU severity.

H3: Negative smartphone use expectancies (NSE) will be positively related to PSU severity.

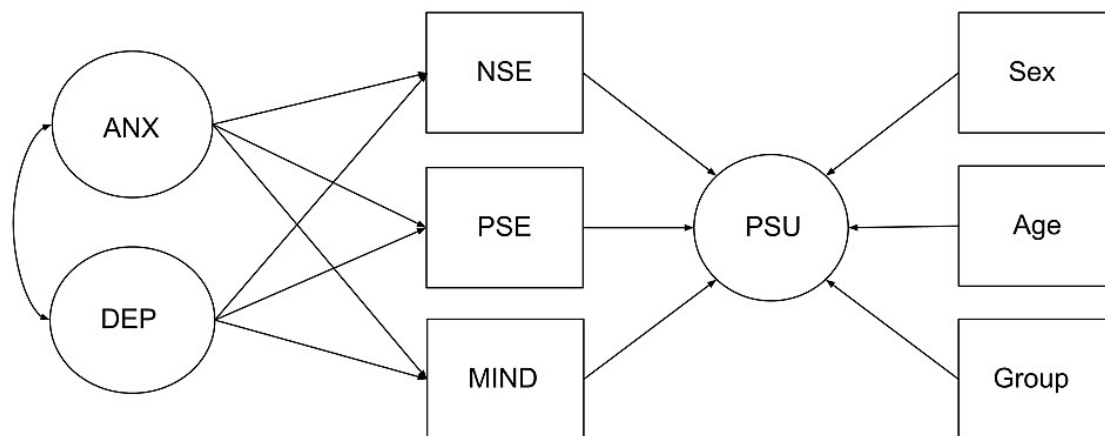
H4: PSE and NSE will mediate relations between depression (H4a) and anxiety (H4b) with PSU severity.

H5: Mindfulness will mediate relations between depression (H5a) and anxiety (H5b) with PSU severity.

Research Model

Our research model is presented in Figure 1.

Figure 1. *Hypothesized Model for Psychological Contributors to PSU, Controlling for Sex, Age, and Social Distancing Group.*



Notes. Circles represent latent variables; squares represent observed variables. ANX=Anxiety; DEP=Depression; PSE=Positive Smartphone Expectancies; NSE=Negative Smartphone Expectancies; MIND=Trait Mindfulness; PSU=Problematic Smartphone Use; Group=Social distancing group.

Depression and anxiety severity are conceptualized to relate to mindfulness, PSE, and NSE, which in turn should relate to PSU severity. Age and sex were also included as covariates of PSU severity; younger age and female sex are associated with increased PSU severity (Csibi et al., 2021; Fischer-Grote et al., 2019). Because data collection was ongoing when the 2020 COVID-19 pandemic emerged in the U.S., we also modeled pre- and post-COVID-19 emergence as a covariate of PSU severity. Our model is consistent with I-PACE by placing psychopathology variables as predictors, protective/risk factors such as mindfulness and expectancies as mediators, and PSU severity as the outcome variable.

Method

Participants and Procedure

The present study used a subset of measures drawn from a larger project. Data were obtained via an online survey through PsychData. The study was approved through the university's Institutional Review Board. Participants were undergraduates from a Midwestern U.S. university recruited from the Psychology Department's research pool. Participants completing the survey were awarded course research points. After consenting to an online consent statement, 388 participants participated. We removed 15 participants for duplicate survey entries (based on

survey timestamps), and 11 participants for completing a very small proportion of items. We also removed 10 participants for careless/inattentive responding (with a string of 19 or more consecutive identical responses), similar to previous estimates and suggestions (Curran, 2016). The resulting sample included 352 participants.

A majority of participants were female (66.2%; $n = 233$; sex was coded as: male = 1, female = 2) and average age was 19.79 years old ($SD = 3.43$; $Min = 18$; $Max = 53$; only 3.13% were age 25 and older). Racial breakdown included: 80.7% ($n = 284$) White, 13.9% ($n = 49$) Black, 5.7% ($n = 20$) Asian. Approximately 5.4% ($n = 19$) of participants identified as Latinx. A majority of student participants were either employed part-time (51.98%; $n = 183$) or unemployed (40%; $n = 141$).

A portion of the survey data were collected during the COVID-19 pandemic. We assessed if the pandemic affected our results. The university closed in-person instruction on March 16, 2020, resulting in online-only learning, and significant changes to students' lives, including vacating dormitories and moving back to their family's homes. We formed two groups in our dataset: a pre-social distancing group of 169 participants (before university closure), and social distancing group of 183 participants (after closure) based on survey timestamps.

Measures

In addition to demographics assessed, we administered the following surveys. Table 1 displays the current sample's coefficient alphas.

Depression Anxiety Stress Scales-21 (DASS-21)

We administered the DASS-21 (Gomez et al., 2020). The DASS-21 is composed of three subscales that assess depression, anxiety, and stress. Items are rated via a Likert scale from 0 = *Did not apply to me at all* to 3 = *Applied to me very much, or most of the time*. The depression and anxiety subscales specifically were used for the current study and have demonstrated reliability and validity (Zanon et al., 2021).

Smartphone Use Expectancies Scale

Smartphone expectancies were assessed using the Smartphone Use Expectancies Scale (adapted from the Internet Use Expectancies Scale; Brand et al., 2014; Elhai, Yang, Dempsey, et al., 2020). The scale consists of 8 items rated on a Likert scale of 1 = *Completely disagree* to 6 = *Completely agree*. Subscales assess positive (e.g., "I use my smartphone to experience pleasure") and negative expectancies (e.g., "I use my smartphone to avoid loneliness"). The scale has adequate psychometric properties (Brand et al., 2014; Elhai, Yang, Dempsey, et al., 2020).

Mindful Attention Awareness Scale (MAAS)

Trait mindfulness was measured using the MAAS (Mohsenabadi et al., 2018). The MAAS contains 15 items rated on a Likert scale of 1 = *Almost always* to 6 = *Almost never*. The MAAS has demonstrated reliability and validity (Van Dam et al., 2018).

Smartphone Addiction Scale-Short Version (SAS)

PSU severity was measured using the SAS (Harris et al., 2020). The SAS consists of 10 items (e.g., "I missed planned work due to smartphone use") rated on a scale of 1 = *Strongly disagree* to 6 = *Strongly agree*. The SAS has demonstrated reliability and validity (Harris et al., 2020; Lopez-Fernandez, 2017). We voiced all items in the first person for consistency (Duke & Montag, 2017b).

Data Analysis

We used R 4.0.2 (R Core Team, 2019) to clean and pre-process data, and for preliminary analyses. We used the following R packages: *careless* (for inattentive responding), *dplyr* (data cleaning), *naniar* (to assess data missingness), *mice* (missing data imputation), *corrplot* (correlations), *fmsb* (internal consistency), and *sjstats*

(ANOVA effects). Missing data comprised 1.9% of the sample. Data were analyzed using bivariate correlations, and ANOVA to compare scores by sex and social distancing group status.

Confirmatory factor analysis (CFA) and structural equation model (SEM) analyses were conducted using Mplus 8 (Muthén & Muthén, 1998-2019). We used weighted least squares estimation with a mean- and variance-adjusted (WLSMV) chi-square, using a polychoric covariance matrix and probit factor loadings (Lei & Shiverdecker, 2020) to test single-factor CFAs of PSU, depression, and anxiety. We correlated residual error variances for PSU items 1 and 2 (involving school or work impairment) and 4 and 5 (both involving psychological withdrawal from lack of smartphone use). We treated the smartphone use expectancies and mindfulness variables as summed scores because of model estimation and convergence problems when adding too many latent variables in our models. For SEM models, we used estimation methods described above.

To test mediation, we computed cross-products of direct effects to obtain indirect effects (Hayes, 2017). We estimated indirect effect standard errors using the Delta method, with 1000 non-parametric bootstrapped replications.

Results

Table 1. *Descriptive Statistics (Mean, Standard Deviation), Internal Consistency (Cronbach's Alpha), and Inferential Statistics (ANOVA) by sex for the Primary Variables.*

Variable	Male		Female		ANOVA				
	<i>M</i> (<i>SD</i>)	α	<i>M</i> (<i>SD</i>)	α	<i>df</i>	Mean Squares	<i>F</i>	<i>p</i>	Eta Squared
1. Depression	3.82 (3.87)	.87	4.74 (5.04)	.92	1, 350	67.63	3.099	.079	.009
2. Anxiety	2.90 (3.33)	.79	3.85 (4.02)	.82	1, 350	71.90	4.981	.026	.014
3. PSE	15.07 (4.67)	.87	15.31 (4.89)	.85	1, 350	4.86	0.21	.647	.001
4. NSE	12.33 (4.80)	.81	14.41 (5.86)	.91	1, 350	342.3	11.22	.001	.031
5. MIND	58.97 (13.28)	.90	55.20 (14.48)	.91	1, 350	1120.6	5.648	.018	.001
6. PSU	24.51 (8.97)	.85	28.09 (10.17)	.87	1, 350	1014.9	10.6	.001	.029

Note. PSE=Positive smartphone use expectancies; NSE=Negative smartphone use expectancies; MIND=Mindfulness; PSU=Problematic smartphone use.

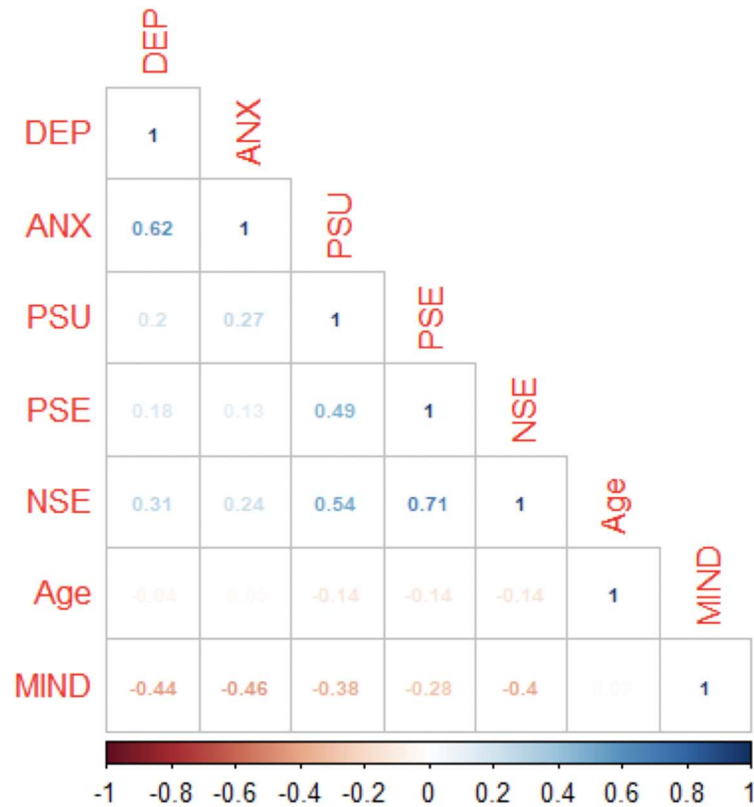
Table 2. *Descriptive Statistics, Internal Consistency (Cronbach's Alpha), and ANOVA Differences by Social Distancing Group on the Primary Variables.*

Variable	Pre-social distancing		Social Distancing		ANOVA			
	<i>M</i> (<i>SD</i>)	α	<i>M</i> (<i>SD</i>)	α	<i>df</i>	<i>F</i>	<i>p</i>	Eta Squared
1. Depression	3.78 (4.53)	.92	5.03 (4.75)	.90	1, 350	6.371	.012	.018
2. Anxiety	3.66 (3.81)	.79	3.40 (3.83)	.84	1, 350	0.401	.527	.001
3. PSE	15.31 (4.84)	.85	15.15 (4.80)	.86	1, 350	0.098	.755	.000
4. NSE	13.92(5.63)	.88	13.51 (5.58)	.89	1, 350	0.467	.495	.001
5. MIND	56.39 (14.61)	.92	56.57 (13.80)	.90	1, 350	0.015	.904	.000
6. PSU	27.72(9.84)	.86	26.09 (9.95)	.87	1, 350	2.379	.124	.007

Note. PSE=Positive smartphone use expectancies; NSE=Negative smartphone use expectancies; MIND=Mindfulness; PSU=Problematic smartphone use.

Correlations among primary (observed) variables are displayed in Figure 2.

Figure 2. Correlation Matrix of Primary Variables.



Notes. ANX=Anxiety; DEP=Depression; PSE=Positive Smartphone Expectancies; NSE=Negative Smartphone Expectancies; MIND=Trait Mindfulness; PSU=Problematic Smartphone Use. All correlations were significant at $p < .01$, except for Age with PSE and ANX with PSE at $p < .05$, and Age with DEP ($p = .402$), Age with ANX ($p = .579$), and Age with MIND ($p = .615$). Correlations with a darker shade indicate stronger correlations.

CFA and SEM Results

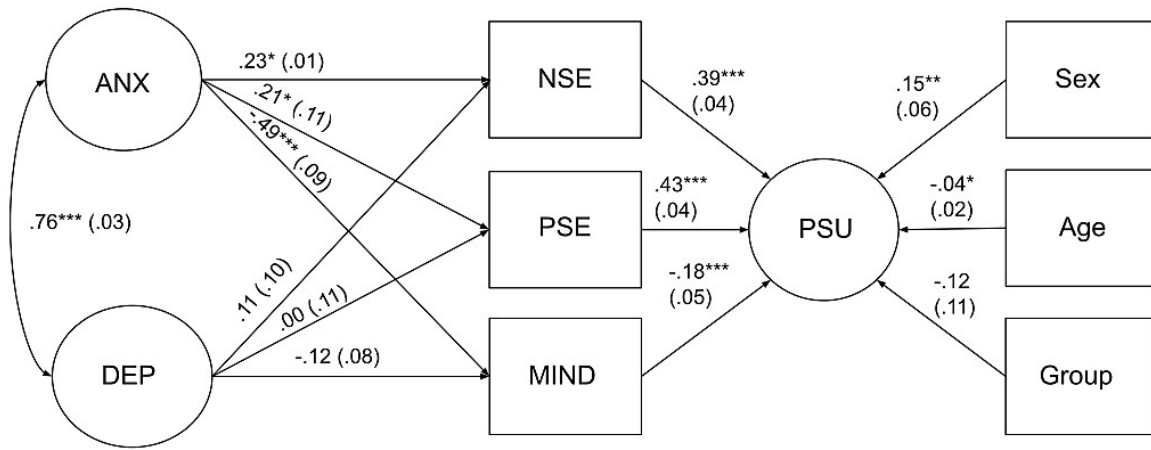
The PSU measurement model showed evidence for adequate fit, $WLSMV \chi^2(33, N = 352) = 158.62, p < .001, CFI = .97, TLI = .95, RMSEA = .10$ (90% CI [.09, .12]), $SRMR = .04$.¹ Depression yielded good fit, $WLSMV \chi^2(14, N = 352) = 54.71, p < .001, CFI = .99, TLI = .99, RMSEA = .09$ (90% CI [.07, .12]), $SRMR = .03$. Anxiety primarily showed evidence for good fit, $WLSMV \chi^2(14, N = 352) = 56.05, p < .001, CFI = .98, TLI = .97, RMSEA = .09$ (90% CI [.07, .12]), $SRMR = .04$.

Trait mindfulness showed evidence for adequate fit, $WLSMV \chi^2(90, N = 352) = 343.66, p < .001, CFI = .96, TLI = .95, RMSEA = .09$ (90% CI [.08, .10]), $SRMR = .04$. NSE yielded adequate fit, $WLSMV \chi^2(90, N = 352) = 343.66, p < .001, CFI = .96, TLI = .95, RMSEA = .09$ (90% CI [.08, .10]), $SRMR = .04$. However, PSE resulted in poor fit, $WLSMV \chi^2(24, N = 352) = 5033.83, p < .001, CFI = .24, TLI = .11, RMSEA = .77$ (90% CI [.75, .79]), $SRMR = .34$. In subsequent analyses, we treated mindfulness, PSE and NSE as summed scores because of model estimation and convergence problems when adding too many latent variables.

We tested Figure 1's model, which fit reasonably well based on most indices, $WLSMV \chi^2(393, N = 352) = 743.992, p < .001, CFI = .96, TLI = .96, RMSEA = .05$ (90% CI [.045, .056]), $SRMR = .09$. Figure 3 displays standardized parameter estimates.

Anxiety severity significantly predicted trait mindfulness (negative effect), PSE (positive effect), and NSE (positive effect), when adjusting for age, sex, and social distancing group covariates. Consistent with hypotheses, trait mindfulness (i.e., less awareness; H1), increased PSE (H2), and increased NSE (H3) significantly predicted greater PSU severity (adjusting for covariates). Further, younger age and female sex significantly predicted greater PSU severity.

Figure 3. SEM Model With Standardized Path Coefficients.



Notes. Circles represent latent variables; squares represent observed variables. ANX=Anxiety; DEP=Depression; PSE=Positive Smartphone Expectancies; NSE=Negative Smartphone Expectancies; MIND=Trait Mindfulness; PSU=Problematic Smartphone Use; Group=Social distancing group. Standard errors are displayed in parentheses. Sex was coded as: male = 1, female = 2. Group was coded as: participants participating before COVID-19-related university closure = 1, and participants participating after closure = 2. Factor loadings are not displayed for the latent variables, for simplicity, but are available upon request from the first author. * $p < .05$, ** $p < .01$, *** $p < .001$.

Mediation Results

Trait mindfulness mediated relations between anxiety and PSU severity (H5b), $\beta = 0.09$, $SE = 0.04$, $p = .03$, but not between depression and PSU severity (H5a), $\beta = 0.02$, $SE = 0.03$, $p = .50$. Contrary to hypotheses, PSE did not mediate relations between anxiety and PSU severity (H4b), $\beta = 0.09$, $SE = 0.13$, $p = .47$, nor between depression and PSU severity (H4a), $\beta = 0.001$, $SE = 0.13$, $p = .99$. Additionally, NSE did not mediate relations between anxiety and PSU severity (H4b), $\beta = 0.09$, $SE = 0.10$, $p = .34$, nor between depression and PSU severity (H4a), $\beta = 0.04$, $SE = 0.10$, $p = .66$.

Discussion

We tested mindfulness and smartphone use expectancies as mediators between depression/anxiety and PSU severity. We focused on mindfulness and smartphone use expectancies as they have rarely been investigated in this relationship. We found that mindfulness mediated relations between anxiety (but not depression) and PSU severity. Smartphone use expectancies did not mediate relations between anxiety/depression and PSU severity.

In support of H1, we found that increased trait mindfulness was associated with reduced PSU severity. This result supports prior findings on mindfulness being inversely related to PIU and addictive involvement in specific online activities, from studies sampling university students from North America (Elhai, Levine, O'Brien, et al., 2018) and Europe (Arslan et al., 2017; Kircaburun et al., 2019), completing internet-based self-report surveys. Mindfulness may reduce PSU by providing adaptive strategies for regulating negative emotion (Leyro et al., 2010), in turn reducing motivation for engaging in PIU/PSU (Kardefelt-Winther, 2017). In fact, better emotion regulation is associated with decreased PSU severity (Elhai, Levine, O'Brien, et al., 2018). Results are also consistent with I-PACE, proposing that emotion processing strategies influence excessive internet use (Brand et al., 2019), as increased mindfulness is associated with increased emotion processing (Wu et al., 2019), thus reducing PSU.

We found that increased PSE and increased NSE predicted greater PSU severity, supporting H2 and H3 respectively. Positive and negative internet use expectancies are related to SUDs in North American adolescents using a repeated measures design (Montes et al., 2019) and PIU severity via cross-sectional self-report surveys in European university students (Stodt et al., 2018; Wegmann et al., 2017), but smartphone use expectancies have been relatively unexamined. We found one study with American college students using self-report surveys (Elhai, Yang, Dempsey, et al., 2020) that investigated smartphone use expectancies, finding increased NSE predicted greater PSU severity. Results are consistent with past findings and also fit with I-PACE's conceptualization of internet-related cognitive bias influencing PSU. Further, the importance of negative over positive expectancies to PSU is consistent with models of negative reinforcement in the context of addiction (Wegmann & Brand, 2019).

We found that smartphone use expectancies did not mediate relations between depression or anxiety with PSU severity, rejecting H4a and H4b. Prior research found that expectancies mediate relations between psychopathology and PIU severity in a sample of European university students (Wegmann et al., 2017) consistent with I-PACE's conceptualization of cognitive bias influencing PSU. However, prior work has not explored smartphone use expectancies in such a mediating role. Confounding variables, such as stress related to the COVID-19 pandemic and associated upheavals in academic, occupational, and social pursuits, may have impacted the results. Specifically, expected benefits from smartphone use (and use frequency) may have been different during the pandemic than before (Elhai, Yang, McKay, et al., 2020), confounding the relationship between PSE/NSE with PSU severity. Alternatively, it is possible that smartphone use expectancies behave differently from other use expectancies (e.g., from alcohol). Limited prior work on smartphone use expectancies (Elhai, Yang, Dempsey, et al., 2020) found NSE as a significant correlate of PSU. Future studies should seek to clarify how best to conceptualize PSE/NSE with PSU.

Finally, we discovered that mindfulness mediated the relationship between anxiety with PSU severity, supporting H5b, but not between depression with PSU severity, rejecting H5a. Said plainly, individuals in the current sample anticipated avoiding negative emotion (rather than experiencing positive emotion) by using their smartphone. Increased trait mindfulness may serve as a buffer against the impact of anxiety symptoms on PSU severity. Prior research found that increased mindful attention was related to decreased PSU via online self-report in a sample of North American university students (Regan et al., 2020), and mindfulness mediated relations between depression/anxiety and PSU severity via internet-based self-report in a sample of North American university students (Elhai, Tiamiyu, & Weeks, 2018). Our findings on anxiety are consistent with prior work and with I-PACE's conceptualization of cognitive and affective responses as mediators between psychopathology symptoms and PSU. Specifically, emotion regulation serves as a buffer between depression/anxiety symptoms and PSU severity. With respect to depression, mindfulness-based therapies for depression (e.g., Segal et al., 2018) highlight the importance of cultivating positive experiences and mindfully engaging with negative experiences. Recent meta-analysis (Goldberg et al., 2018) highlight mindfulness as an effective intervention for anxiety (with medium effect sizes) and depression (with medium effect sizes), but other risk and resilience factors (e.g., worry, rumination, reappraisal, suppression, etc.) may explain the impact of mindfulness on depression and anxiety (Parmentier et al., 2019). Smartphone use expectancies represent another risk/resilience factor and, as discussed above, increased PSE was associated with increased PSU severity. Other aforementioned confounding variables, such as stress related to the COVID-19 pandemic and associated life upheavals, may have also impacted relations between depression and PSU severity (Kiraly et al., 2020). Risk/resilience factors may differentially affect depression and anxiety. Future studies should seek to clarify such relationships.

It is worth noting that female sex and age were associated with PSU severity. This finding is consistent with previous work that women and adolescents/young adults may be at higher risk for PSU (Csibi et al., 2021; Fischer-Grote et al., 2019).

Limitations include use of a sample of university students, which may not generalize to the general population. Self-selected participation may be a source of bias in the data. Furthermore, our data were cross-sectional, and causality cannot be inferred. Additionally, we relied on self-report measures, and self-reported smartphone use does not validate well against objective phone logs (Andrews et al., 2015; Elhai, Levine, Alghraibeh, et al., 2018; Rozgonjuk et al., 2018). We also focused exclusively on smartphone use but did not consider specific activities or the context of smartphone use (i.e., gaming, SNS, etc.). Finally, we did not measure other predisposing or response variables from I-PACE.

Conclusion

Although relations between depression and anxiety with PSU severity are well known, mediators are less established. The current study provides initial insight (albeit based on self-report surveys only in an American sample) demonstrating that positive and negative smartphone use expectancies are related to PSU severity, and supports recent findings linking mindful attention with decreased PSU severity (Elhai, Levine, O'Brien, et al., 2018). Importantly, trait mindfulness mediated relations between anxiety and PSU severity, suggesting that mindfulness may be an important mechanism explaining why some anxious individuals engage in PSU but others do not. Results further our understanding of relations between psychopathology and PSU severity and may have

implications for clinical interventions. Mindfulness interventions reduce symptoms of anxiety and depression (Hedman-Lagerlöf et al., 2018) and may be beneficial in treating behavioral addictions (Luberto et al., 2017), which suggests mindfulness interventions, specifically those that increase awareness of smartphone engagement and provide behavior alternatives, may be beneficial for reducing PSU (e.g., Lan et al., 2018). Future research could benefit from further examination of mediating variables tested here, such as mindfulness and smartphone use expectancies in order to further explore mechanisms implicated in why some depressed or anxious individuals excessively engage in smartphone use.

Footnotes

¹ Although RMSEA did not evidence good fit with the PSU measurement model, it should be noted that with WLSMV and ordinal data, RMSEA is not as precise when assessing model fit compared to SRMR (Shi et al., 2020).

Conflict of Interest

The Author(s) declare(s) that there is no conflict of interest.

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