

## EMPIRICAL ARTICLE

# Anxiety sensitivity mediates relations between anxiety (but not depression) and problematic smartphone use severity, adjusting for age and sex, in Chinese adolescents early in the COVID-19 pandemic

Caleb J. Hallauer<sup>1</sup> | Emily A. Rooney<sup>1</sup> | Haibo Yang<sup>2</sup> | Qingjun Meng<sup>3</sup> |  
Christian Montag<sup>4,5</sup> | Jon D. Elhai<sup>1,6</sup>

<sup>1</sup>Department of Psychology, University of Toledo, Toledo, Ohio, USA

<sup>2</sup>Academy of Psychology and Behavior, Tianjin Normal University, Tianjin, China

<sup>3</sup>School Health Care Institute, Tianjin, China

<sup>4</sup>Department of Molecular Psychology, Institute of Psychology and Education, Ulm University, Ulm, Germany

<sup>5</sup>neuSCAN Laboratory, Clinical Hospital of the Chengdu Brain Science Institute and Key Laboratory for Neuroinformation, University of Electronic Science and Technology of China, Chengdu, China

<sup>6</sup>Department of Psychiatry, University of Toledo, Toledo, Ohio, USA

## Correspondence

Haibo Yang, Academy of Psychology and Behavior, Tianjin Normal University, No. 393 Binshuixi Road, Xiqing District, Tianjin 300387, China.  
Email: yanghaibo@tjnu.edu.cn

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## Abstract

Risk factors for problematic smartphone use (PSU) have rapidly become an important area of research due to the prevalence of smartphones and functional impairment associated with PSU. Our aim was to examine relations between established predictors of PSU (depression and anxiety) and a potential mediator of PSU (anxiety sensitivity; AS). Participants ( $N = 4752$ ) from junior and senior high schools in Tianjin, China completed a web-based survey with measures of depression, anxiety, AS, and PSU. Descriptive and inferential analyses revealed significant differences between males and females on depression severity, and between junior and senior high school students on AS and PSU severity. Results of structural equation modeling indicated that anxiety was positively associated with AS when adjusting for depression; and AS was significantly associated with greater PSU severity, adjusting for age and sex. Additionally, AS mediated relations between anxiety and PSU severity. Current findings on AS are consistent with theoretical models of problematic internet use (Interaction of Person-Affect-Cognition-Execution) and previous research linking AS to other kinds of behavioral addictions (e.g., smoking, alcohol use).

## KEYWORDS

anxiety, anxiety sensitivity, depression, problematic smartphone use, structural equation modeling

## 1 | INTRODUCTION

Statista (O'Dea, 2020) estimated 3 billion people, or 2 out of every 5 persons globally, regularly used a smartphone in 2019. The prevalence of smartphone use has led to concerns about excessive smartphone engagement resulting in functional daily life impairment (Busch & McCarthy, 2020; Elhai, Yang, & Montag, 2019). In fact, excessive smartphone use has adverse consequences, such as sleep problems from late night overuse (Yang et al., 2020), academic interference (Busch & McCarthy, 2020), and greater distractibility while driving, leading to poorer reaction times and increased risk of driving

accidents (Li, Liu, & Dong, 2019) and pedestrian accidents (e.g., falls, bumps, collisions; Kim et al., 2017). In this context also a recent review on cognitive functions and smartphone use is of interest (Liebherr et al., 2020). Smartphone overuse is associated with mental health symptoms broadly and depression and anxiety specifically (Elhai, Dvorak, et al., 2017; Elhai, Levine, & Hall, 2019; Thomée, 2018). However, only recently have researchers examined other psychological variables that influence the relationship between psychopathology, such as depression and anxiety, and smartphone overuse.

Smartphone overuse is often referred to as problematic smartphone use (PSU). PSU refers to uncontrolled and excessive use

of the smartphone which leads to tangible negative consequences, such as interpersonal and school/work impairment (Billieux, 2012; Busch & McCarthy, 2020; Elhai, Levine, & Hall, 2019; Lee et al., 2019). Although several terms are used to refer to this construct, including “smartphone use disorder” and “smartphone addiction,” consistent with concerns of over-pathologizing normal behavior (e.g. Billieux et al., 2019; Starcevic et al., 2021), no consensus currently exists on diagnostic criteria to define a “Use Disorder” associated with the smartphone and no such disorder is currently recognized by the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; DSM-5, American Psychiatric Association, 2013) or *International Classification of Diseases* (11th ed.; ICD-11; World Health Organization, 2019) even though similarities exist in presenting symptoms (e.g., loss of control, withdrawal-like manifestations) and psychosocial risk factors (Billieux, 2012; Billieux et al., 2015; Montag, 2019; Montag et al., 2016; Panova & Carbonell, 2018; Ryding & Kaye, 2018) between addictive disorders and PSU. Further, use of the term “addiction” is complicated in the context of PSU. Recent work (Panova & Carbonell, 2018; Starcevic et al., 2021) suggests that one does not become addicted to the smartphone or internet itself, but rather content and/or channels on the internet—access to which is facilitated by the smartphone. Further, Duke and Montag (2017) highlight that a smartphone can become a learned cue related to the aforementioned channels/content and may be sufficient to elicit cue-reactivity on its own. As perhaps the pre-eminent method of accessing the internet today (Montag et al., 2021) and consistent with current research seeking to identify general risk factors that promote smartphone-mediated problematic behaviors (Billieux et al., 2015; Canale et al., 2021), PSU may be the current driving force behind disordered use of the internet but should not be placed in the same category as drug and alcohol use disorders.

Although some constructs are well-established vulnerability factors for PSU (Busch & McCarthy, 2020), many constructs remain relatively unexamined. Prior research suggests that PSU severity is associated with depression (with medium effect sizes) and anxiety severity (with small-to-medium effect sizes) (Busch & McCarthy, 2020; Elhai, Levine, & Hall, 2019; Elhai, Tiamiyu, & Weeks, 2018). Current evidence indicates psychopathology drives PSU as a method of coping or self-regulation, rather than the reverse (Brand et al., 2016, 2019). This idea also reflects work by Kardefelt-Winther (2014) describing problematic internet use (PIU) as a compensatory mechanism, and one might conceptualize overuse of the smartphone as a mobile form of PIU in a way comparable to self-medication of negative affect (Chen et al., 2020). Thus, the smartphone and subsequent PSU may help individuals experience positive emotion or avoid negative emotion, combating aspects of well-established risk factors like depression and anxiety.

Recent research has supported additional contributing psychological influences on PSU. Such influences involve cognitive- and emotion-related coping strategies (see Elhai, Yang, & Montag, 2019 for a review; Extremera et al., 2019), including rumination (Elhai, Tiamiyu, & Weeks, 2018), emotion dysregulation (Rozgonjuk & Elhai, 2021), fear of missing out (Elhai, Levine, Alghraibeh, Alafnan,

et al., 2018; Gezgin et al., 2018), low self-esteem (Li, Liu, & Dong, 2019), and proneness to boredom (Elhai, Vasquez, et al., 2017; Hong et al., 2020). The current paper considers one such influence: anxiety sensitivity (AS).

AS is a relatively unexamined potential risk factor of PSU. AS is often described as the fear of fear (Hovenkamp-Hermelink et al., 2019) or fear of arousal-based symptoms, such as heart palpitations, sweating and trembling, and their negative physical or social consequences (e.g., panic attacks or embarrassment; Reiss & McNally, 1985; Reiss, 1991). AS is associated with anxiety disorders (e.g., Ino et al., 2017; see Taylor, 2014 for a review) and with addictive disorders, such as alcohol use disorder (Lebeaut et al., 2020). In fact, AS has been supported as a correlate of PSU severity in only one study (Elhai, Levine, O'Brien, & Armour, 2018), but has not been examined as a mediator between psychopathology variables and PSU. In the context of the present work, different coping styles investigated within repressor/sensitizer theory are relevant. Vigilance coping (hence those persons more sensitive toward danger and likely more anxiety sensitive) was also associated with PIU (Jung et al., 2019). Because being focused upon AS leads to fear/avoidance of physical sensations, AS may influence the relationship between anxiety with PSU by driving smartphone engagement during times of stress and distress.

## 1.1 | Aims

Although the relationship between depression/anxiety and PSU severity has been established (Busch & McCarthy, 2020; Elhai, Dvorak, et al., 2017), less is known about variables that mediate this relationship (see Elhai, Levine, & Hall, 2019 for a review). We examined relations between depression/anxiety and PSU severity, with AS as a potential mediating variable.

## 1.2 | Theory

Relevant to this study is Brand et al.'s (2016, 2019) Interaction of Person-Affect-Cognition-Execution (I-PACE) model of PIU (e.g., PSU). 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 (e.g., depression and anxiety). Second, I-PACE proposes responses to personal components (e.g., AS) 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. Previous research supports I-PACE in modeling PIU/PSU severity (Dempsey et al., 2019; Elhai et al., 2020; Lemenager et al., 2018; Oberst et al., 2017; Yuan

et al., 2021). Of note, I-PACE is relevant to studying PSU, as PSU could be seen as a mobile form of PIU (Montag et al., 2021). Further, the key variable in the present study (AS) might be best characterized as an affect-process variable in the realm of I-PACE, making AS a potential mediator between anxiety/depression (P-variable; psychopathology) and the outcome (PSU). Although not based on I-PACE, previous research across several domains (e.g. between emotional disorders and smoking [Zvolensky et al., 2014], attachment and aggression [Watt et al., 2020], and between anxiety/depression and opioid misuse [Rogers et al., 2020]) established AS as a mediator, suggesting AS may best be conceptualized as a mediating variable in the present study.

### 1.3 | Hypotheses

The following hypotheses are posed based on the theory and literature presented. According to I-PACE, AS is conceptualized as a risk factor for PSU severity, mediating the relationship between depression/anxiety (predisposing factors) and PSU severity.

**Hypothesis 1 (H1).** AS will be positively related to PSU severity (Elhai, Levine, O'Brien, & Armour, 2018).

**Hypothesis 2 (H2).** AS will mediate the relationship between depression (H2a) and anxiety (H2b) with PSU severity. Given the evidence that negative responses to psychopathology (in I-PACE) mediate relations between depression/anxiety and PSU severity (Elhai, Tiamiyu, & Weeks, 2018; Extremera et al., 2019; Li, Oviedo-Trespalacios, et al., 2019), the same relationship should be present between psychopathology, AS and PSU. Additionally, AS has mediated or moderated relations between psychopathology symptoms with other addictive behaviors (Berenz et al., 2016; Farris et al., 2015; Seyed Hashemi et al., 2020; Zvolensky et al., 2014).

### 1.4 | Research model

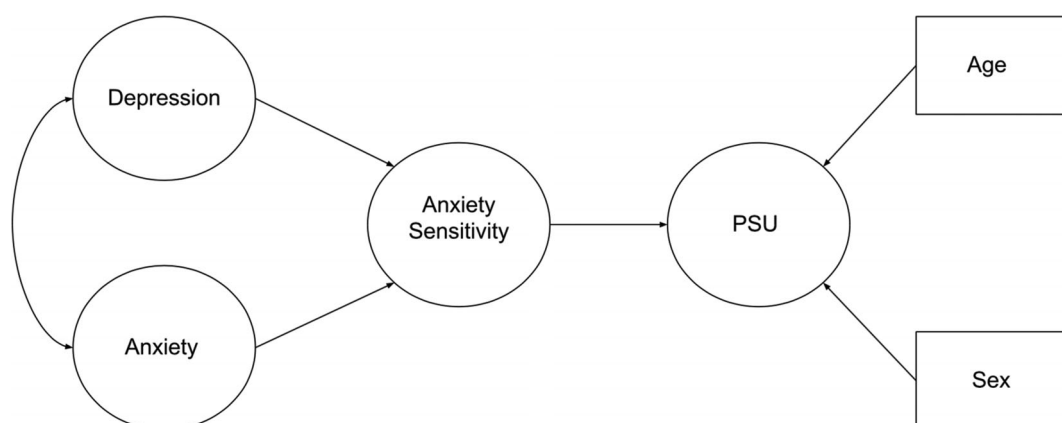
Our research model is presented in Figure 1. Depression and anxiety severity are conceptualized to relate to AS, which in turn should relate to PSU severity. Age and sex were also included as covariates of PSU severity; younger age and female sex are associated with increased PSU severity (Csibi et al., 2021; Fischer-Grote et al., 2019). Our model is consistent with I-PACE by modeling psychopathology variables as predictors, AS as a mediator, and PSU severity as the outcome variable.

## 2 | METHOD

### 2.1 | Participants and procedure

Approval for the study was granted through Tianjin Normal University's Psychology Ethics Board. Participants were recruited from junior and senior high schools in Tianjin, China, a large metropolitan city with 14 million people. Participants were asked to complete a web-based survey examining smartphone use. The Chinese web survey platform, wjx.cn, was used for the present study. Participants were directed to an online informed consent statement prior to enrollment in the study. All measures were administered in Simplified Chinese characters. Survey data were collected from February 2020 to March 2020. This timeframe was early in the COVID-19 pandemic in China, during restrictive lockdown. All student participants were at home during this time, attending school online.

After excluding participants for careless responding (more than 30 uninterrupted consecutive responses) and missingness, a total of 4752 participants from two categories were included: junior high students ( $n = 2929$ ,  $M_{\text{age}} = 14.38$ ,  $SD = 1.71$ , range = [12,16]) and senior high students ( $n = 1823$ ,  $M_{\text{age}} = 16.88$ ,  $SD = 1.53$ , range = [15,19]). Overall, participants were primarily adolescents with an average age of 15.34 years ( $SD = 2.04$ ). A majority of participants were female (59.3%;  $n = 2819$ ) and of Chinese Han ethnicity (95.1%;  $n = 4521$ ).



**FIGURE 1** Hypothesized model for psychological contributors to PSU severity (controlling for age and sex). Circles represent latent variables; rectangles represent observed variables. PSU, problematic smartphone use

## 2.2 | Measures

In addition to demographics assessed, the following measures were administered. Coefficient alpha values are displayed in Table 1.

### 2.2.1 | Depression Anxiety and Stress Scale 21

Severity of depression and anxiety symptoms was measured using the Depression Anxiety and Stress Scale-21 (DASS-21; Coker et al., 2018). The depression and anxiety subscales were used for the present study and consist of seven items each. Each item is rated on a Likert scale from 0 (“Did not apply to me at all”) to 3 (“Applied to me very much, or most of the time”). Higher scores are indicative of greater severity of symptoms. The DASS-21 has demonstrated adequate reliability and validity (Coker et al., 2018), including the Chinese version we used (Wang et al., 2016).

### 2.2.2 | Short Scale Anxiety Sensitivity Index

AS was measured using the Short Scale Anxiety Sensitivity Index (SSASI; Zvolensky et al., 2018; adapted from the Anxiety Sensitivity Index-3 [ASI-3; Taylor et al., 2007]). The SSASI consists of 5 items from the ASI-3 (items 6, 8, 12, 14, and 18) that assess physical (e.g., “When I feel pain in my chest, I worry that I'm going to have a heart attack.”), cognitive (e.g., “When my thoughts seem to speed up, I worry that I might be going crazy.”), and social (e.g., “When I tremble in the presence of others, I fear what people might think of me.”) aspects of AS. Items are rated on a 5-point Likert scale from 0 (“Very little”) to 4 (“Very much”). Higher scores indicate greater fear of anxiety-related symptoms. The SSASI has demonstrated good reliability and validity (Zvolensky et al., 2018), including the Chinese version we used (Cai et al., 2018).

### 2.2.3 | Smartphone Addiction Scale-short version

PSU was measured using the Smartphone Addiction Scale-short version (SAS), which maps onto the construct of PSU (Kwon et al., 2013). The original SAS (Kwon et al., 2013) includes 10 items (e.g., “I use my smartphone longer than I had intended”) rated on Likert scale with

response options including 1 (“Strongly disagree”), 2 (“Disagree”), 3 (“Weakly disagree”), 4 (“Weakly agree”), 5 (“Agree”), and 6 (“Strongly agree”). Higher scores are indicative of excessive smartphone use and impairment associated with PSU. The SAS has demonstrated adequate psychometric properties (Cheung et al., 2019; Lopez-Fernandez, 2017; Luk et al., 2018), including the Chinese version we used (Chen et al., 2017).

## 2.3 | Data analysis

We used R v.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* (for data cleaning), *mice* (for missing data imputation), *corrplot* (correlations), *fmsb* (internal consistency), and *sjstats* (ANOVA effects). Data were analyzed using bivariate correlations, and ANOVA to compare scores by sex and school level.

Confirmatory factor analysis (CFA) and structural equation modeling (SEM) analyses were conducted using Mplus v.8.1 (Muthén & Muthén, 1998–2020). 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, AS, 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). For SEM models, we used the 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.

## 3 | RESULTS

### 3.1 | Descriptive findings

Scale descriptive and internal consistency statistics for the full sample are reported in Table 1. The scales demonstrated good internal consistency (Cronbach's alpha range: .82–.90). Correlations among primary (observed) variables are displayed in Figure 2. Sex differences are reported in Table 2, and school level differences are reported in Table 3. There was a significant difference between males and females on depression severity, and there were significant differences between junior and senior high school students on AS and PSU severity.

### 3.2 | CFA and SEM results

The PSU measurement model showed evidence for adequate fit, WLSMV  $\chi^2(33, N = 4752) = 3224.14, p < .001, CFI = 0.96,$

**TABLE 1** Means, standard deviations, and Cronbach's alphas for primary variables

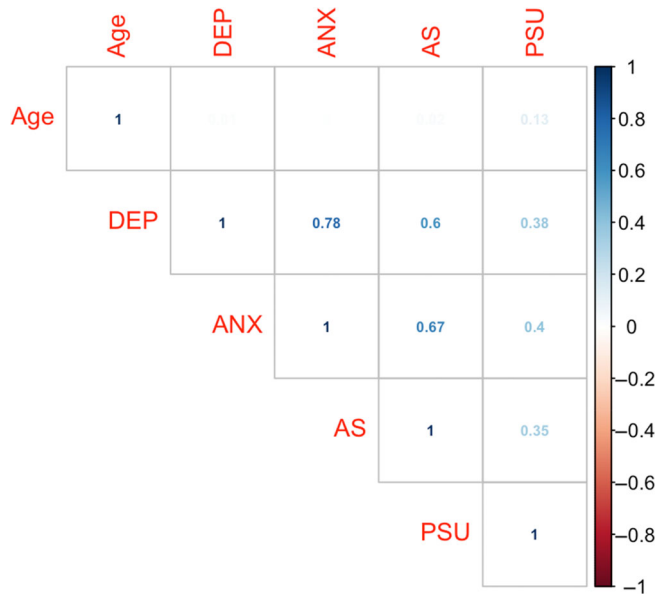
Variable	M	SD	$\alpha$
1. Depression	3.94	4.42	.87
2. Anxiety	4.40	4.15	.82
3. Anxiety sensitivity	3.27	4.07	.84
4. PSU	30.44	11.58	.90

Abbreviation: PSU, problematic smartphone use.

TLI = 0.95, RMSEA = 0.14 (90% CI: 0.139–0.147), SRMR = 0.04.<sup>1</sup> Depression yielded good fit, WLSMV  $\chi^2(14, N = 4752) = 308.33, p < .001, CFI = 0.99, TLI = 0.99, RMSEA = 0.07$  (90% CI: 0.060–0.073), SRMR = 0.02. Anxiety primarily showed evidence for good fit, WLSMV  $\chi^2(14, N = 4752) = 321.93, p < .001, CFI = 0.99, TLI = 0.98, RMSEA = 0.09$  (90% CI: 0.062–0.075), SRMR = 0.03. AS demonstrated good fit, WLSMV  $\chi^2(5, N = 4752) = 202.02, p < .001,$

CFI = 0.99, TLI = 0.99, RMSEA = 0.09 (90% CI: 0.081–0.102), SRMR = 0.02.

We tested Figure 1's model, which fit reasonably well based on recognized cutoffs for model fit indices (see Schreiber et al., 2006 for a review), WLSMV  $\chi^2(427, N = 4752) = 6931.732, p < .001, CFI = 0.96, TLI = 0.95, RMSEA = 0.06$  (90% CI: 0.056–0.058), SRMR = 0.05. Figure 3 displays standardized parameter estimates. Anxiety severity was positively associated with AS when adjusting for depression; however, depression severity was not associated with AS when adjusting for anxiety. Consistent with our hypothesis, AS was significantly associated with greater PSU severity (H1), adjusting for age and sex. Finally, age was significantly, positively associated with PSU severity.



**FIGURE 2** Correlation matrix of primary variables. All correlations were significant at  $p < .001$ , except for age with DEP ( $p = .361$ ), ANX ( $p = .872$ ), and AS ( $p = .099$ ). Correlations with a darker shade indicate stronger correlations. ANX, anxiety; AS, anxiety Sensitivity; DEP, depression; PSU, problematic smartphone use

### 3.3 | Mediation results

AS mediated relations between anxiety and PSU severity (H2b),  $\beta = .46, SE = 0.03, p < .001$ . However, AS did not mediate relations between depression and PSU severity (H2a),  $\beta = -.01, SE = 0.03, p = .83$ .

## 4 | DISCUSSION

We tested AS as a mediator between depression/anxiety and PSU severity. We focused on AS, which has rarely been examined in the context of PSU. We found that AS was positively related to PSU severity. Further, AS mediated relations between anxiety (but not depression) with PSU severity.

In support of H1, we found that AS was positively associated with PSU severity. This finding is consistent with previous research on

Variable	Male (N = 1933)		Female (N = 2819)		ANOVA <sup>a</sup>		
	M	SD	M	SD	df	F	p
1. Depression	4.17	4.50	3.79	4.36	1,4750	8.578	.003
2. Anxiety	4.42	4.10	4.39	4.12	1,4750	0.038	.845
3. Anxiety sensitivity	3.25	4.14	3.28	4.02	1,4750	0.051	.821
4. PSU	30.40	11.65	30.46	11.53	1,4750	0.033	.856

Abbreviation: PSU, problematic smartphone use.

<sup>a</sup>Effect sizes for all ANOVAs were  $\eta^2 < .001$ .

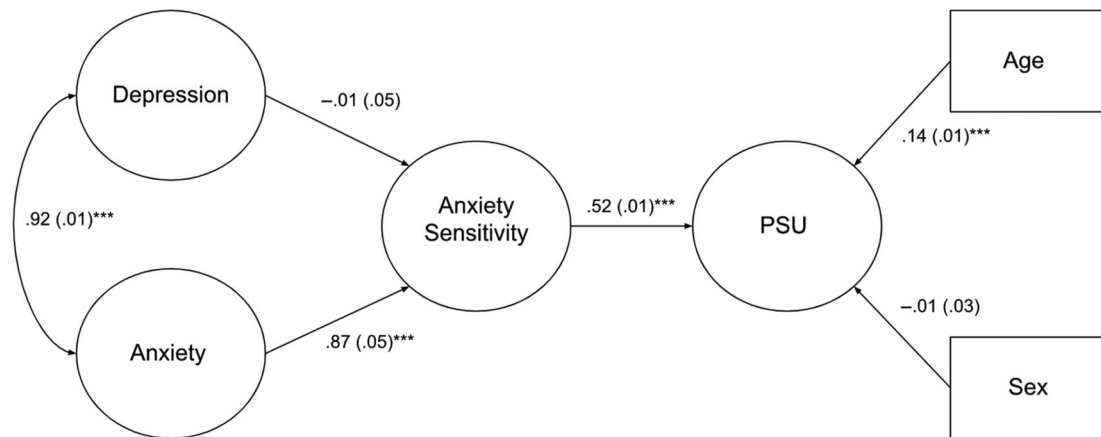
**TABLE 2** Means, standard deviations, and inferential statistics (ANOVA) for primary variables by sex

Variable	Junior (N = 2929)		Senior (N = 1823)		ANOVA <sup>a</sup>		
	M	SD	M	SD	df	F	p
1. Depression	3.91	4.45	3.99	4.37	1,4750	0.351	.553
2. Anxiety	4.38	4.20	4.44	4.07	1,4750	0.223	.637
3. Anxiety sensitivity	3.15	4.13	3.45	3.97	1,4750	6.188	.012
4. PSU	29.09	11.68	32.60	11.09	1,4750	105.4	<.001

Abbreviation: PSU, problematic smartphone use.

<sup>a</sup>Effect sizes for all ANOVAs were  $\eta^2 < .001$ .

**TABLE 3** Means, standard deviations, and inferential statistics (ANOVA) for primary variables by school level



**FIGURE 3** SEM with standardized path coefficients. Circles represent latent variables; rectangles represent observed variables. Standard errors are displayed in parentheses. Sex was coded as: male = 1, female = 2. Factor loadings are not displayed for the latent variables, for simplicity, but are available upon request from the first author. \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$ . PSU, problematic smartphone use; SEM, structural equation model

relations between AS and PSU (Elhai, Levine, O'Brien, & Armour, 2018), relations between AS with PIU (Seyed Hashemi et al., 2020), and is consistent with theory on AS (see Taylor, 2014 for a review). It fits also with earlier findings by Jung et al. (2019) showing that a vigilant coping style is related to PIU, although that paper did not investigate depression/anxiety. Specifically, smartphones may offer a convenient, socially acceptable source of avoidance and distraction from anxiety symptoms during times of stress and distress. This process may negatively reinforce future smartphone use, in turn driving PSU (Billieux et al., 2015; Oulasvirta et al., 2012; Przybylski et al., 2013). The current result is also consistent with models for development and maintenance of substance addiction (Wise & Koob, 2014) and with I-PACE, which conceptualizes AS as a risk factor predisposing individuals to PSU.

We found support for H2b, but not H2a. AS mediated relations between anxiety with PSU severity, supporting H2b, but not between depression with PSU severity, rejecting H2a. To the best of our knowledge, AS has not previously been tested as a mediator between depression/anxiety with PSU severity and has rarely been examined in the context of other problematic technology use, such as PIU (Seyed Hashemi et al., 2020). This finding is consistent with I-PACE and models of AS, and similar patterns have been demonstrated with respect to substance use (e.g., Lebeaut et al., 2020). Our above discussion of negative reinforcement potentially driving PSU is again relevant to the anxiety  $\rightarrow$  AS  $\rightarrow$  PSU mediating relationship. Although depression is a well-established predictor of PSU severity, other factors may explain the relationship between depression with PSU. Wegmann and Brand (2019) highlighted that a desire to experience positive emotions, rather than avoidance of negative emotions, may drive the relationship between depression with PIU. Consistent with I-PACE, a similar process may occur between depression with PSU. Additionally, confounding variables, such as stress related to the COVID-19 pandemic and associated upheaval 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 et al., 2020).

It is worth noting that older adolescent age was associated with greater PSU severity. Our sample consisted of students in junior high and high school, indicating that older adolescents may be at higher risk for PSU than younger adolescents. These findings are consistent with previous work that adolescents and young adults use their smartphones more frequently and may be at higher risk for PSU (Fischer-Grote et al., 2019).

Limitations include the use of Chinese adolescents and young adults that may not generalize to the general population. The use of cross-sectional data indicates that causality cannot be inferred. We relied on self-report measures of smartphone use, which do not validate well against objective measures of smartphone use (Rozgonjuk et al., 2018; Elhai et al., 2018). Data collection occurred during the COVID-19 pandemic, which may have introduced confounds. We focused exclusively on smartphone use, but did not consider specific activities or context of use (i.e., social network use, gaming, etc.). Finally, we did not measure other predisposing or response variables articulated in I-PACE.

## 5 | CONCLUSIONS

Although the relationship between depression and anxiety with PSU severity is well established, mediators are less established. The current study provides initial insight on how AS mediates relations between depression/anxiety with PSU. Results further our understanding of relations between psychopathology and PSU severity and may have implications for clinical interventions. Specifically, cognitive restructuring and exposure have demonstrated efficacy in reducing the symptoms of anxiety and AS (Taylor, 2019), suggesting they may be important components in the treatment of comorbid AS and PSU.

**CONFLICT OF INTEREST**

The authors do not have any conflicts of interest to report.

**PEER REVIEW**

The peer review history for this article is available at <https://publons.com/publon/10.1002/hbe2.319>.

**DATA AVAILABILITY STATEMENT**

Data available on request from the authors.

**ENDNOTE**

<sup>1</sup> Although RMSEA did not evidence a good fit in 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).

**REFERENCES**

- American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). <https://doi.org/10.1176/appi.books.9780890425596>
- Berenz, E. C., Kevorkian, S., Chowdhury, N., Dick, D. M., Kendler, K. S., & Amstadter, A. B. (2016). Posttraumatic stress disorder symptoms, anxiety sensitivity, and alcohol-use motives in college students with a history of interpersonal trauma. *Psychology of Addictive Behaviors*, *30*, 755–763. <https://doi.org/10.1037/adb0000193>
- Billieux, J. (2012). Problematic use of the mobile phone: A literature review and a pathways model. *Current Psychiatry Reviews*, *8*, 299–307. <https://doi.org/10.2174/157340012803520522>
- Billieux, J., Flayelle, M., Rumpf, H.-J., & Stein, D. J. (2019). High involvement versus pathological involvement in video games: A crucial distinction for ensuring the validity and utility of gaming disorder. *Current Addiction Reports*, *6*, 323–330.
- Billieux, J., Maurage, P., Lopez-Fernandez, O., Kuss, D. J., & Griffiths, M. D. (2015). Can disordered mobile phone use be considered a behavioral addiction? An update on current evidence and a comprehensive model for future research. *Current Addiction Reports*, *2*, 156–162. <https://doi.org/10.1007/s40429-015-0054-y>
- Brand, M., Wegmann, E., Stark, R., Muller, A., Wolfing, K., Robbins, T. W., & Potenza, M. N. (2019). The Interaction of Person-Affect-Cognition-Execution (I-PACE) model for addictive behaviors: Update, generalization to addictive behaviors beyond internet-use disorders, and specification of the process character of addictive behaviors. *Neuroscience and Biobehavioral Reviews*, *104*, 1–10. <https://doi.org/10.1016/j.neubiorev.2019.06.032>
- Brand, M., Young, K., Laier, C., Wöfling, K., & Potenza, M. (2016). Integrating psychological and neurological considerations regarding the development and maintenance of specific internet-use disorders: An interaction of person-affect-cognition-execution (I-PACE) model. *Neuroscience and Biobehavioral Reviews*, *71*, 252–266. <https://doi.org/10.1016/j.neubiorev.2016.08.033>
- Busch, P. A., & McCarthy, S. (2020). Antecedents and consequences of problematic smartphone use: A systematic literature review of an emerging research area. *Computers in Human Behavior*, *114*, 106414. <https://doi.org/10.1016/j.chb.2020.106414>
- Cai, W., Dong, W., Pan, Y., Wei, C., Zhang, S., Tian, B., Yan, J., & Deng, G. (2018). Reliability, validation and norms of the Chinese version of Anxiety Sensitivity Index 3 in a sample of military personnel. *PLoS One*, *13*, e0201778. <https://doi.org/10.1371/journal.pone.0201778>
- Canale, N., Moretta, T., Pancani, L., Buodo, G., Vieno, A., Dalmaso, M., & Billieux, J. (2021). A test of the pathway model of problematic smartphone use. *Journal of Behavioral Addictions*, *10*(1), 181–193. <https://doi.org/10.1556/2006.2020.00103>
- Chen, B., Liu, F., Ding, S., Ying, X., Wang, L., & Wen, Y. (2017). Gender differences in factors associated with smartphone addiction: A cross-sectional study among medical college students. *BMC Psychiatry*, *17*, 341. <https://doi.org/10.1186/s12888-017-1503-z>
- Chen, I.-H., Pakpour, A. H., Leung, H., Potenza, M. N., Su, J.-A., Lin, C.-Y., & Griffiths, M. D. (2020). Comparing generalized and specific problematic smartphone/internet use: Longitudinal relationships between smartphone application-based addiction and social media addiction and psychological distress. *Journal of Behavioral Addictions*, *9*(2), 410–419. <https://doi.org/10.1556/2006.2020.00023>
- Cheung, T., Lee, R. L. T., Tse, A. C. Y., Do, C. W., So, B. C. L., Szeto, G. P. Y., & Lee, P. H. (2019). Psychometric properties and demographic correlates of the smartphone addiction scale-short version among Chinese children and adolescents in Hong Kong. *Cyberpsychology, Behavior and Social Networking*, *22*, 714–723. <https://doi.org/10.1089/cyber.2019.0325>
- Coker, A. O., Coker, O. O., & Sanni, D. (2018). Psychometric properties of the 21-item Depression Anxiety Stress Scale (DASS-21). *African Research Review*, *12*, 135. <https://doi.org/10.4314/afrrrev.v12i2.13>
- Csibi, S., Griffiths, M. D., Demetrovics, Z., & Szabo, A. (2021). Analysis of problematic smartphone use across different age groups within the 'components model of addiction'. *International Journal of Mental Health and Addiction*, *19*, 616–631. <https://doi.org/10.1007/s11469-019-00095-0>
- Dempsey, A., O'Brien, K., Tiamiyu, M., & Elhai, J. (2019). Fear of missing out (FoMO) and rumination mediate relations between social anxiety and problematic Facebook use. *Addictive Behaviors Reports*, *9*, 100150. <https://doi.org/10.1016/j.abrep.2018.100150>
- Duke, É., & Montag, C. (2017). Smartphone addiction and beyond: Initial insights on an emerging research topic and its relationship to internet addiction. In C. Montag & M. Reuter (Eds.), *Internet addiction: Neuroscientific approaches and therapeutical implications including smartphone addiction* (pp. 359–372). Springer.
- Elhai, J. D., Dvorak, R. D., Levine, J. C., & Hall, B. J. (2017). Problematic smartphone use: A conceptual overview and systematic review of relations with anxiety and depression psychopathology. *Journal of Affective Disorders*, *207*, 251–259. <https://doi.org/10.1016/j.jad.2016.08.030>
- Elhai, J. D., Levine, J. C., Alghraibeh, A. M., Alafnan, A. A., Aldraiweesh, A. A., & Hall, B. J. (2018). Fear of missing out: Testing relationships with negative affectivity, online social engagement, and problematic smartphone use. *Computers in Human Behavior*, *89*, 289–298. <https://doi.org/10.1016/j.chb.2018.08.020>
- Elhai, J. D., Levine, J. C., & Hall, B. J. (2019). The relationship between anxiety symptom severity and problematic smartphone use: A review of the literature and conceptual frameworks. *Journal of Anxiety Disorders*, *62*, 45–52. <https://doi.org/10.1016/j.janxdis.2018.11.005>
- Elhai, J. D., Levine, J. C., O'Brien, K. D., & Armour, C. (2018). Distress tolerance and mindfulness mediate relations between depression and anxiety sensitivity with problematic smartphone use. *Computers in Human Behavior*, *84*, 477–484. <https://doi.org/10.1016/j.chb.2018.03.026>
- Elhai, J. D., Tiamiyu, M. F., & Weeks, J. W. (2018). Depression and social anxiety in relation to problematic smartphone use: The prominent role of rumination. *Internet Research*, *28*, 315–332. <https://doi.org/10.1108/IntR-01-2017-0019>
- Elhai, J. D., Tiamiyu, M. F., Weeks, J. W., Levine, J. C., Picard, K. J., & Hall, B. J. (2018). Depression and emotion regulation predict objective smartphone use measured over one week. *Personality and Individual Differences*, *133*, 21–28. <https://doi.org/10.1016/j.paid.2017.04.051>
- Elhai, J. D., Vasquez, J. K., Lustgarten, S. D., Levine, J. C., & Hall, B. C. (2017). Proneness to boredom mediates relationships between problematic smartphone use with depression and anxiety severity. *Social Science Computer Review*, *6*, 707–720. <https://doi.org/10.1177/0894439317741087>
- Elhai, J. D., Yang, H., McKay, D., & Asmundson, G. J. G. (2020). COVID-19 anxiety symptoms associated with problematic smartphone use

- severity in Chinese adults. *Journal of Affective Disorders*, 274, 576–582. <https://doi.org/10.1016/j.jad.2020.05.080>
- Elhai, J. D., Yang, H., & Montag, C. (2019). Cognitive- and emotion-related dysfunctional coping processes: Transdiagnostic mechanisms explaining depression and anxiety's relations with problematic smartphone use. *Current Addiction Reports*, 6, 410–417. <https://doi.org/10.1007/s40429-019-00260-4>
- Extremera, N., Quintana-Orts, C., Sánchez-Álvarez, N., & Rey, L. (2019). The role of cognitive emotion regulation strategies on problematic smartphone use: Comparison between problematic and non-problematic adolescent users. *International Journal of Environmental Research and Public Health*, 16, 3142. <https://doi.org/10.3390/ijerph16173142>
- Farris, S. G., Paulus, D. J., Gonzalez, A., Mahaffey, B. L., Bromet, E. J., Luft, B. J., Kotov, R., & Zvolensky, M. J. (2015). Anxiety sensitivity mediates the association between post-traumatic stress symptom severity and interoceptive threat-related smoking abstinence expectancies among World Trade Center disaster-exposed smokers. *Addictive Behaviors*, 51, 204–210. <https://doi.org/10.1016/j.addbeh.2015.07.031>
- Fischer-Grote, L., Kothgassner, O. D., & Felhofer, A. (2019). Risk factors for problematic smartphone use in children and adolescents: A review of existing literature. *Neuropsychiatrie*, 33, 179–190. <https://doi.org/10.1007/s40211-019-00319-8>
- Gezgin, D. M., Hamutoglu, N. B., Sezen-Gultekin, G., & Gemikonakli, O. (2018). Relationship between nomophobia and fear of missing out among Turkish university students. *Cypriot Journal of Educational Sciences*, 13, 549–561. <https://doi.org/10.18844/cjes.v13i4.3464>
- Hayes, A. F. (2017). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach* (2nd ed.). Guilford.
- Hong, W., Liu, R.-D., Ding, Y., Zhen, R., Jiang, R., & Fu, X. (2020). Autonomy need dissatisfaction in daily life and problematic mobile phone use: The mediating roles of boredom proneness and mobile phone gaming. *International Journal of Environmental Research and Public Health*, 17, 5305. <https://doi.org/10.3390/ijerph17155305>
- Hovenkamp-Hermelink, J. H. M., van der Veen, D. C., Oude Voshaar, R. C., Batelaan, N. M., Penninx, B. W. J. H., Jeronimus, B. F., Schoevers, R. A., & Riese, H. (2019). Anxiety sensitivity, its stability and longitudinal association with severity of anxiety symptoms. *Scientific Reports*, 9, 4314. <https://doi.org/10.1038/s41598-019-39931-7>
- Ino, K., Ogawa, S., Kondo, M., Imai, R., Ti, T., Furukawa, T. A., & Akechi, T. (2017). Anxiety sensitivity as a predictor of broad dimensions of psychopathology after cognitive behavioral therapy for panic disorder. *Neuropsychiatric Disease and Treatment*, 13, 1835–1840. <https://doi.org/10.2147/NDT.S121360>
- Jung, S., Sindermann, C., Li, M., Wernicke, J., Quan, L., Ko, H.-C., & Montag, C. (2019). Anxiety-related coping styles, social support, and internet use disorder. *Frontiers in Psychiatry*, 10, 640. <https://doi.org/10.3389/fpsy.2019.00640>
- Kardefelt-Winther, D. (2014). A conceptual and methodological critique of internet addiction research: Towards a model of compensatory internet use. *Computers in Human Behavior*, 31, 351–354. <https://doi.org/10.1016/j.chb.2013.10.059>
- Kim, H.-J., Min, J.-Y., Kim, H.-J., & Min, K.-B. (2017). Accident risk associated with smartphone addiction: A study on university students in Korea. *Journal of Behavioral Addictions*, 6, 699–707. <https://doi.org/10.1556/2006.6.2017.070>
- Kwon, M., Kim, D.-J., Cho, H., & Yang, S. (2013). The smartphone addiction scale: Development and validation of a short version for adolescents. *PLoS One*, 8(12), e83558. <https://doi.org/10.1371/journal.pone.0083558>
- Lebeaut, A., Tran, J. K., & Vujanovic, A. A. (2020). Posttraumatic stress, alcohol use severity, and alcohol use motives among firefighters: The role of anxiety sensitivity. *Addictive Behaviors*, 106, 106353. <https://doi.org/10.1016/j.addbeh.2020.106353>
- Lee, D., Namkoong, K., Lee, J., Lee, B. O., & Jung, Y. C. (2019). Lateral orbitofrontal gray matter abnormalities in subjects with problematic smartphone use. *Journal of Behavioral Addiction*, 8, 404–411. <https://doi.org/10.1556/2006.8.2019.50>
- Lei, P. W., & Shiverdecker, L. K. (2020). Performance of estimators for confirmatory factor analysis of ordinal variables with missing data. *Structural Equation Modeling: A Multidisciplinary Journal*, 27, 584–601. <https://doi.org/10.1080/10705511.2019.1680292>
- Lemenager, T., Hoffmann, S., Dieter, J., Reinhard, I., Mann, K., & Kiefer, F. (2018). The links between healthy, problematic, and addicted internet use regarding comorbidities and self-concept-related characteristics. *Journal of Behavioral Addictions*, 7, 31–43. <https://doi.org/10.1556/2006.7.2018.13>
- Li, C., Liu, D., & Dong, Y. (2019). Self-esteem and problematic smartphone use among adolescents: A moderated mediation model of depression and interpersonal trust. *Frontiers in Psychology*, 10, 2872. <https://doi.org/10.3389/fpsyg.2019.02872>
- Li, X., Oviedo-Trespalacios, O., Rakotonirainy, A., & Yan, X. (2019). Collision risk management of cognitively distracted drivers in a car-following situation. *Transportation Research Part F: Traffic Psychology and Behaviour*, 60, 288–298. <https://doi.org/10.1016/j.trf.2018.10.011>
- Liebherr, M., Schubert, P., Antons, S., Montag, C., & Brand, M. (2020). Smartphones and attention, curse or blessing? – A review on the effects of smartphone usage on attention, inhibition, and working memory. *Computers in Human Behavior Reports*, 1, 100005. <https://doi.org/10.1016/j.chbr.2020.100005>
- Lopez-Fernandez, O. (2017). Short version of the Smartphone Addiction Scale adapted to Spanish and French: Towards a cross-cultural research in problematic mobile phone use. *Addictive Behaviors*, 64, 275–280. <https://doi.org/10.1016/j.addbeh.2015.11.013>
- Luk, T. T., Wang, M. P., Shen, C., Wan, A., Chau, P. H., Olliffe, J., Viswanath, K., Chan, S. S., & Lam, T. H. (2018). Short version of the Smartphone Addiction Scale in Chinese adults: Psychometric properties, sociodemographic, and health behavioral correlates. *Journal of Behavioral Addictions*, 7, 1157–1165. <https://doi.org/10.1556/2006.7.2018.105>
- Montag, C. (2019). The neuroscience of smartphone/social media usage and the growing need to include methods from ‘Psychoinformatics’. In F. Davis, R. Riedl, J. vom Brocke, P. M. Léger, & A. Randolph (Eds.), *Information systems and neuroscience*. Lecture Notes in Information Systems and Organisation (pp. 275–283). Springer.
- Montag, C., Sindermann, C., Becker, B., & Panksepp, J. (2016). An affective neuroscience framework for the molecular study of internet addiction. *Frontiers in Psychology*, 7, 1906. <https://doi.org/10.3389/fpsyg.2016.01906>
- Montag, C., Wegmann, E., Sariyska, R., Demetrovics, Z., & Brand, M. (2021). How to overcome taxonomical problems in the study of internet use disorders and what to do with “smartphone addiction”? *Journal of Behavioral Addictions*, 9(4), 908–914. <https://doi.org/10.1556/2006.8.2019.59>
- Muthén, L. K., & Muthén, B. O. (1998–2020). *Mplus user's guide* (8th ed.). Muthén & Muthén.
- Oberst, U., Wegmann, E., Stodt, B., Brand, M., & Chamarro, A. (2017). Negative consequences from heavy social networking in adolescents: The mediating role of fear of missing out. *Journal of Adolescence*, 55, 51–60. <https://doi.org/10.1016/j.adolescence.2016.12.008>
- O'Dea, S. (2020). Number of smartphone users worldwide from 2016 to 2021. Statista. <https://www.statista.com/statistics/330695/number-of-smartphone-users-worldwide/>
- Oulasvirta, A., Rattenbury, T., Ma, L., & Raita, E. (2012). Habits make smartphone use more pervasive. *Personal and Ubiquitous Computing*, 16, 105–114. <https://doi.org/10.1007/s00779-011-0412-2>



- Panova, T., & Carbonell, X. (2018). Is smartphone addiction really an addiction? *Journal of Behavioral Addictions*, 7, 252–259. <https://doi.org/10.1556/2006.7.2018.49>
- Przybylski, A. K., Murayama, K., DeHaan, C. R., & Gladwell, V. (2013). Motivational, emotional, and behavioral correlates of fear of missing out. *Computers in Human Behavior*, 29, 1841–1848. <https://doi.org/10.1016/j.chb.2013.02.014>
- R Core Team. (2019). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. <https://www.R-project.org/>
- Reiss, S. (1991). Expectancy model of fear, anxiety, and panic. *Clinical Psychology Review*, 11, 141–153. [https://doi.org/10.1016/0272-7358\(91\)90092-9](https://doi.org/10.1016/0272-7358(91)90092-9)
- Reiss, S., & McNally, R. J. (1985). Expectancy model of fear. In S. Reiss & R. R. Bootzin (Eds.), *Theoretical issues in behavior therapy* (pp. 107–121). Academic Press.
- Rogers, A. H., Garey, L., Bakhshaie, J., Viana, A. G., Ditte, J. W., & Zvolensky, M. J. (2020). Anxiety, depression, and opioid misuse among adults with chronic pain: The role of anxiety sensitivity. *Clinical Journal of Pain*, 36(11), 862–867. <https://doi.org/10.1097/AJP.0000000000000870>
- Rozgonjuk, D., & Elhai, J. D. (2021). Emotion regulation in relation to smartphone use: Process smartphone use mediates the association between expressive suppression and problematic smartphone use. *Current Psychology*, 40, 3246–3255. <https://doi.org/10.1007/s12144-019-00271-4>
- Rozgonjuk, D., Levine, J. C., Hall, B. J., & Elhai, J. D. (2018). The association between problematic smartphone use, depression and anxiety symptom severity, and objectively measured smartphone use over one week. *Computers in Human Behavior*, 87, 10–17. <https://doi.org/10.1016/j.chb.2018.05.019>
- Ryding, F. C., & Kaye, L. K. (2018). “Internet addiction”: A conceptual minefield. *International Journal of Mental Health and Addiction*, 16, 225–232. <https://doi.org/10.1007/s11469-017-9811-6>
- Schreiber, J. B., Nora, A., Stage, F. K., Barlow, E. A., & King, J. (2006). Reporting structural equation modeling and confirmatory factor analysis results: A review. *The Journal of Educational Research*, 99, 323–338. <https://doi.org/10.3200/JOER.99.6.323-338>
- Seyed Hashemi, S. G., Hosseinnazhad, S., Dini, S., Griffiths, M. D., Lin, C.-Y., & Pakpour, A. H. (2020). The mediating effect of the cyberchondria and anxiety sensitivity in the association between problematic internet use, metacognition beliefs, and fear of COVID-19 among Iranian online population. *Heliyon*, 6, e05135. <https://doi.org/10.1016/j.heliyon.2020.e05135>
- Shi, D., Maydeu-Olivares, A., & Rosseel, Y. (2020). Assessing fit in ordinal factor analysis models: SRMR vs. RMSEA. *Structural Equation Modeling*, 27(1), 1–15. <https://doi.org/10.1080/10705511.2019.1611434>
- Starcevic, V., King, D. L., Delfabbro, P. H., Schimmenti, A., Castro-Calvo, J., Giardina, A., & Billieux, J. (2021). “Diagnostic inflation” will not resolve taxonomical problems in the study of addictive online behaviours. Commentary on: How to overcome taxonomical problems in the study of internet use disorders and what to do with “smartphone addiction”? (Montag et al., 2020). *Journal of Behavioral Addictions*, 9(4), 915–919. <https://doi.org/10.1556/2006.2020.00083>
- Taylor, S. (2014). *Anxiety sensitivity: Theory, research, and treatment of the fear of anxiety*. Routledge.
- Taylor, S. (2019). Treating anxiety sensitivity in adults with anxiety and related disorders. In J. A. J. Smits, M. W. Otto, M. B. Powers, & S. O. Baird (Eds.), *The clinician's guide to anxiety sensitivity treatment and assessment* (1st ed., pp. 55–75). Academic Press. <https://doi.org/10.1016/B978-0-12-813495-5.00004-8>
- Taylor, S., Zvolensky, M. J., Cox, B. J., Deacon, B., Heimberg, R. G., Ledley, D. R., Abramowitz, J. S., Holaway, R. M., Sandin, B., Stewart, S. H., Coles, M., Eng, W., Daly, E. S., Arrindell, W. A., Bouvard, M., & Cardenas, S. J. (2007). Robust dimensions of anxiety sensitivity: Development and initial validation of the Anxiety Sensitivity Index-3. *Psychological Assessment*, 19, 176–188. <https://doi.org/10.1037/1040-3590.19.2.176>
- Thomé, S. (2018). Mobile phone use and mental health: A review of the research that takes a psychological perspective on exposure. *International Journal of Environmental Research and Public Health*, 15, 2692. <https://doi.org/10.3390/ijerph15122692>
- Wang, K., Shi, H. S., Geng, F. L., Zou, L. Q., Tan, S. P., Wang, Y., Neumann, D. L., Shum, D. H., & Chan, R. C. (2016). Cross-cultural validation of the Depression Anxiety Stress Scale-21 in China. *Psychological Assessment*, 28, e88–e100. <https://doi.org/10.1037/pas0000207>
- Watt, M. C., Gallagher, C. E., Couture, M.-E., Wells, R., & MacLean, K. (2020). Anxiety sensitivity mediates relations between attachment and aggression differently by gender. *Journal of Interpersonal Violence*, 35(1–2), 364–383. <https://doi.org/10.1177/0886260516683173>
- Wegmann, E., & Brand, M. (2019). A narrative overview about psychosocial characteristics as risk factors of a problematic social networks use. *Current Addiction Reports*, 6, 402–409. <https://doi.org/10.1007/s40429-019-00286-8>
- Wise, R. A., & Koob, G. F. (2014). The development and maintenance of drug addiction. *Neuropsychopharmacology*, 39, 254–262. <https://doi.org/10.1038/npp.2013.261>
- World Health Organization. (2019). *International statistical classification of diseases and related health problems* (11th ed.). <https://icd.who.int/>
- Yang, J., Fu, X., Liao, X., & Li, Y. (2020). Association of problematic smartphone use with poor sleep quality, depression, and anxiety: A systematic review and meta-analysis. *Psychiatry Research*, 284, 112686. <https://doi.org/10.1016/j.psychres.2019.112686>
- Yuan, G., Elhai, J. D., & Hall, B. J. (2021). The influence of depressive symptoms and fear of missing out on severity of problematic smartphone use and internet gaming disorder among Chinese young adults: A three-wave mediation model. *Addictive Behaviors*, 112, 106648. <https://doi.org/10.1016/j.addbeh.2020.106648>
- Zvolensky, M. J., Farris, S. G., Leventhal, A. M., & Schmidt, N. B. (2014). Anxiety sensitivity mediates relations between emotional disorders and smoking. *Psychology of Addictive Behaviors*, 28, 912–920. <https://doi.org/10.1037/a0037450>
- Zvolensky, M. J., Garey, L., Fergus, T. A., Gallagher, M. W., Viana, A. G., Shepherd, J. M., Mayorga, N. A., Kelley, L. P., Griggs, J. O., & Schmidt, N. B. (2018). Refinement of anxiety sensitivity measurement: The Short Scale Anxiety Sensitivity Index (SSASI). *Psychiatry Research*, 269, 549–557. <https://doi.org/10.1016/j.psychres.2018.08.115>

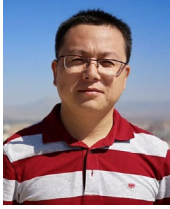
## AUTHOR BIOGRAPHIES



**Caleb Hallauer** is a graduate student in clinical psychology at the University of Toledo. His research interests include problematic technology use (smartphones, video games, social media, etc.) and subsequent risk/protective factors, such as trauma, emotion regulation, and use expectancies.



**Emily Rooney** is a clinical psychology graduate student at the University of Toledo. Her research interests are trauma-related psychopathology, subsequent risk/protective factors, and transdiagnostic mechanisms, specifically emotion regulation.



**Haibo Yang** is a Professor in the Academy of Psychology and Behavior at Tianjin Normal University. His primary area of research is cognitive processing in children and adolescents with posttraumatic stress disorder, studying attentional bias and execution control. In recent years, he has focused on the study of cyberpsychology and overuse of smartphones among adolescents.



**Qingjun Meng** is the director of school health care institute in Dongli District, Tianjin. He has been engaged in the physical and mental health of middle school students and primary school students. His research field focuses on student health education and student mental health promotion.



**Christian Montag** is a Professor for Molecular Psychology at Ulm University (Ulm, Germany). He studied psychology at University of Giessen (Giessen, Germany) and then worked on his PhD and habilitation dissertation at University of Bonn (Bonn, Germany). Christian Montag is interested in Personality Neuroscience. Here, he also combines molecular genetics with brain imaging techniques such as structural/functional MRI to better understand individual

differences in human nature. Adding to this he conducts research in the fields of Neuroeconomics, Technological Use Disorders, and Psychoinformatics. In the realm of Psychoinformatics, he applies mobile sensing and digital phenotyping principles to predict psychological traits and states.



**Jon D. Elhai** is a Professor of Psychology and Psychiatry at the University of Toledo, and has an academic affiliation with Tianjin Normal University. His primary area of research is in post-traumatic stress disorder, studying the disorder's underlying dimensions, and relations with cognitive coping processes and externalizing behaviors. He also has a program of research on cyberpsychology, examining problematic internet and smartphone use.

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