The Effect of Neuroticism on Problematic Smartphone Use: A Mediation Model of Self-Control for Males and Females

Yanan Liu[1], Xiuna Wang[1], Jiaqi Zhai[2], Fang Luo[3], & Tao Xin[1]

[1] Collaborative Innovation Center of Assessment for Basic Education Quality, Beijing Normal University, Beijing, China
[2] Beijing Jingdong Century Trading, Beijing, China
[3] Faculty of Psychology, Beijing Normal University, Beijing, China

Abstract

Exploring the effect of certain factors on problematic smartphone use (PSU) and the mechanism of these effects may help researchers understand the antecedents of PSU and propose targeted interventions. Accordingly, the current study tested the mediating role of self-control and the moderating role of gender in the relationship between neuroticism and PSU. A sample of 768 Chinese smartphone users (439 female, 329 male) aged 14–37 years (M = 22.5, SD = 3.27) completed questionnaires on neuroticism, self-control, nomophobia, and mobile phone addiction. The results showed that females reported significantly higher PSU than males. In addition, for females, self-control partially mediated the relationship between neuroticism and PSU, while for males, neuroticism had only a direct effect on PSU. The findings shed light on the effect of neuroticism on PSU and highlight the importance of gender in this effect.

Editorial Record

Keywords: neuroticism; self-control; problematic smartphone use; nomophobia; mobile phone addiction; gender difference

Introduction

To most individuals, smartphones are indispensable for daily life. Indeed, statistics show that, by December 2021, nearly 1.029 billion people (73% of China's population) used smartphones to access the internet in China (CNNIC, 2022). Smartphones have influenced our patterns of purchasing, communicating, studying, and more. Smartphone use may also facilitate social interactions (Y. Kim et al., 2016), health improvements (Bert et al., 2014), better job performance (K. Y. Lee et al., 2017), and distance learning (Shin et al., 2011). However, excessive smartphone use might lead to problematic smartphone use (PSU).

PSU refers to an unhealthy phone use pattern that impairs users' daily functioning (Elhai, Dvorak et al., 2017; Ezoe et al., 2009; Horwood & Anglim, 2018). The prevalence of PSU is estimated to range between 20–35% among Chinese undergraduates (Chen et al., 2017; Long et al., 2016), and the number of people engaging in PSU is steadily increasing across countries (Olson et al., 2022; Yang et al., 2020). Although a few studies have shown that PSU is not significantly correlated with depression (Elhai et al., 2016), anxiety (Rozgonjuk et al., 2018), health-related quality of life (Buctot et al., 2020), and life satisfaction (Cha & Seo, 2018), a greater number of studies have shown that it is associated with deficits in emotional health, physical health, professional performance, and social skills (Busch & McCarthy, 2021; Elhai, Dvorak et al., 2017; Elhai et al., 2019; Wacks & Weinstein, 2021).

With its high prevalence and negative consequences, PSU is attracting significant research attention. Demographically, researchers have found that female and younger individuals tend to report greater PSU (Busch & McCarthy, 2021; De-Sola et al., 2017; Musa et al., 2017; Rodríguez-García et al., 2020). Additionally, many studies have explored psychological variables related to PSU, finding personality (Horwood & Anglim, 2018), anxiety (De-Sola et al., 2017; Hussain et al., 2017), depression (Elhai, Levine et al., 2017), stress (Long et al., 2016), self-control (Servidio, 2021; West et al., 2021), shyness (Hong et al., 2019), and self-esteem (Wacks & Weinstein, 2021) as antecedents. Among these factors, personality has received extensive attention. Many studies (Horwood & Anglim, 2018, 2021b; Urieta et al., 2022; Wei et al., 2022) have found a positive association between PSU and neuroticism (representing one of the main personality traits), with higher levels of neuroticism correlated with greater PSU (Carvalho et al., 2018; Marciano et al., 2020). Though the association between these factors is clear, the influence path (i.e., the mechanism behind their relation) is not. Clarifying the mechanism by which neuroticism affects PSU may help researchers understand the antecedents of PSU and propose targeted interventions. Accordingly, the present study explored the influence path of neuroticism on PSU, while also exploring potential differences in this influence path between groups.

Problematic Smartphone Use, Mobile Phone Addiction, and Nomophobia

From a clinical perspective, PSU is considered compulsive and addictive behavior (Contractor et al., 2017; Marciano et al., 2021; Tavakolizadeh et al., 2014), in line with the addictive disorder described in the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5; APA, 2013). The term PSU is often used interchangeably with mobile phone addiction (MPA), which refers to the uncontrolled or excessive use of mobile phones, with an impact on daily life (Billieux, 2012). Both PSU and MPA are characterized by smartphone dependence, withdrawal symptoms, a strong motivation to use a smartphone, and extended use of a smartphone (Horwood & Anglim, 2018; Yıldız, 2017). However, researchers are increasingly suggesting that the severity of symptoms and negative consequences of MPA do not satisfy addiction criteria (Billieux et al., 2015; Panova & Carbonell, 2018). Rather, MPA seems to describe a problematic or maladaptive use pattern referred to as "problematic smartphone use" (D. A. Ellis, 2019; Panova & Carbonell, 2018). Thus, the present article uses the term PSU, throughout. Scales measuring smartphone addiction remain the most common measure of PSU (Olson et al., 2022).

Another emerging term relevant to PSU is *nomophobia* (i.e., "no mobile phone phobia," or a phobia of lacking a mobile phone connection). Nomophobia refers to the experience of fear, anxiety, and discomfort when a smartphone is not available (Rodríguez-García et al., 2020). As nomophobia and PSU have similar symptoms (Busch & McCarthy, 2021; León-Mejía et al., 2021), antecedents, and negative influences (Buctot et al., 2021; Yildiz Durak, 2019), many researchers consider them closely related theoretical constructs (Vasist & Pillai, 2021) that are comorbid in nature (Yildirim & Correia, 2015). In this vein, nomophobia may be considered a type of PSU (Tran, 2016; Vasist & Pillai, 2021) that should be assessed together with MPA to determine PSU (Busch & McCarthy, 2021; Pivetta et al., 2019; Vasist & Pillai, 2021). Thus, the present study used the Mobile Phone Addiction Index Scale and the Nomophobia Questionnaire to measure PSU.

Neuroticism and Problematic Smartphone Use

Neuroticism is a core personality trait representing emotional instability and the tendency to experience negative emotions within the Five Factor Model (T. Gao et al., 2017; Judge & Ilies, 2002). It is predictive of addictive behaviors, including smartphone addiction (T. Gao et al., 2017; Montag et al., 2021). Individuals who are high in neuroticism tend to be more sensitive to negative life events and more prone to experiencing negative emotions such as anxiety, depression, and stress (Elhai, Levine et al., 2017; T. Gao et al., 2017; Yang et al., 2020); many may turn to mobile phones to escape from these uncomfortable feelings (J.-H. Kim et al., 2015). While some studies have found no significant relationship between neuroticism and PSU (Andreassen et al., 2013; Bianchi & Phillips, 2005), many studies have established a robust positive association between these factors (Eichenberg et al., 2021; T. Gao et al., 2017; Horwood & Anglim, 2018, 2021a; Liu et al., 2020; Urieta et al., 2022; Wei et al., 2022). L. Gao et al. (2022) used the random-effects model to analyze data from 36 studies, finding neuroticism to be positively associated with PSU. This positive association received additional support from a meta-analysis of 26 studies (Marengo et al., 2020).

The effect of neuroticism on PSU may be explained by the pathway model (Billieux, 2012) and the Interaction of Person-Affect-Cognition-Execution (I-PACE) model (Brand et al., 2016). According to the *relationship maintenance pathway*, individuals who are high in neuroticism may check their smartphones compulsively to seek constant reassurance for their affective relationships (Billieux, 2012; Marengo et al., 2020). Thus, they may use mobile phones excessively to alleviate nervousness and anxiety arising from interpersonal relationships (Elhai, Levine et al., 2017; L. Gao et al., 2022). The I-PACE model was originally proposed to explain internet use disorders. However, given the connection between the internet and smartphones (Sha et al., 2019), researchers have also considered it a theoretical framework for PSU (Horwood & Anglim, 2021a; Liu et al., 2020; Montag et al., 2021). The I-PACE model describes that predisposing factors (e.g., biopsychological construction, psychopathological features, personality, social cognition, and motives) contribute to the development of addictive behaviors (Brand et al., 2016). Further, the model suggests that this influence is mediated by affective and cognitive responses and moderated by executive function (Brand et al., 2016). While the link between neuroticism and PSU has been well established (Marengo et al., 2020), the origination of this influence and the mediators and moderators of the effect remain unexplored.

Mediation via Self-Control

Self-control is the ability to regulate one's thoughts, emotions, and behaviors, and the ability to inhibit impulses and monitor oneself to achieve goals (Maranges & Baumeister, 2016). On one hand, self-control and neuroticism have a consistent and significant negative correlation (Andrei et al., 2014; de Vries & van Gelder, 2013; Hoyle & Davisson, 2016; Mao et al., 2018; Rush, 2013; Zhang et al., 2019). Self-control is conceptually connected with neuroticism (Hoyle & Davisson, 2016), whereby low neuroticism is characterized by low impulsivity and high emotional regulation (Aslan & Cheung-Blunden, 2012; Hoyle & Davisson, 2016; Urieta et al., 2022). Individuals with high self-control tend to use more emotional regulation strategies (Paschke et al., 2016).

On the other hand, self-control is not limited to emotion regulation, but also the regulation of behavior, etc. Low self-control has been shown to contribute to smoking addiction (Hwang & Yun, 2015), alcohol addiction (Muraven et al., 2002), drug addiction (Mohammadkhani et al., 2015), internet addiction (C. Li et al., 2014; Özdemir et al., 2014), and MPA (De-Sola Gutiérrez et al., 2016; Yildiz Durak, 2019). Concerning PSU, self-control has been found to be negatively associated with smartphone addiction (Busch & McCarthy, 2021) and nomophobia (Akyol Guner & Demir, 2022; Hidayati et al., 2021; Ilmiah et al., 2021). According to Billieux (2012), self-control affects PSU through an impulsive pathway: when individuals experience an intense emotional urgency to use a smartphone, those with high self-control are more likely to overlook or suppress the impulse, while those with low self-control are more likely to obey the impulse and engage in PSU (Berger et al., 2018; Billieux, 2012; Busch & McCarthy, 2021; Mao et al., 2018). In general, self-control reduces PSU and encourages the development of positive smartphone habits (Ilmiah et al., 2021).

According to the energy model, self-control depends on a limited energy resource (Baumeister et al., 2007). Individuals experiencing negative emotions would have fewer self-control resources (Stucke & Baumeister, 2006; Yu et al., 2013). In the I-PACE model, self-control is considered an executive component that affects addictive behaviors (Brand et al., 2016). When individuals lose self-control, they fail to inhibit themselves from making disadvantageous decisions and, ultimately, develop behavioral addictions (Brand et al., 2016; Goldstein & Volkow, 2011). Additionally, the I-PACE model suggests that self-control might affect the influence of personality on PSU. Individuals with low neuroticism are more likely to have greater self-control, which may inhibit impulsivity and decrease problematic behaviors. Given the negative association between neuroticism and self-control, as well as the negative association between self-control and PSU, we hypothesized that self-control may play a mediating role in the relationship between neuroticism and PSU.

Gender Differences

Males and females differ in many aspects of smartphone use. Specifically, a large body of research has shown that PSU is significantly higher in females than in males (Busch & McCarthy, 2021; De-Sola Gutiérrez et al., 2016; León-Mejía et al., 2021; Rodríguez-García et al., 2020). In addition, males and females differ in their smartphone use patterns and motivations for using smartphones (Chen et al., 2017; Taywade & Khubalkar, 2019). Females tend to spend more time communicating and shopping online to obtain social approval (E. J. Lee & Kim, 2018; Totten et al., 2005), while males tend to use their smartphones to work and play games (Totten et al., 2005). Further, gender

has been shown to moderate the relationship between PSU and other variables. For example, researchers have found closer relationships between PSU and sleep duration (Yoon et al., 2021), PSU and alienation (W. Wang et al., 2022), and PSU and depression (Chen et al., 2017) in females than in males; and greater associations between PSU and peer relationships (W. Wang et al., 2022) and PSU and academic performance (Nayak, 2018) in males than in females.

In general, gender may play an important role in determining phone use patterns, motivations for using smartphones, and the antecedents and consequences of PSU. As for the hypothesized mediation of self-control in the relationship between neuroticism and PSU, prior studies have found greater associations between neuroticism and PSU (Arpaci & Kocadag Unver, 2020) and self-control and PSU in females than in males (Park & Lee, 2022). Thus, considering the hypothesis outlined in the preceding section, it was further hypothesized that the mediation effect of self-control in the relationship between neuroticism and PSU would be significant only for females.

Age as a Covariate

Prior studies have explored which groups may be more prone to PSU, identifying younger age groups (Busch & McCarthy, 2021; Rodríguez-García et al., 2020). On the one hand, younger individuals tend to report a greater dependency on smartphones and more time spent using smartphones, likely because they have been exposed to smartphones from a younger age, and are therefore more accustomed to and proficient at using smartphones (Anshari et al., 2016; Nahas et al., 2018). On the other hand, older individuals tend to experience less social stress, practice greater self-regulation and enjoy more personal interests (van Deursen et al., 2015), which may reduce their smartphone use. Therefore, the present study considered age as a covariate that might affect PSU.

The Present Study

The present study aimed at exploring whether: (1) self-control mediates the relationship between neuroticism and PSU, and (2) gender moderates this mediation effect. According to the literature reviewed above, two hypotheses were proposed (see Figure 1):

H1: self-control would mediate the relationship between neuroticism and PSU; and

H2: the mediation effect of self-control on the relationship between neuroticism and PSU would be significant for only females.

Figure 1. *Conceptual Model.*
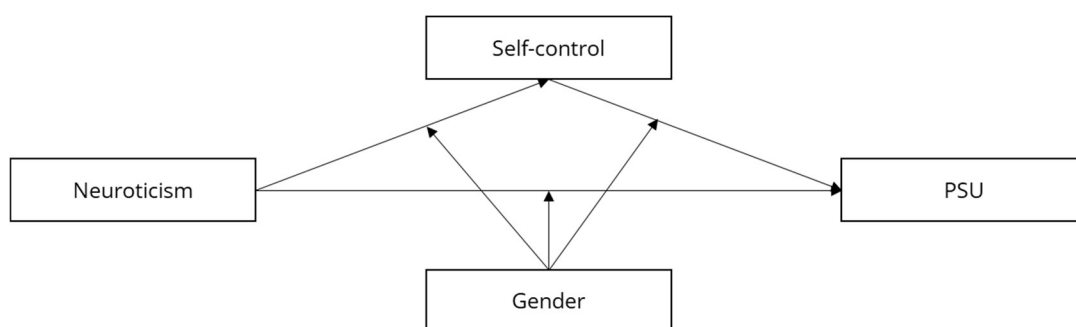
Methods

Participants

The study was approved by the Ethical Committee for Scientific Research at the authors' institution. Smartphone users were recruited from various Chinese social media applications, and all participants completed the questionnaires anonymously. Each participant was paid 10 Chinese yuan after their data were qualified. A minimum sample size of 138 was determined, using Soper's (2022) online SEM calculator, to detect a small to moderate effect size (0.15), assuming 95% power and a 5% level of statistical significance. From January to February, 2022, a total of 768 Chinese smartphone users completed the survey, which aimed at measuring

neuroticism, self-control, nomophobia, and MPA. Of these, 57.2% were female. Participants' average age was 22.5 years (SD = 3.27, range = 14–37).

Measures

Neuroticism

Neuroticism was measured using a subscale of the Chinese Big Five Personality Inventory (CBF-PI; M. Wang et al., 2010a). This subscale includes eight items, which are rated on a six-point Likert scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*). As negative items are reverse scored, higher scores indicate higher levels of neuroticism. The subscale has been shown to have satisfactory validity and reliability among the Chinese population (M. Wang et al., 2010b). In the present study, confirmatory factor analysis (CFA) was applied to establish the one-dimensionality of the inventory (χ^2/df = 4.31, RMSEA = .07, CFI = .98, TLI = .98, SRMR = .02). Cronbach's α (.89) was greater than .7, indicating good internal consistency.

Self-Control

Self-control was measured using the Effortful Control Scale (L. K. Ellis & Rothbart, 2001). The Chinese version of this scale measures activation control, attention, and inhibitory control across 16 items (D. Li et al., 2010). Each item is rated on a six-point Likert scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*). As negative items are reverse scored, higher scores indicate higher levels of effortful control. In the present study, CFA was applied to establish the one-dimensionality of the scale (χ^2/df = 4.71, RMSEA = .07, CFI = .95, TLI = .93, SRMR = .04), and good internal consistency was confirmed by Cronbach's α of .90.

Problematic Smartphone Use

The Mobile Phone Addiction Index Scale (MPAI; Leung, 2008) was used to measure mobile phone addiction. The scale assesses four dimensions: inability to control cravings (seven items), anxiety and feeling lost (four items), withdrawal and escape (three items), and productivity loss (three items). Each of the 17 items is rated on a five-point Likert scale ranging from 1 (*never*) to 5 (*always*). Higher scores indicate greater levels of addiction. In the present study, CFA was applied to establish the structure validity of the scale (χ^2/df = 5.17, RMSEA = .07, CFI = .92, TLI = .91, SRMR = .04), and Cronbach's α (.93) indicated good internal consistency.

Nomophobia was assessed using the Nomophobia Questionnaire (NMP-Q; Yildirim & Correia, 2015). Previous studies have shown that the Chinese version of the NMP-Q has good reliability and validity (Y. Gao et al., 2020; Ma & Liu, 2021; Ren et al., 2020). The NMP-Q is comprised of 16 items measuring four dimensions: *not being able to reach information* (4 items), *losing connectedness* (4 items), *not being able to communicate* (4 items), and *giving up convenience* (4 items; Ren et al., 2020). Each item is rated on a seven-point Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). CFA was applied to establish the structure validity of the scale (χ^2/df = 5.15, RMSEA = .07, CFI = .95, TLI = .95, SRMR = .03), and Cronbach's α (.94) indicated good internal consistency.

Demographic Variables

Gender and age were respectively measured using two items: *Please choose your gender* and *What is your age?* Respondents chose either male or female as their gender and typed their age in numerical form.

Data Analytic Approach

In the present study, the descriptive statistics were first analyzed to identify and compare the prevalence of nomophobia and MPA between male and female respondents. Subsequently, Pearson correlations were calculated to examine the bivariate associations for all research variables, using SPSS 22.0. Fisher's *z*-transformation was performed on the respective groups of correlation coefficients and the difference statistic *z* was calculated to identify differences in the correlation coefficients between male and female participants. Further, the mediation model of self-control in the relationship between neuroticism and nomophobia and MPA was tested. The bootstrap method was used and a total of 5,000 bootstrapping samples were generated through

random sampling of the raw data. In the mediation model, the collinearity diagnosis showed no collinearity. When predicting PSU together, the variance inflation factor was lower than 10 and the tolerance was greater than 0.1 for each variable; furthermore, the conditional index was lower than 30 for each model, indicating no collinearity between variables (Belsley, 1991). Finally, the moderated mediation model of gender in the mediation model was tested. The mediation model and moderated mediation model were both tested using Mplus v7.11 (Muthén & Muthén, 2012).

Results

Prevalence of Problematic Smartphone Use

Table 1 presents the means and standard deviations for neuroticism, self-control, nomophobia, and MPA for all participants, female and male participants, specifically. Relative to female participants, male participants scored lower on nomophobia ($t = -5.49$, $p < .001$, Cohen's $d = -0.40$) and MPA ($t = -2.58$, $p = .010$, Cohen's $d = -0.18$).

Table 1. *Means, Standard Deviations, and Gender Differences in Neuroticism, Self-Control, Nomophobia, and Mobile Phone Addiction.*

	M	SD	Male (*n* = 329)		Female (*n* = 439)			
			M	SD	M	SD	t	p
Neuroticism	3.18	1.16	3.09	1.20	3.24	1.13	−1.80	.072
Self-control	3.82	0.90	3.89	0.93	3.76	0.87	1.98	.048
Nomophobia	4.46	1.38	4.15	1.50	4.70	1.23	−5.49	< .001
MPA	3.29	0.81	3.20	0.85	3.35	0.77	−2.58	.010

Table 2 presents the frequency distribution of nomophobia and MPA for male and female participants. The classification of nomophobia was based on the cut-off points recommended by Yildirim et al. (2016) and León-Mejía et al. (2021). While a small proportion of participants (i.e., less than 5% of both female and male participants) suffered from severe nomophobia, more than half (i.e., 64.1% and 77.0% of male and female participants, respectively) displayed moderate nomophobia. Relative to male participants, more female participants suffered from mild to severe nomophobia, $\chi^2_{(2)} = 22.33$, $p < .001$, Cramér's $V = .17$. The cut-off score for MPA was adopted from Tavakolizadeh et al. (2014). Among all participants, 201 males (61.1%) and 327 females (74.5%) displayed excessive mobile phone use. A significantly higher proportion of female participants were classified as mobile phone addicts compared to male participants, $\chi^2_{(1)} = 15.70$, $p < .001$, Cramér's $V = .14$.

Table 2. *Frequency Distribution of Nomophobia and MPA in Males and Females.*

PSU	Classification	Male		Female	
		Frequency	Percent (%)	Frequency	Percent (%)
Nomophobia	Absence (≤ 20)	4	1.2	0	0
	Mild (> 20 ≤ 60)	106	32.2	80	18.2
	Moderate (> 60 ≤ 100)	211	64.1	338	77.0
	Severe (> 100)	8	2.4	21	4.8
MPA	Usual usage (≤ 51)	128	38.9	112	25.5
	Excessive usage (> 51)	201	61.1	327	74.5
	Total	329	100	439	100

Correlations Between Problematic Smartphone Use, Neuroticism, and Self-Control

Table 3 presents the correlations between PSU, neuroticism, and self-control. Neuroticism was negatively associated with self-control ($r = -.797$, $p < .001$) and positively associated with nomophobia ($r = .549$, $p < .001$) and MPA ($r = .541$, $p < .001$). Self-control was associated moderately with nomophobia ($r = -.515$, $p < .001$) and MPA ($r = -.492$, $p < .001$).

Table 3. *Correlations Between Neuroticism, Self-Control, Nomophobia, and MPA.*

Variable	1	2	3	4
1. Neuroticism	1			
2. Self-control	−.797**	1		
3. Nomophobia	.549**	−.515**	1	
4. MPA	.541**	−.492**	.841**	1

Note. **$p < .01$.

In addition, Table 4 presents the correlations between these variables among female participants above the diagonal and the equivalent correlations among male participants below the diagonal. A difference test showed that the correlations between neuroticism and self-control ($z = −4.13$), nomophobia ($z = 6.12$), and MPA ($z = 5.06$); and the correlations between self-control and nomophobia ($z = 4.53$) and MPA ($z = 3.60$), were stronger for male participants than for female participants.

Table 4. *Correlations Between Neuroticism, Self-Control, Nomophobia, and MPA for Males and Females.*

Variable	1	2	3	4
1. Neuroticism	1	−.748**	.401**	.420**
2. Self-control	−.854**	1	−.395**	−.397**
3. Nomophobia	.703**	−.635**	1	.824**
4. MPA	.674**	−.594**	.865**	1

Note. Correlations appear above the diagonal for females and below the diagonal for males.
**$p < .01$.

Mediation Effect of Self-Control

A regression analysis was conducted with PSU as the dependent variable and age as the independent variable. The results showed a significant effect of age on nomophobia ($β = −.096$, $p = .008$, adjusted $r^2 = .008$) and no significant effect of age on MPA ($β = −.054$, $p = .135$, adjusted $r^2 = .002$). Thus, in the following analysis, age was added to the model as a control variable.

Table 5 presents the regression coefficients of the mediation models. The results showed that neuroticism was negatively associated with self-control ($β = −.79$, $p < .001$). Neuroticism was positively associated with nomophobia ($β = .38$, $p < .001$) and MPA ($β = .41$, $p < .001$), and self-control was negatively associated with nomophobia ($β = −.21$, $p < .001$) and MPA ($β = −.17$, $p < .001$).

Table 5. *Regression Coefficients of the Mediation Models.*

Variable	β	SE	t	p
Mediator variable model for predicting self-control				
Constant	5.48***	0.15	36.70	< .001
Age	.05*	0.01	2.14	.033
Neuroticism	−.79***	0.02	−36.37	< .001
Dependent variable model for predicting nomophobia				
Constant	4.64***	0.52	8.90	< .001
Age	−.04	0.01	−1.42	.157
Neuroticism	.38***	0.06	7.69	< .001
Self-control	−.21***	0.08	−4.17	< .001
Dependent variable model for predicting mobile phone addiction				
Constant	2.97***	0.31	9.62	< .001
Age	−.00	0.01	−0.08	.935
Neuroticism	.41***	0.03	8.13	< .001
Self-control	−.17***	0.05	−3.32	< .001

Note. *$p < .05$, **$p < .01$, ***$p < .001$.

As can be seen in Table 6, the direct and indirect effects of neuroticism on nomophobia and MPA were significant. The mediation model explained 31.94% of the variance in nomophobia. Of the total effect, the direct effect accounted for 70.31% and the indirect effect accounted for 29.69%. In a similar vein, the mediation model explained 30.23% of the variance in MPA. Of the total effect, the direct effect accounted for 75.68% and the indirect effect accounted for 24.32%. Thus, self-control partially mediated the association between neuroticism and nomophobia, as well as the association between neuroticism and MPA.

Table 6. *Direct and Bootstrapping Indirect Effect of the Mediation Model.*

Path	Effect	Boot *SE*	Boot LLCI	Boot ULCI
Neuroticism → nomophobia	0.45	0.06	0.34	0.57
Neuroticism → self-control → nomophobia	0.19	0.05	0.09	0.29
Neuroticism → MPA	0.28	0.03	0.21	0.35
Neuroticism → self-control → MPA	0.09	0.03	0.03	0.15

Note. Bootstrap samples = 5,000. LL = low limit; UL = upper limit; CI = 95% confidence interval; MPA = mobile phone addiction.
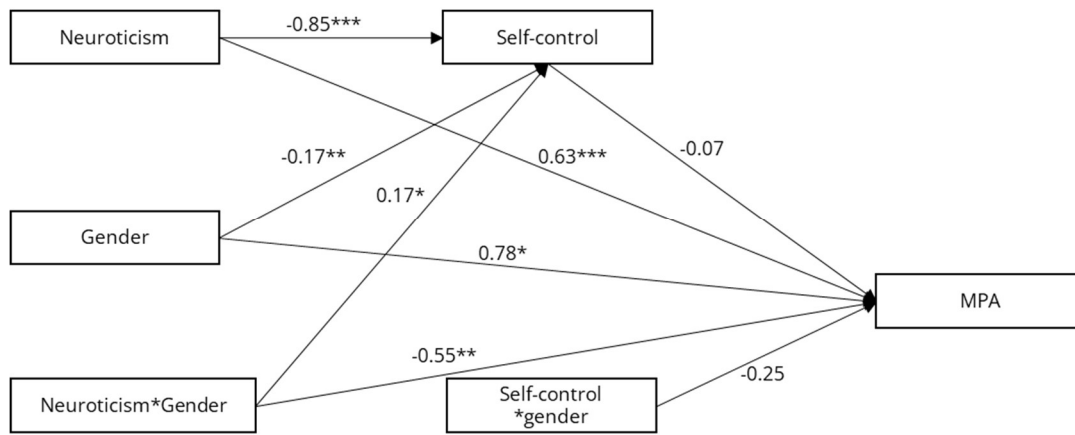
Moderated Mediation Models

Moderated mediation models were run to test the equivalence of each path in the mediation model between male and female participants. Table 7, Figure 2, and Figure 3 present the regression coefficients of these models. The results showed that neuroticism was still negatively associated with self-control ($β = −.84$, $p < .001$). Additionally, gender was significantly associated with self-control ($β = −.17$, $p = .008$), and the interaction of neuroticism and gender was positively associated with self-control ($β = .17$, $p = .012$). Consequently, gender moderated the association between neuroticism and self-control.

Table 7. *Regression Coefficients of the Moderated Mediation Models.*

Variable	β	SE	t	p
Mediator variable model for predicting self-control				
Age	.01*	0.01	2.03	.042
Neuroticism	−.85***	0.02	−26.37	< .001
Gender	−.17**	0.13	−2.65	.008
Neuroticism*gender	.17*	0.04	2.03	.012
Dependent variable model for predicting nomophobia				
Age	−.03	0.03	−1.12	.263
Gender	.82*	0.94	2.44	.015
Neuroticism	.63***	0.09	7.61	< .001
Self-control	−.14	0.13	−1.67	.096
Neuroticism*gender	−.63***	0.11	−3.98	< .001
Self-control*gender	−.12	0.17	−0.55	.584
Dependent model for predicting mobile phone addiction				
Age	.00	0.01	0.13	.898
Gender	.78*	0.62	2.23	.026
Neuroticism	.63***	0.06	7.36	< .001
Self-control	−.07	0.09	−0.81	.417
Neuroticism*gender	−.55**	0.07	−3.37	.001
Self-control*gender	−.25	0.10	−1.09	.272

Note. *p < .05, **p < .01, ***p < .001.

Figure 2. *Moderated Mediation Model on MPA.*


Note. *p < .05, **p < .01, ***p < .001.

Figure 3. *Moderated Mediation Model on Nomophobia.*
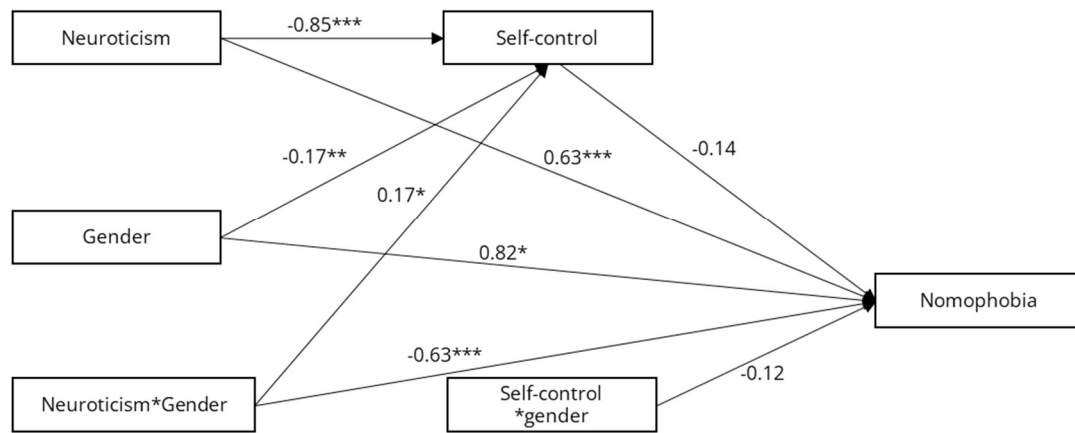
Note. *p < .05, **p < .01, ***p < .001.

To illustrate the moderating effect of gender, differences in self-control with low neuroticism (1 *SD* below the mean) and high neuroticism (1 *SD* above the mean) were plotted for male and female participants. As shown in Figure 4, the association between neuroticism and self-control was stronger in male participants than in female participants.

Figure 4. *Plot of the Relationship Between Neuroticism and Self-Control in Males and Females.*
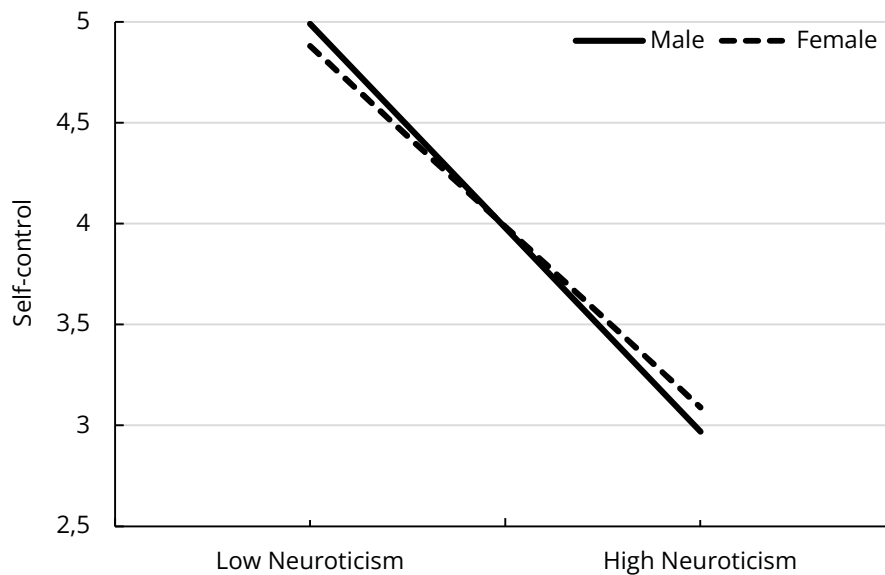
As shown in Table 7, in the dependent variable model, neuroticism was still positively associated with nomophobia (β = .63, p < .001) and MPA (β = .63, p < .001). Moreover, the interaction between neuroticism and gender was significantly associated with nomophobia (β = −.63, p < .001) and MPA (β = −.55, p < .001). Accordingly, gender moderated the association between neuroticism and both nomophobia and MPA. To illustrate the moderating effect of gender, differences in nomophobia and MPA with low neuroticism (1 SD below the mean) and high neuroticism (1 SD above the mean) were plotted for male and female participants. As shown in Figure 5, the association between neuroticism and nomophobia was stronger in male participants than in female participants. Similarly, as shown in Figure 6, the association between neuroticism and MPA was stronger in male participants than in female participants.

Figure 5. *Plot of the Relationship Between Neuroticism and Nomophobia in Males and Females.*
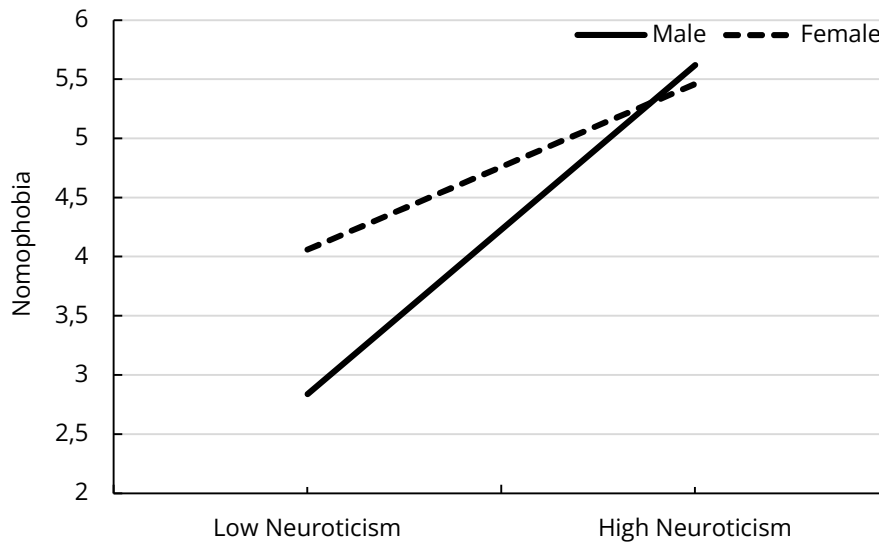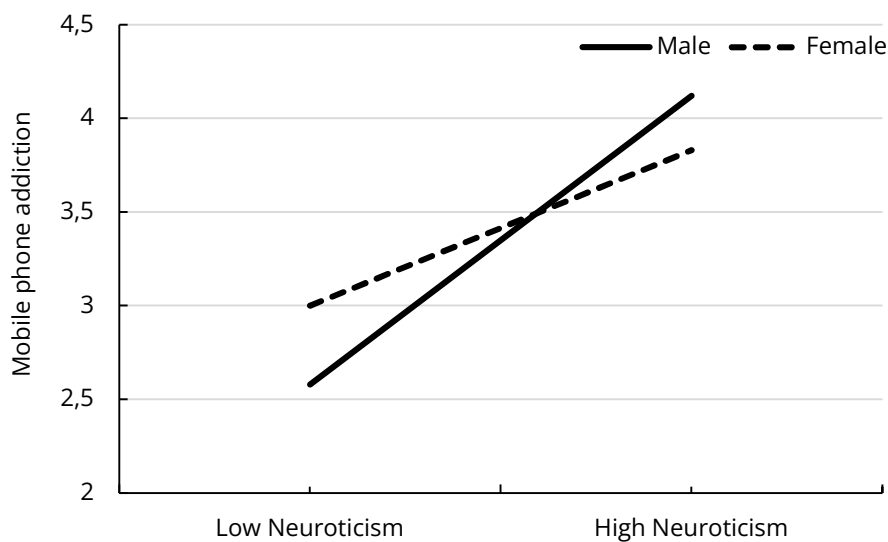

Figure 6. *Plot of the Relationship Between Neuroticism and MPA in Males and Females.*

According to the regression coefficients presented in Table 7, self-control was not significantly associated with nomophobia (β = −.14, p = .096) or MPA (β = −.07, p = .417). Further, the interaction between self-control and gender was not significantly associated with nomophobia (β = −.12, p = .584) or MPA (β = −.25, p = .272).

As shown in Table 8, the mediating effect of self-control was significant for female participants, but not male participants. Specifically, for male participants, the effect of neuroticism on nomophobia and MPA was almost direct. For female participants, the indirect effect accounted for 39.53% of the total effect of neuroticism on nomophobia and 32.14% of the total effect of neuroticism on MPA. In general, self-control partially mediated the association between neuroticism and both nomophobia and MPA, and this mediation effect was moderated by gender.

Table 8. *Direct and Bootstrapping Indirect Effect of the Mediation Model for Males and Females.*

Gender	Path	Effect	Boot *SE*	Boot LLCI	Boot ULCI
Male	Neuroticism → nomophobia	0.74	0.10	0.55	0.93
	Neuroticism → self-control → nomophobia	0.14	0.09	−0.03	0.30
	Neuroticism → MPA	0.44	0.06	0.32	0.55
	Neuroticism → self-control → MPA	0.04	0.06	−0.07	0.15
Female	Neuroticism → nomophobia	0.26	0.07	0.13	0.40
	Neuroticism → self-control → nomophobia	0.17	0.06	0.04	0.28
	Neuroticism → MPA	0.19	0.04	0.11	0.27
	Neuroticism → self-control → MPA	0.09	0.04	0.02	0.17

Note. Bootstrap samples = 5,000. LL = low limit; UL = upper limit; CI = 95% confidence interval; MPA = mobile phone addiction.

Discussion

The present study surveyed the prevalence of PSU in a Chinese sample and tested the mediation effect of self-control in the relationship between neuroticism and PSU in males and females. The results showed that: (1) females reported more serious PSU than males; and (2) self-control partially mediated the relationship between neuroticism and PSU for females, while neuroticism affected PSU only directly for males.

First, the study found that, relative to male participants, female participants reported more serious PSU. This finding is consistent with the results of most prior research (Billieux, 2012; De-Sola et al., 2017; Hong et al., 2019), and may be explained by the fact that, on average, females spend more time using mobile phones (Nayak, 2018). Further, females tend to have greater social anxiety and are more likely to chat with strangers online, visit social networking sites and check texts and emails to alleviate negative emotions (E. J. Lee & Kim, 2018; Totten et al., 2005). Finally, females tend to experience more anxiety when they cannot access their smartphones (Arpaci, 2022).

PSU was highly prevalent among the study participants. In total, 75.26% suffered from moderate to severe nomophobia and 12.2% scored one standard deviation above the mean—a rate that was slightly lower than that found in a prior study (16%; Ma & Liu, 2021). In addition, 68.75% of participants reported excessive smartphone use, with mean scores (*M* = 3.20 for males, *M* = 3.35 for females) that were higher than those reported by Hao et al. (2019) and Liu et al. (2020; who respectively recorded mean values of 2.42 for males and 2.47 for females; and 2.69 for all participants). The differing findings may be attributed to two factors. First, the average age at which individuals first acquire a mobile phone is lowering (De-Sola Gutiérrez et al., 2016), and the risk of developing PSU increases in line with the amount of time spent with a smartphone (Ibrahim, 2018). Second, the mean age of the participants in the present study was older than that of the participants in prior research, and age has been shown to have a significant effect on smartphone use (Csibi et al., 2021; Hussain et al., 2017). Third, during the COVID-19 pandemic, individuals spent more time on smartphones (Ni, 2020), and increased daily smartphone use is associated with a greater likelihood of developing PSU (Kara et al., 2021; Kuss, 2017; Nikhita et al., 2015).

Second, neuroticism was positively associated with PSU for both males and females. Wei et al. (2022) used network analysis to explore the relationship between neuroticism and PSU, finding negative emotions, low self-esteem, and maladaptive cognition of neuroticism related to reassurance and PSU. This result is aligned with the *maintenance pathway model*, which holds that individuals with negative emotions and low self-esteem may use smartphones to reassure themselves; and the *impulsive pathway model*, which suggests that maladaptive cognition may lead to intense emotions and a strong impulse to use one's smartphone immediately (Billieux, 2012).

Third, a significant mediation effect of self-control was found in the relationship between neuroticism and PSU for females, while for male participants, neuroticism affected PSU only directly. This difference may result from distinctly gendered motivations for using smartphones. Females who use smartphones excessively or problematically tend to be driven by emotional problems (E. J. Lee & Kim, 2018) related to self-control. In contrast, males tend to use smartphones for work (Totten et al., 2005), which is less related to self-control, and for entertainment (Totten et al., 2005), which is more related to problematic internet use. For example, as discussed above, females tend to experience greater social anxiety, which may push them to use smartphones to establish social connections with others. In this process, if they can effectively control or regulate their emotions and inhibit their needs, they may be able to avoid PSU.

The mediation effect for females may also stem from a closer relationship between self-control and PSU. For females, low self-control may lead to internet and smartphone use, whereas for males, self-control and internet and smartphone use are not significantly correlated (Park & Lee, 2022). This may be because lower self-control is always accompanied by high impulsivity. Impulsive females are still constrained by social norms (Mouakket, 2018), making their impulsivity more likely to manifest as PSU; however, males may feel less socially constrained in their ability to manifest their impulsivity through other forms, such as misconduct (DeLisi et al., 2010).

The absence of a mediation effect for males may also stem from a closer direct relationship between neuroticism and PSU. Highly neurotic individuals are more likely to engage in online social interactions and less neurotic individuals are more likely to engage in offline social activities (Orchard & Fullwood, 2010). Neurotic individuals tend to be emotionally unstable with more affection needs, and highly neurotic males may find that their emotional needs cannot be expressed and met offline, due to social expectations (Plant et al., 2000); this may lead them to use smartphones to socialize online anonymously. As a result, neurotic males may be more likely to develop PSU. This finding differs from that of a prior study examining the moderating role of gender in the relationship between neuroticism and PSU, which found a positive association between neuroticism and PSU for females and no equivalent association for males (Arpaci & Kocadag Unver, 2020). This may be due to the differences in subjects and measurement tools between the two studies. Thus, the relationship merits further exploration.

Limitations and Implications

There are several limitations of the present study. First, the data were collected during the COVID-19 pandemic, and this public health emergency may have had a significant impact on smartphone use (Ni, 2020). Thus, the findings require further empirical support. Second, while efforts were made to recruit smartphone users of all ages, the study sample was aged 14–35 years. This is problematic, as 11.5% of all smartphone users (CNNIC, 2022) are aged 60 years and older, and this age group was unable to be investigated in the present study. Future research should include older smartphone users to validate the current findings. Third, the present study only used the neuroticism personality subscale. Future research should apply the entire personality inventory to explore the association between other personality dimensions and PSU. Fourth, as the present study was cross-sectional, a causal relationship between variables could not be determined. Future research should be longitudinal to make up for this limitation. Fifth, the research used self-report measures to determine PSU, and such measures cannot provide an objective description of behavior (D. A. Ellis et al., 2019). Future research should aim at measuring mobile phone usage patterns more accurately, via mobile phone apps that collect usage time and other objective indicators.

Despite these limitations, the present study has important implications. First, both MPA and nomophobia were measured as indicators of PSU, reflecting an expanded understanding of this concept. Second, the effects of both neuroticism and self-control on PSU suggested a close relationship between emotion and PSU. In this way, PSU may be reduced by the management of emotional problems and improved emotional regulation ability. Third, the study found significant gender differences in the prevalence of PSU, the relationship between neuroticism and PSU, and the association between self-control and PSU. These findings shed significant light on the effect of gender on PSU, and suggest that gender should be considered an important factor in future studies on PSU.

Conflict of Interest

The authors have no conflicts of interest to declare.

Authors' Contribution

Yanan Liu: conceptualization, formal analysis, software, writing—original draft, writing—review & editing. **Xiuna Wang**: formal analysis, writing—review & editing. **Jiaqi Zhai**: data curation, investigation. **Fang Luo**: conceptualization, formal analysis, methodology, resources, supervision, writing—review & editing. **Tao Xin**: conceptualization, data curation, funding acquisition, project administration, supervision.

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About Authors

Yanan Liu is a graduate student of the PhD program at Collaborative Innovation Center of Assessment for Basic Education Quality at Beijing Normal University, China. Her research interests include the impact of technology on human behavior, psychology and education, applications of technology in teaching and learning.

https://orcid.org/0000-0001-5541-9966

Xiuna Wang is a PhD student at Collaborative Innovation Center of Assessment for Basic Education Quality at Beijing Normal University. Her research interests are educational assessment, including achievement test development and data analysis technique.

Jiaqi Zhai is a graduate student of Statistics at Beijing Normal University. Her research interest is psychological statistics.

Fang Luo, Ph.D. is the Professor at Faculty of Psychology, Beijing Normal University. She is also the vice Chairman of Education Statistics and Measurement Branch of the Chinese Society of Education. Her research interests include talent assessment and selection, test theory and technology, psychological and educational statistics. Recent researches focus on human-computer interactive test development and process data mining, intelligent mental health assessment, methods of examination cheating screening, data analysis methods and applications of large-scale educational tests.

https://orcid.org/0000-0003-3281-9574

Tao Xin, Ph.D. is the Professor at Collaborative Innovation Center of Assessment for Basic Education Quality, Beijing Normal University. He is also the committee member of the Experts Commission Secretariat of National Teaching Material Committee, specialist of National Education Test Steering committee, committee member of The Academic Committee of The Chinese Society of Education. His research interests include psychometrics, cognitive diagnostic theory, adaptive learning theory, educational evaluation, school education and student adaptation. He has published more than 200 papers in domestic or international important academic journals, and published many works and textbooks such as Regression Analysis and Experimental Design.

https://orcid.org/0000-0002-2308-8557

✉ **Correspondence to**
Fang Luo, Beijing Normal University, No. 19 Xin Jie Kou Wai Street, Hai Dian District, 100875, Beijing, China, luof@bnu.edu.cn; Tao Xin, Beijing Normal University, No. 19 Xin Jie Kou Wai Street, Hai Dian District, 100875, Beijing, China, xintao@bnu.edu.cn