



Anxiety symptoms and problematic smartphone use severity among Chinese college students: The moderating role of social support

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Abstract

Increasing attention has been given to the role of anxiety symptoms in influencing problematic smartphone use (PSU). However, less is known about potential moderation mechanisms underlying this relationship. In the present study, we examined the relationship between anxiety symptoms and PSU severity, and whether this relationship was moderated by perceived social support. College students ($N = 723$) from China were recruited to complete questionnaires assessing anxiety symptoms, perceived social support, and PSU severity. The results showed that anxiety symptoms were positively associated with PSU severity, while perceived social support was negatively associated with PSU severity. Moreover, perceived social support positively moderated the relationship between anxiety symptoms and PSU severity; this relationship was significant at higher but not lower levels of perceived social support. These findings highlight the important role of perceived social support as a potential buffering factor for anxiety on PSU.

Keywords Anxiety symptoms · Problematic smartphone use · Perceived social support · College students · Cross-sectional design

Introduction

In recent years, smartphones have become an essential part of daily life for people across the lifespan. According to data from the Pew Research Center (2019), there are 2.5 billion smartphone users globally, and ownership prevalence in adults is 95% in South Korea, 81% in the USA, and 76% in the UK, with large majority of younger adults adopt a smartphone. Similarly, the number of smartphone users in China reached 817 million by December 2018, accounting for 99% of all internet users (China Internet Network Information Center, 2019). Undeniably, smartphones are highly portable devices offering many benefits for users, however, when users' smartphone usage becomes

excessive, adverse effects can result. Problematic smartphone use (PSU) is conceptualized as overuse of a smartphone with functional impairments in daily life and symptoms similar to those in substance use disorders such as tolerance and withdrawal when one's smartphone phone is unavailable (Billieux et al., 2015). It should be noted that PSU is not officially recognized as a disorder and is not included in the latest edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5); nonetheless it is an important construct to study. Although some researchers have instead used terms such as “smartphone addiction” (Alhassan et al., 2018; Noë et al., 2019) to describe this construct, Panova and Carbonell (2018) argued that there is inadequate evidence to confirm the addictive nature of a smartphone despite its potential adverse effects. Therefore, we use the term PSU instead, focusing on mental health correlates of PSU severity.

Evidence suggests that PSU is a substantial problem for many smartphone users. For example, among Chinese undergraduate smartphone users, studies found that the prevalence of PSU was estimated to be 21% ($n = 1062$; Long et al., 2016) and 30% ($n = 1441$; Chen et al., 2017). In cross-cultural research using the same instrument (Smartphone Addiction Scale – Short Version [SAS-SV]; Kwon et al., 2013), studies demonstrated that Chinese undergraduates reported significantly higher levels of PSU than participants from Germany (Lachmann et al., 2018)

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and Britain (Yang et al., 2019). Furthermore, empirical research across a range of countries has identified that PSU can lead to a variety of negative consequences for college students such as lower subjective well-being including more negative affect and less positive affect and life satisfaction (Horwood & Anglim, 2019) and quality of life (Gao et al., 2017), greater alcohol consumption and poorer academic performance (Grant et al., 2019), and worse sleep quality (Demirci et al., 2015). Consequently, exploring correlates of PSU severity is of critical importance in developing intervention and prevention strategies.

As an important psychopathological construct, the role of anxiety symptoms in predicting PSU severity has received considerable scholarly attention (e.g., Elhai et al., 2017; Elhai et al., 2019). However, most prior work has examined the relationship between anxiety symptoms and PSU severity, while research is warranted to investigate potential moderating variables in such relationship (Coyne et al., 2019; Elhai et al., 2019). Therefore, we aimed to examine the relationship between anxiety symptoms and PSU severity, as well as the moderating role of perceived social support in this link.

Anxiety Symptoms and PSU Severity

Researchers have used various theories to account for the relationship between anxiety symptoms and PSU severity, including the Uses and Gratifications Theory (UGT; Blumler, 1979), social enhancement model (Kraut et al., 2002), negative reinforcement models (Baker et al., 2004), and Compensatory Internet Use Theory (CIUT; Kardefelt-Winther, 2014). More recently, a comprehensive theoretical framework was proposed to discuss the development and maintenance of excessive Internet use: the Interaction of Person-Affect-Cognition-Execution (I-PACE) model (Brand et al., 2016; Brand et al., 2019). I-PACE argues that excessive Internet use (e.g., PSU) results from the interaction of predisposing variables (e.g., anxiety, depression, stress vulnerability), affective and cognitive responses (e.g., perceived social support, cognitive bias, expectancies, coping style, urge for mood regulation), and executive functions (e.g., inhibitory control, decision-making). Specifically, predisposing variables are risks factors that may lead users to excessively use particular Internet applications. And affective and cognitive response variables may mediate or moderate this link between predisposing variables and excessive internet use. In I-PACE, anxiety could be viewed as a predisposing variable, and social support involves a coping response in the affective/cognitive responses category, both potentially impacting severity of PSU.

Based on empirical evidence, a large number of studies found that anxiety symptoms were positively associated with PSU severity among young adults through cross-sectional (e.g., Elhai et al., 2020; Richardson et al., 2018; Shen et al., 2019), repeated measures (e.g., Elhai et al., 2018; Rozgonjuk et al., 2018), and experimental designs (e.g., Cheever et al.,

2014; Clayton et al., 2015). Yet some contrary findings have been reported (e.g., Coyne et al., 2019), so the relationship between anxiety symptoms and PSU severity may differ according to moderating variables (Elhai et al., 2019). On the basis of I-PACE, perceived social support may be an important variable that can buffer the impact of anxiety symptoms on PSU (Brand et al., 2016, 2019). Thus, in the present paper, we focus on perceived social support as a moderator.

Perceived Social Support

Perceived social support refers to an individual's subjective feelings and evaluations about being supported by others (e.g., family members, friends, and significant other) in time of need (Zimet et al., 1988), which includes two important dimensions: accessibility of supporting individuals, and satisfaction obtained from a social support (Kitamura et al., 1999). Cohen and Wills (1985) proposed two models (i.e., the main effects model, and buffering model) to explain the functions of social support. The main effects model holds that an individual's positive perceptions of their social networks may have a direct positive effect on their mental health regardless of the level of risk factors. From this perspective, perceived social support may help individuals combat PSU severity. Numerous cross-sectional studies (Aker et al., 2017; Celik & Konan, 2019; Gökçearsan et al., 2018) identified that college students with lower levels of perceived social support report higher levels of PSU. Longitudinal studies (Herrero et al., 2019, b) also found that social support predicts reduction in PSU over time.

The buffering model implies that social support protects individuals from the negative effects of particular risk factors. In line with the view, Putnam (2001) stated that if individuals perceive more social support from their social networks, their feelings of anxiety in offline social interactions may decrease. In contrast, individuals with low social support often rely more on a smartphone for communication than on face-to-face communication to reduce their negative feelings (Kim, 2017). Accordingly, perceived social support may alleviate negative effects of anxiety symptoms on PSU severity. Several relevant studies have lent support to this assumption. For example, Ruppel and McKinley (2015) found that students who reported less social support were more likely to use websites to alleviate negative emotion. In a sample of Facebook users, Brailovskaia et al. (2019) found that individuals who perceived higher levels of offline social support were less likely to increase Facebook use when facing daily stress.

The Present Study

The primary goals of this study were to investigate relations between anxiety symptoms and PSU severity among Chinese

college students, and whether this relationship was moderated by perceived social support. Based on the above review, we proposed the following hypotheses: anxiety symptoms should be positively associated with PSU severity (Hypothesis 1), perceived social support should be negatively associated with PSU severity (Hypothesis 2), and perceived social support should moderate the relationship between anxiety symptoms and PSU severity (Hypothesis 3). Specifically, the negative impact of anxiety symptoms on PSU severity should be weaker in students with high levels of perceived social support.

Method

Participants and Procedure

A total of 723 Chinese college students with an average age of 19.96 ($SD = 1.39$, range = 17–25) participated in the present study. Among them, 71.9% were females. This sample size is consistent with the literature on mental health relations with problematic smartphone use – Elhai et al. (2017) in their systematic review found that the average sample size in this area was 623 participants. Demographic information of the current sample is reported in Table 1. The study was approved by the university’s ethics committee. The paper-and-pencil survey was conducted in classrooms in the absence of faculty. Participants were informed about the research purpose, possible time needed, anonymity and confidentiality of their responses, and that participation was voluntary without

compensation. The research assistants were trained psychological postgraduates. We reviewed completed surveys with participants and when missing data were found, we asked participants to complete missing items, resulting in no missing item-level data for analysis. After informed consent was obtained from interested participants, they were administered questionnaires, including basic information (i.e., age, gender, major) in the classroom setting.

Measures

Anxiety Symptoms The State Anxiety scale from the State-Trait Anxiety Inventory (Dambi et al., 2018; Spielberger et al., 1970) was used to assess anxiety symptoms. This scale comprises 20 items such as “I am tense” and “I am worried.” Each item is rated on a 4-point Likert scale ranging from 1 (not at all) to 4 (very much). Shek (1988) discovered that the Chinese scale version comprised three factors: anxiety present, calmness, and happiness. A composite score is calculated by summing the 20 items, with higher scores indicating greater anxiety. We used the Chinese scale version demonstrating satisfactory internal consistency in Chinese college students (e.g., $\alpha = .90$; Shen et al., 2019). In the present study, internal consistency was .89.

Perceived Social Support The Multidimensional Scale of Perceived Social Support (MSPSS; Gros et al., 2007; Zimet et al., 1988) was used to measure perceived social support. The MSPSS includes 12 items evaluating perceived social support from family, friends, and significant others (three factors). An example item is: “There is a special person in my life who cares about my feelings”. Each item is rated on a 7-point Likert scale from 1 (very strongly disagree) and 7 (very strongly agree). An overall score is created by summing the 12 items with higher scores reflecting stronger perceived social support. We used the Chinese scale version, which is widely used in Chinese college student samples (e.g., $\alpha = .83$; Wang et al., 2018). In the present study, internal consistency was .90.

Problematic Smartphone Use Severity The Mobile Phone Addiction Index (MPAI; Huang et al., 2014; Leung, 2008) was used to assess PSU severity. The MPAI includes 17 items evaluating inability to control cravings, feeling anxious and lost, withdrawal or escape, and productivity loss (four factors). An example item is: “Your productivity has decreased as a direct result of the time you spend on the smartphone”. Each item is rated on 5-point Likert scale from 1 (never) to 5 (always). A total score is summed across items with higher scores indicating greater PSU. We used the Chinese MPAI, demonstrating good internal consistency among Chinese college students ($\alpha = .89$; Lian et al., 2016). In the present study, internal consistency was .92.

Table 1 Demographic characteristics ($N = 723$)

Variable	N	%
Gender		
Male	203	28.1
Female	520	71.9
Major		
Liberal arts	293	40.5
Science	430	59.5
Grade		
Freshman	146	20.2
Sophomore	272	37.6
Junior	208	28.8
Senior	97	13.4
Family type		
Only child	277	38.3
Non-only child	446	61.7
Family address		
Rural areas	466	64.5
Urban areas	257	35.5

Statistical Analysis

The data were analyzed with SPSS 19.0 and Mplus 8.3 (Muthén & Muthén, 1998–2019). First, skewness, kurtosis, means, standard deviations, and correlations were calculated using SPSS. According to Curran et al. (1996), kurtosis <7 (abs) and skewness <2 (abs), indicate normal distributions. Next, measurement models were conducted to examine model fit for the State Anxiety scale, MPSS, and MPAI. Latent variables were measured by subscales, rather than using item-level data – to preserve statistical power. As mentioned before, three factors for State Anxiety scale and MSPSS respectively, and four factors for MPAI were modeled. Because gender is associated with anxiety (Demirci et al., 2015), social support (Tinajero et al., 2015), and PSU (Elhai et al., 2020), we controlled for gender in each of these models. There was a high correlation between inability to control cravings and productivity loss factors of PSU due to very similar content, thus we set a correlated residual error between these two factors. Also, anxiety symptoms are highly negatively correlated with perceived social support (Mahmoud et al., 2015), thus we set a correlated residual error between them.

After ensuring measurement model fit, the structural model was performed to test the moderating effect via latent moderated structural equations (LMS; Maslowsky et al., 2015). The LMS method uses the XWITH command and full information maximum likelihood estimation with robust standard errors (MLR), and consists of two steps. The first step was to estimate the main effect model (i.e., Model 0), providing model fit indices. The second step was to estimate the latent interaction (i.e., Model 1). Model fit improvement between Model 0 and Model 1 was assessed by the log-likelihood ratio test (also denoted as D). A significant D value indicates a meaningful improvement in model fit after adding the interaction term, and thus a moderating effect. In the present study, model fit indexes include the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root-Mean-Square Error of Approximation (RMSEA). Acceptable fit for CFI and TLI is indicated with values > .94, for RMSEA < .06, and SRMR < .08 (Hu & Bentler, 1999).

Results

Preliminary Analysis

As indicated in Table 2, study variables were normally distributed. Anxiety symptoms were significantly positively related to PSU severity, while significantly negatively related to perceived social support. Perceived social support was significantly negatively related to PSU severity.

Measurement Model

The CFA for anxiety symptoms showed adequate fit, $\chi^2(2, N = 723) = 5.26, p = .07, CFI = .99, TLI = .99, RMSEA = .05, SRMR = .01$. The CFA for perceived social support yielded adequate fit, $\chi^2(2, N = 723) = 8.31, p < .05, CFI = .99, TLI = .97, RMSEA = .07, SRMR = .02$. The CFA for PSU showed adequate fit, $\chi^2(4, N = 723) = 9.08, p = .06, CFI = .99, TLI = .99, RMSEA = .04, SRMR = .02$.

Structural Model

The results of the main effect model and latent interaction model are presented in Table 3. The main effect model showed good model fit, $\chi^2(38, N = 723) = 121.68, p < .001, CFI = .97, TLI = .96, RMSEA = .06, SRMR = .04$. Anxiety symptoms were significantly associated with PSU severity ($\beta = .34, p < .001$), whereas perceived social support was not associated with PSU severity ($\beta = .01, p > .05$). The main effect model explained 12% of variance in PSU severity ($p < .001$).

In the latent interaction model, the interaction term between anxiety symptoms and perceived social support was significantly associated with PSU severity ($\beta = .06, p < .01$). The latent interaction model explained 13% of variance in PSU ($p < .001$). An additional 1% of variance in PSU severity was explained by the interaction term between anxiety symptoms and perceived social support. Based on log-likelihood values of the main effect model and latent interaction model, the log-likelihood difference value was $D(1) = 7.98, p < .01$; thus, the latent interaction model significantly improved model fit.

To interpret the significant interaction, a simple slope test (Aiken & West, 1991) was performed by inspecting anxiety symptoms on PSU severity at low (one standard deviation below the mean) and high (one standard deviation above the mean) levels of perceived social support. The simple slope test showed that the relationship between anxiety symptoms and PSU severity was significant when perceived social support was high ($\beta = .41, p < .001$), while their relationship was not significant when perceived social support was low ($\beta = -.01, p > .05$). The plot of the interaction effect was illustrated in Fig. 1.

Discussion

The present study explored the relationship between anxiety symptoms, perceived social support, and PSU severity in a sample of Chinese college students. Findings indicate that anxiety symptoms were positively associated with PSU severity, whereas perceived social support was negatively associated with PSU severity. The relationship between anxiety

Table 2 Means, standard deviations, and correlations of study variables ($N = 723$)

	<i>M</i>	<i>SD</i>	Min	Max	Skewness	Kurtosis	1	2	3
1. AS	39.64	8.84	20	65	-.006	-.52	–		
2. PSS	62.82	9.55	37	84	-.10	-.68	-.44**	–	
3. PSU severity	45.09	12.12	17	75	-.06	-.52	.28**	-.15**	–

* $p < .05$, ** $p < .01$, AS Anxiety symptoms, PSS Perceived social support, PSU Problematic smartphone use

symptoms and PSU severity was moderated by perceived social support. Concretely, this positive relationship was significant for students at high levels of perceived social support, while non-significant for those at low levels.

As expected from our hypothesis 1, we found that anxiety symptoms were positively associated with PSU severity. This finding is consistent with past research (Elhai et al., 2020; Richardson et al., 2018; Rozgonjuk et al., 2018). This finding also supports the I-PACE model (Brand et al., 2016, 2019) that predisposing factors such as anxiety are risk factors for the development of a specific Internet disorder (e.g., PSU). According to the I-PACE model, after experiencing abnormal mood such as anxiety symptoms, individuals may have different affective responses, for example, an urge to regulate anxiety symptoms, and therefore, they may engage in using a smartphone to cope. The decision to use a smartphone may have positive functions such as gratification as a short-term remedy in the very beginning of the addiction process. But when experiencing gratification builds a positive relationship with a smartphone use, especially when this relationship is reinforced and strengthened, individuals subsequently rely on using a smartphone to manage anxiety symptoms in daily life. This perspective is consistent with CIUT (Kardefelt-Winther, 2014) stating that PSU can be viewed as a

compensatory behavior to alleviate anxiety symptom and supported by empirical studies (e.g., Elhai et al., 2018).

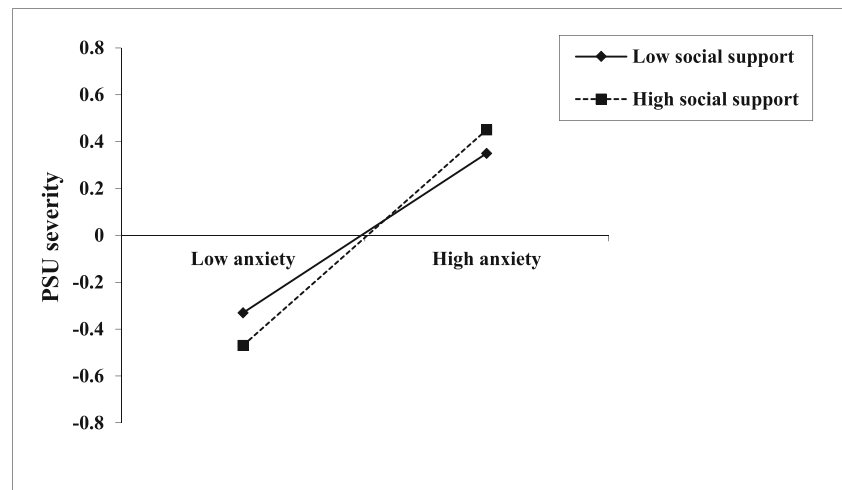
We found that perceived social support was negatively related to PSU severity in bivariate analyses, supporting our hypothesis 2 and the main effects model of social support (Cohen & Wills, 1985). However, their relationship was not significant in the structural model, suggesting that anxiety symptoms might interact with perceived social support. Indeed, we found that perceived social support plays an important moderating role in the relationship between anxiety symptoms and PSU severity. Contrary to our expectation, this partly supported our hypothesis 3 because the relationship between anxiety symptoms and PSU severity was significant only when perceived social support was high. Although inconsistent with the buffering model of social support (Cohen & Wills, 1985) arguing that social support can improve outcomes in a variety of settings by buffering the negative impact of risk factors, this finding is in line with prior empirical studies (Fu et al., 2020; Park et al., 2020; Wang et al., 2018). For instance, Fu et al. (2020) found that perceived social support moderated the relationship between depression and PSU severity such that this relationship was stronger for adolescents with higher perceived social support. Also, this finding supports the I-PACE model (Brand et al., 2016, 2019) that

Table 3 The results of moderation analysis ($N = 723$)

	Main effect model (M0)		Latent interaction model (M1)	
	β	SE	β	SE
Model fit index				
χ^2 (df)	121.68 (38)			
CFI	.97			
TLI	.96			
RMSEA	.06			
SRMR	.04			
Log-likelihood	-17,715.79		-17,711.80	
<i>D</i> (df)	7.98** (1)			
Standardized path coefficients				
Gender	.02 ^a , .05 ^b , .03 ^c	.04 ^a , .04 ^b , .04 ^c	.02 ^a , .05 ^b , .02 ^c	.04 ^a , .04 ^b , .04 ^c
Anxiety symptoms	.34***	.05	.40**	.07
Perceived social support	.01	.05	-.01	.08
Anxiety × Social support			.06**	.02
R^2	.12***	.03	.13***	.03

** $p < .01$, *** $p < .001$, ^a gender on anxiety symptoms, ^b gender on social support, ^c gender on PSU severity

Fig. 1 Interaction of anxiety symptoms and social support in predicting PSU severity



perceived social support is a variable that may moderate the relation between personal psychopathology with PSU. As predicted by the social enhancement perspective (Kraut et al., 2002), one possibility is that individuals who have social resources and support would benefit more from using a smartphone to maintain and create social connections, especially for those with mental or emotional problems (Ruppel & Mckinley, 2015). A study found that one's perception of social support has a positive relation with the size of online social network (Eastin & Larose, 2005). Meanwhile, as smartphones deeply immerse into people's daily lives and online environment is safer, more comfortable, and less threat (Caplan, 2005), those with high anxiety symptoms and high social support perceived websites and online support groups as more useful (Ruppel & Mckinley, 2015), thus they may prefer to use the smartphone for communication thereby rendering them more vulnerable to develop PSU.

Implications and Limitations

Despite mounting evidence on the adverse impact of anxiety symptoms in predicting PSU severity, little is known regarding the underlying boundary condition whereby anxiety symptoms have different effects on PSU severity. Therefore, the current study broadens previous studies by focusing on the moderating role of perceived social support in the relationship between anxiety symptoms and PSU severity, which can provide further understanding of this relationship. We found that both anxiety symptoms and perceived social support had significant relations with PSU severity, however, only anxiety symptoms significantly predicted PSU severity when simultaneously tested in the moderation model. Moreover, perceived social support moderated the relation between anxiety symptoms and PSU severity. Specifically, the negative impact of anxiety symptoms on PSU severity were exacerbated by high levels of perceived social support. Although the preliminary

findings should be replicated more widely before developing prevention programs, these findings challenge the point that perceived social support invariably plays a protective role against the adverse impact of risk factors on individual's well-being, inspiring future researchers to identify the buffering effect of social support in diverse situations. From another angle, using a smartphone appropriately to communicate with parents, friends, and significant others might be beneficial for some specific populations (e.g., people experiencing anxiety symptoms), when high anxiety symptoms and high perceived social support simultaneously appear as smartphones become an important tool for them to obtain social support. This study also supported and enriched the I-PACE model (Brand et al., 2016, 2019) by examining the moderating role of perceived social support and investigating in the context of PSU beyond other addictive behaviors such as gambling, gaming, buying-shopping, and compulsive sexual behavior.

This study also has some limitations that should be noted. First, the investigation nature of the present study was a cross-sectional design, failing to infer causal relations between anxiety and PSU severity. Thus, future studies could adopt longitudinal and experimental analyses to investigate these associations. Second, this study administrated self-report questionnaires among college students and might lead to the social desirability bias and an upward shift in the distribution of responses as participants respond positively to questionnaire items (Podsakoff & Organ, 1986). Although we controlled for the potential social desirability in the data collection process (e.g., explaining details about the study and absence of faculty), future studies could also use different forms of investigation (e.g., online and written survey, reports from parents and teachers) to better avoid potential response bias. Third, we regarded perceived social support as a unitary construct, however, some studies indicated that the buffering role of perceived social support may vary across different sources such as parents, teacher, and friends (Shin & Lee, 2019; see also Naseri et al., 2015; Tan, 2019). Future research would benefit from explore the specific sources of perceived social

support to examine the buffering effects of perceived social support in the link between anxiety symptoms and PSU severity.

In conclusion, anxiety symptoms are related to college students' PSU severity, and their positive link was moderated by perceived social support. Specifically, students who perceived high levels of social support had a greater link between increased smartphone use and anxiety symptoms.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s12144-021-01610-0>.

Author Contributions Xiangling Hou contributed to study concept and design, data collection, and draft the manuscript. Jon D. Elhai contributed to data analysis and revise the manuscript critically for important intellectual content. Tianqiang Hu contributed to data analysis and interpretation. Zhuang She contributed to data collection. Juzhe Xi contributed to study supervision and final approval of the version to be submitted.

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Data Availability All data analyzed during this study are included in the supplementary file.

Declarations

Conflict of Interest Outside the scope of the present paper, Dr. Elhai notes that he receives royalties for several books published on posttraumatic stress disorder (PTSD); is a paid, full-time faculty member at University of Toledo; is a paid, visiting scientist at Tianjin Normal University; occasionally serves as a paid, expert witness on PTSD legal cases; and receives grant research funding from the U.S. National Institutes of Health and Department of Defense.

Ethics Approval The study was approved by the Ethics Committee of Psychological Research at East China Normal University and the study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

Consent to Participate Informed consent was obtained from all individual participants included in the study.

References

- Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interactions*. Sage.
- Aker, S., Şahin, M. K., Sezgin, S., & Oguz, G. (2017). Psychosocial factors affecting smartphone addiction in university students. *Journal of Addictions Nursing*, 28(4), 215–219. <https://doi.org/10.1097/JAN.000000000000197>.
- Alhassan, A. A., Alqadhib, E. M., Taha, N. W., Alahmari, R. A., Salam, M., & Almutairi, A. F. (2018). The relationship between addiction to smartphone usage and depression among adults: A cross sectional study. *BMC Psychiatry*, 18(1), 1–8. <https://doi.org/10.1186/s12888-018-1745-4>.
- Baker, T. B., Piper, M. E., McCarthy, D. E., Majeskie, M. R., & Fiore, M. C. (2004). Addiction motivation reformulated: An affective processing model of negative reinforcement. *Psychological Review*, 111(1), 33–51. <https://doi.org/10.1037/0033-295X.111.1.33>.
- Billieux, J., Maurage, P., Lopezfernandez, 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(2), 156–162. <https://doi.org/10.1007/s40429-015-0054-y>.
- Blumler, J. G. (1979). The role of theory in uses and gratifications studies. *Communication Research*, 6(1), 9–36. <https://doi.org/10.1177/009365027900600102>.
- Brailovskaia, J., Rohmann, E., Bierhoff, H.-W., Schillack, H., & Margraf, J. (2019). The relationship between daily stress, social support and Facebook addiction disorder. *Psychiatry Research*, 276, 167–174. <https://doi.org/10.1016/j.psychres.2019.05.014>.
- Brand, M., Wegmann, E., Stark, R., Müller, A., Wolfling, 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. S., Laier, C., Wolfling, K., & Potenza, M. N. (2016). Integrating psychological and neurobiological 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>.
- Caplan, S. E. (2005). A social skill account of problematic internet use. *Journal of Communication*, 55(4), 721–736. <https://doi.org/10.1111/j.1460-2466.2005.tb03019.x>.
- Celik, O. T., & Konan, N. (2019). The mediator role of interaction anxiety in the relationship between social support perception and smartphone addiction. *Journal of Education and Future*, 15, 63–75. <https://doi.org/10.30786/jef.397445>.
- Cheever, N. A., Rosen, L. D., Carrier, L. M., & Chavez, A. (2014). Out of sight is not out of mind: The impact of restricting wireless mobile device use on anxiety levels among low, moderate and high users. *Computers in Human Behavior*, 37, 290–297. <https://doi.org/10.1016/j.chb.2014.05.002>.
- 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(1), 341–341. <https://doi.org/10.1186/s12888-017-1503-z>.
- China Internet Network Information Center. (2019). The 43rd “Statistical Report on the Development of China’s Internet”. http://cnnic.cn/g y w m / x w z x / r d x w / 2 0 1 7 2 0 1 7 _ 7 0 5 6 / 2 0 1 9 0 2 / W020190228474508417254.pdf.
- Clayton, R. B., Leshner, G., & Almond, A. (2015). The extended iSelf: The impact of iPhone separation on cognition, emotion, and physiology. *Journal of Computer-Mediated Communication*, 20(2), 119–135. <https://doi.org/10.1111/jcc4.12109>.
- Cohen, S., & Wills, T. A. (1985). Stress, social support, and the buffering hypothesis. *Psychological Bulletin*, 98(2), 310–357. <https://doi.org/10.1037/0033-2909.98.2.310>.
- Coyne, S. M., Stockdale, L., & Summers, K. (2019). Problematic cell phone use, depression, anxiety, and self-regulation: Evidence from a three year longitudinal study from adolescence to emerging

- adulthood. *Computers in Human Behavior*, 96, 78–84. <https://doi.org/10.1016/j.chb.2019.02.014>.
- Curran, P. J., West, S. G., & Finch, J. F. (1996). The robustness of test statistics to nonnormality and specification error in confirmatory factor analysis. *Psychological Methods*, 1(1), 16–29. <https://doi.org/10.1037/1082-989X.1.1.16>.
- Dambi, J. M., Corten, L., Chiwaridzo, M., Jack, H. E., Mlambo, T., & Jelsma, J. (2018). A systematic review of the psychometric properties of the cross-cultural translations and adaptations of the multidimensional perceived social support scale (MSPSS). *Health and Quality of Life Outcomes*, 16(1), 80. <https://doi.org/10.1186/s12955-018-0912-0>.
- Demirci, K., Akgonul, M., & Akpinar, A. (2015). Relationship of smartphone use severity with sleep quality, depression, and anxiety in university students. *Journal of Behavioral Addictions*, 4(2), 85–92. <https://doi.org/10.1556/2006.4.2015.010>.
- Eastin, M. S., & Larose, R. (2005). Alt.Support: Modeling social support online. *Computers in Human Behavior*, 21(6), 977–992. <https://doi.org/10.1016/j.chb.2004.02.024>.
- 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., & 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., Obrien, 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., Yang, H., Fang, J., Bai, X., & Hall, B. J. (2020). Depression and anxiety symptoms are related to problematic smartphone use severity in Chinese young adults: Fear of missing out as a mediator. *Addictive Behaviors*, 101, 105962. <https://doi.org/10.1016/j.addbeh.2019.04.020>.
- Fu, L., Wang, P., Zhao, M., Xie, X., Chen, Y., Nie, J., & Lei, L. (2020). Can emotion regulation difficulty lead to adolescent problematic smartphone use? A moderated mediation model of depression and perceived social support. *Children and Youth Services Review*, 108, 104660. <https://doi.org/10.1016/j.childyouth.2019.104660>.
- Gao, T., Xiang, Y., Zhang, H., Zhang, Z., & Mei, S. (2017). Neuroticism and quality of life: Multiple mediating effects of smartphone addiction and depression. *Psychiatry Research*, 258, 457–461. <https://doi.org/10.1016/j.psychres.2017.08.074>.
- Gökçearsan, Ş., Uluyol, Ç., & Şahin, S. (2018). Smartphone addiction, cyberloafing, stress and social support among university students: A path analysis. *Children and Youth Services Review*, 91, 47–54. <https://doi.org/10.1016/j.childyouth.2018.05.036>.
- Grant, J. E., Lust, K., & Chamberlain, S. R. (2019). Problematic smartphone use associated with greater alcohol consumption, mental health issues, poorer academic performance, and impulsivity. *Journal of Behavioral Addictions*, 8(2), 335–342. <https://doi.org/10.1556/2006.8.2019.32>.
- Gros, D. F., Antony, M. M., Simms, L. J., & McCabe, R. E. (2007). Psychometric properties of the state-trait inventory for cognitive and somatic anxiety (STICSA): Comparison to the state-trait anxiety inventory (STAI). *Psychological Assessment*, 19(4), 369–381. <https://doi.org/10.1186/s12955-018-0912-0>.
- Herrero, J., Torres, A., Vivas, P., & Uruena, A. (2019). Smartphone addiction and social support: A three-year longitudinal study. *Psychosocial Intervention*, 28(3), 111–118. <https://doi.org/10.5093/pi2019a6>.
- Herrero, J., Uruena, A., Torres, A., & Hidalgo, A. (2019). Socially connected but still isolated: Smartphone addiction decreases social support over time. *Social Science Computer Review*, 37(1), 73–88. <https://doi.org/10.1177/0894439317742611>.
- Horwood, S., & Anglim, J. (2019). Problematic smartphone usage and subjective and psychological well-being. *Computers in Human Behavior*, 97, 44–50. <https://doi.org/10.1016/j.chb.2019.02.028>.
- Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, 6(1), 1–55. <https://doi.org/10.1080/10705519909540118>.
- Huang, H., Niu, L. Y., Zhou, C. Y., & Wu, H. M. (2014). Reliability and validity of mobile phone addiction index for Chinese college students. *Chinese Journal of Clinical Psychology*, 22(5), 835–838.
- 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, J. (2017). Smartphone-mediated communication vs. face-to-face interaction: Two routes to social support and problematic use of smartphone. *Computers in Human Behavior*, 67(67), 282–291. <https://doi.org/10.1016/j.chb.2016.11.004>.
- Kitamura, T., Kijima, N., Watanabe, K., Takezaki, Y., & Tanaka, E. (1999). Precedents of perceived social support: Personality and early life experiences. *Psychiatry and Clinical Neurosciences*, 53(6), 649–654. <https://doi.org/10.1046/j.1440-1819.2002.00951.x>.
- Kraut, R. E., Kiesler, S., Boneva, B., Cummings, J. N., Helgeson, V. S., & Crawford, A. M. (2002). Internet paradox revisited. *Journal of Social Issues*, 58(1), 49–74. <https://doi.org/10.1111/1540-4560.00248>.
- Kwon, M., Kim, D., 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>.
- Lachmann, B., Sindermann, C., Sariyska, R., Luo, R., Melchers, M., Becker, B., Cooper, A., & Montag, C. (2018). The role of empathy and life satisfaction in internet and smartphone use disorder. *Frontiers in Psychology*, 9, 398. <https://doi.org/10.3389/fpsyg.2018.00398>.
- Leung, L. (2008). Linking psychological attributes to addiction and improper use of the mobile phone among adolescents in Hong Kong. *Journal of Children and Media*, 2(2), 93–113. <https://doi.org/10.1080/17482790802078565>.
- Lian, L., You, X., Huang, J., & Yang, R. (2016). Who overuses smartphones? Roles of virtues and parenting style in smartphone addiction among Chinese college students. *Computers in Human Behavior*, 65, 92–99. <https://doi.org/10.1016/j.chb.2016.08.027>.
- Long, J., Liu, T., Liao, Y., Qi, C., He, H., Chen, S., & Billieux, J. (2016). Prevalence and correlates of problematic smartphone use in a large random sample of Chinese undergraduates. *BMC Psychiatry*, 16(1), 408. <https://doi.org/10.1186/s12888-016-1083-3>.
- Mahmoud, J. S., Staten, R. T., Lennie, T. A., & Hall, L. A. (2015). The relationships of coping, negative thinking, life satisfaction, social support, and selected demographics with anxiety of young adult college students. *Journal of Child and Adolescent Psychiatric Nursing*, 28(2), 97–108. <https://doi.org/10.1111/jcap.12109>.
- Maslowsky, J., Jager, J., & Hemken, D. (2015). Estimating and interpreting latent variable interactions: A tutorial for applying the latent moderated structural equations method. *International Journal of Behavioral Development*, 39(1), 87–96. <https://doi.org/10.1177/0165025414552301>.
- Muthén, L. K., & Muthén, B. O. (1998-2019). *Mplus user's guide* (8th ed.). Muthén & Muthén.
- Naseri, L., Mohamadi, J., Sayehmiri, K., & Azizpoor, Y. (2015). Perceived social support, self-esteem, and internet addiction among students of Al-Zahra University, Tehran, Iran. *Iranian Journal of*

- Psychiatry and Behavioral Sciences*, 9(3), e421. <https://doi.org/10.17795/ijpbs-421>.
- Noë, B., Turner, L. D., Linden, D. E. J., Allen, S. M., Winkens, B., & Whitaker, R. M. (2019). Identifying indicators of smartphone addiction through user-app interaction. *Computers in Human Behavior*, 99, 56–65. <https://doi.org/10.1016/j.chb.2019.04.023>.
- Panova, T., & Carbonell, X. (2018). Is smartphone addiction really an addiction. *Journal of Behavioral Addictions*, 7(2), 252–259. <https://doi.org/10.1556/2006.7.2018.49>.
- Park, J., Kim, S., & Lee, H. (2020). Effect of work-related smartphone use after work on job burnout: Moderating effect of social support and organizational politics. *Computers in Human Behavior*, 105, 106194. <https://doi.org/10.1016/j.chb.2019.106194>.
- Pew Research Center (February 2019). *Smartphone ownership is growing rapidly around the world, but not always equally*. <https://www.pewresearch.org/global/2019/02/05/smartphone-ownership-is-growing-rapidly-around-the-world-but-not-always-equally/>
- Podsakoff, P. M., & Organ, D. W. (1986). Self-reports in organizational research: Problems and prospects. *Journal of Management*, 12(4), 531–544. <https://doi.org/10.1177/014920638601200408>.
- Putnam, R. D. (2001). *Bowling alone: The collapse and revival of American community*. Simon and Schuster.
- Richardson, M., Hussain, Z., Griffiths, M., & D. (2018). Problematic smartphone use, nature connectedness, and anxiety. *Journal of Behavioral Addictions*, 7(1), 109–116. <https://doi.org/10.1556/2006.7.2018.10>.
- 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>.
- Ruppel, E. K., & Mckinley, C. J. (2015). Social support and social anxiety in use and perceptions of online mental health resources: Exploring social compensation and enhancement. *Cyberpsychology, Behavior and Social Networking*, 18(8), 462–467. <https://doi.org/10.1089/cyber.2014.0652>.
- Shek, D. T. (1988). Reliability and factorial structure of the Chinese version of the state-trait anxiety inventory. *Journal of Psychopathology and Behavioral Assessment*, 10(4), 303–317. <https://doi.org/10.1007/BF00960624>.
- Shen, X., Wang, H., Rost, D. H., Gaskin, J., & Wang, J. (2019). State anxiety moderates the association between motivations and excessive smartphone use. *Current Psychology*, 1–9. <https://doi.org/10.1007/s12144-019-0127-5>.
- Shin, J., & Lee, C. H. (2019). Exposure to internet pornography and sexually aggressive behaviour: Protective roles of social support among Korean adolescents. *Journal of Sexual Aggression*, 25(2), 90–104. <https://doi.org/10.1080/13552600.2018.1528795>.
- Spielberger, C. D., Gorsuch, R. L., & Lushene, R. E. (1970). *Manual for the state-trait anxiety inventory*. Consulting Psychologists Press.
- Tan, K. (2019). The effects of personal susceptibility and social support on internet addiction: An application of Adler’s theory of individual psychology. *International Journal of Mental Health and Addiction*, 17(4), 806–816. <https://doi.org/10.1007/s11469-018-9871-2>.
- Tinajero, C., Martinezlopez, Z., Rodriguez, M. S., Guisande, M. A., & Paramo, M. F. (2015). Gender and socioeconomic status differences in university students’ perception of social support. *European Journal of Psychology of Education*, 30(2), 227–244. <https://doi.org/10.1007/s10212-014-0234-5>.
- Wang, P., Lei, L., Wang, X., Nie, J., Chu, X., & Jin, S. (2018). The exacerbating role of perceived social support and the “buffering” role of depression in the relation between sensation seeking and adolescent smartphone addiction. *Personality and Individual Differences*, 130, 129–134. <https://doi.org/10.1016/j.paid.2018.04.009>.
- Yang, Z., Asbury, K., & Griffiths, M. D. (2019). Do Chinese and British university students use smartphones differently? A cross-cultural mixed methods study. *International Journal of Mental Health and Addiction*, 17(3), 644–657. <https://doi.org/10.1007/s11469-018-0024-4>.
- Zimet, G. D., Dahlem, N. W., Zimet, S. G., & Farley, G. K. (1988). The multidimensional scale of perceived social support. *Journal of Personality Assessment*, 52(1), 30–41. https://doi.org/10.1207/s15327752jpa5201_2.

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