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Sense of security and problematic mobile phone use among freshmen: the mediating role of negative attention bias and the moderating role of relatedness needs satisfaction

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Abstract

Based on the cognitive-behavioral model of pathological internet use and the risk buffering model, the current study explored how and when the sense of security reduces problematic mobile phone use (PMPU) among Chinese freshmen. Specifically, we investigated the underlying mechanism of PMPU by testing a moderated mediation model, in which relatedness needs satisfaction moderated the mediating role of negative attention bias on the relation between sense of security and PMPU. A sample of 458 freshmen in China (76.20% females), with a mean age of 19.58 years ($SD = 1.03$, range = 16–23), were surveyed using the sense of security scale, the attention to negative information subscale, the relatedness needs satisfaction subscale, and the mobile phone addiction index. Mediation analysis indicated the sense of security decreased freshmen' PMPU by reducing negative attention bias. Moderated mediation analysis further demonstrated that high relatedness needs satisfaction ameliorated the adverse impact of negative attention bias on PMPU among freshmen, while low relatedness needs satisfaction sharpened the adverse impact of negative attention bias on PMPU among freshmen. This study highlights the mediating and moderating mechanisms linking the sense of security to PMPU. More importantly, it has prominent implications for the prevention and intervention of PMPU among freshmen.

Keywords Sense of security · Problematic mobile phone use · Negative attention bias · Relatedness needs satisfaction · Freshmen · Moderated mediation · Cross-sectional design

Introduction

With the development of science and technology, internet has become an important platform for college students to obtain knowledge, communicate ideas and search for entertainment. As reported by the 52nd national survey of China Internet Network Information Center (CNNIC) in 2023, mobile internet users accounted for 99.8% of all the internet users (1079 million), far exceeding the proportion of netizens using desktop (34.4%) and laptop computers (32.4%), which suggested that almost all the internet users were by mobile phones. Although the use of mobile phones could offer convenience, promote safety, release pressure, and facilitate learning (Hong et al., 2019) to individuals in various way, excessive or uncontrolled internet use may lead to problematic mobile phone use (PMPU), which seriously threatens individuals' emotion, behavior, and cognition (Dempsey et al., 2019; Peng et al., 2022; Jiang et al., 2022; Akyol et al., 2021). Specifically, maladaptive mobile phone use can be described as PMPU, which refers to a constellation of emerging addiction-related symptoms, such as craving, dependence, tolerance, withdrawal, and negative consequences (Bianchi & Phillips, 2005; Foerster et al., 2015), and is similar to problematic internet use (PIU, which exhibits major differences for PMPU in terms of platform and interface) (Kim et al., 2016). Previous research has fully confirmed the importance of PMPU (Liu et al., 2021; Hong

Highlights Sense of security is associated with freshmen' PMPU.

Sense of security decreased freshmen' PMPU via reducing negative attention bias.

High relatedness needs satisfaction attenuated the negative effect of sense of security acting indirectly on PMPU through negative attention bias.

The results have practical implications for the prevention and intervention of PMPU among freshmen.

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et al., 2019). However, such research remains in its infancy, and our understanding of the etiological factors and mechanism of action associated with PMPU is still very limited. Some studies have explored the effects of individual characteristics (such as personality, emotions, cognition, etc.) and environmental factors (such as family, school, etc.) on PMPU (Han et al., 2017; Jia et al., 2018; Li et al., 2021; Lozano-Blasco et al., 2022; Niu et al., 2020). Specifically, although there have been several studies on the individual characteristics of college individuals' PMPU, and a small amount of research has also focused on the influence of needs (such as autonomy needs and unique needs) on PMPU (Chen et al., 2022; Li et al., 2021), it seemed to have a deficit in sufficient empirical evidence, and less attention has been given to how and when the sense of security, which can reflect the basic psychological needs of individuals, affects PMPU.

Given that sense of security plays an important role for individuals (Ye et al., 2021), several studies have examined the impact of sense of security on PMPU (Parent & Shapka, 2020). Moreover, due to the acceleration of social globalization and the corresponding increase in emergencies, people are facing increasing uncertainty in life. As a social psychological factor that reflects their external living environment, sense of security can explain the variety of types of maladjustment caused by the failure to satisfy the basic psychological needs of individuals, such as social anxiety, depression, aggression, social avoidance, and deviant behavior (Zhao et al., 2020). According to the most recent data reported by the China Internet Network Information Center (CNNIC), the largest group of people using mobile phones access the internet are students (28.4%, 2023). What's more, high PMPU rates have been observed among college students (Chen et al., 2022). Normally, college students may be more involved with the internet than other young people, and the former are particularly vulnerable to PMPU (Young et al., 2011). In particular, freshmen, who are undergoing a transitional period from senior high school to university, have more overall freedoms as a result of diminished parental supervision regarding internet use (Coyne et al., 2013), but face more pressures due to changes in their living environments and lifestyles. Most importantly, they are mentally immature and are at a critical stage in their social adjustment and emotional development in late adolescence (Brand et al., 2014). Therefore, freshmen are in the high-risk group for developing PMPU, and as such, it is worth to paying attention to the risk factors and mechanisms associated with PMPU among freshmen and developing effective strategies for prevention, thus offering the possibility of reducing college students' PMPU and addressing a series of other problems resulting from PMPU. Thus, the current study aimed to investigate the relationship between sense of security and PMPU among Chinese freshmen and the underlying mechanism, with the goals of revealing the etiological mechanism underlying internet addiction and to providing a foundation for the scientific prevention and effective control of internet addiction.

The relation between sense of security and PMPU

Self-determination theory posits that the satisfaction of basic psychological needs has critical implications for individuals' adaptive behavior (Deci & Ryan, 2000). A lack of basic psychological needs satisfaction may lead people to develop need substitutes or compensatory motives (Vansteenkiste et al., 2020; Ahn & Reeve, 2021). In addition, according to the psychological decompensation hypothesis of internet addiction, if people's psychological needs satisfaction is substantially hindered, they might compensate for their unmet needs by engaging in internet addiction behavior (Kardefelt-Winther, 2014). As the most basic psychological need, sense of security refers to a belief regarding possible physical or psychological dangers or risks in the surrounding world, and to an individual's sense of his or her ability (or inability) to cope with such a situation. Sense of security, which mainly takes the form of interpersonal security and certainty in control (Cong & An, 2004), is one of the most important determinants of mental health (Maslow et al., 1945). Individuals with a high sense of security usually have optimistic attitudes and focus on resolving events as they occur; they also typically believe that the world is safe and that people are friendly (Ye et al., 2021).

The lack of sense of security threatens basic human psychological needs satisfaction, and, individuals who lack such a sense tend to work diligently to maintain their sense of security. Coincidentally, mobile phones are linked by a strong interpersonal network connection system and offer rich information. In addition, this technology offers many other advantages such as virtuality, accessibility and convenience, which can meet people's need for sense of security (Guan et al., 2023). Individuals with low sense of security may often experience interpersonal threats in real life, lose control of their own lives and thus experience social evasion or anxiety (Yang et al., 2021). Therefore, the use of mobile phones may become a typical evasive behavior and a preferred way in which individuals can deal with interpersonal relationships in real life as well as negative emotions (Fu et al., 2020). Prior studies have observed that as important internal motivations for individual mobile phone dependence (Yang et al., 2021), the desires to avoid interpersonal relationships in real life and alleviate negative emotions might be principal reasons underlying the PMPU of college students (Melodia et al., 2020). Then, individuals with low sense of security may meet their security needs by overusing mobile phones. Therefore, a close association between sense of security and problematic mobile phone use is proposed.

The mediating role of negative attention bias

Some studies have investigated the effect of sense of security on PMPU (Jia et al., 2017, 2018; Pan et al., 2018; Zhang et al., 2022). However, the mechanism underlying the impact of sense of security on PMPU has received little attention. According to the cognitive-behavioral model of pathological internet use, PMPU is a combination of proximal and distal factors (Davis, 2001). Distal factors refer to causes that lie toward the end of the chain in a set of symptoms, including individual characteristics (such as depression and loneliness, etc.) and environmental stress (such as negative life events), while proximal factors are defined as causes that lie near the beginning of the chain, i.e., distant from the set of symptoms, including maladaptive cognition, which is the most critical and stable factor affecting the formation and maintenance of internet addiction (Davis, 2001). In general, individual characteristics influence internet addiction through the mediation of maladaptive cognition (Davis, 2001). Similar to maladaptive cognition, negative attention bias is viewed as a kind of negative cognitive process, a concept which is defined as the tendency of individuals to pay attention to negative information or negative aspects of information (Bodenschatz et al., 2019). The mediating role of negative attention bias in the relationship between sense of security and problematic mobile phone use can be conceptualized based on the cognitive-behavioral model of pathological internet use. Specifically, in this study, the distal factor of sense of security may affect problematic mobile phone use through proximal negative attention bias. Although this view has not been directly examined, some evidence has indirectly supported the mediating effect of negative attention bias on this relation.

On the one hand, low sense of security may increase negative attention bias. Maslow et al. (1945) claimed that individuals who lacked a sense of security are more likely to interpret external stimuli as threatening, to process external stimuli in an unsafe way, and to believe that they are worthless and unworthy of love. Namely, when individuals with low sense of security are more likely to be attracted to negative information such as that pertaining to failure, rejection, and threats (Schmitz et al., 2023; Peng et al., 2023), they have difficulty moving away from this information. Thus, a low sense of security may be a key factor in the generation of negative attention bias, thereby reflecting a distorted cognition of oneself and the real world (Bar-Haim et al., 2007). In other words, a lower sense of security may have a negative effect on negative attention bias. On the other hand, negative attention bias has a positive effect on problematic mobile phone use. As a tendency toward negative cognition, negative attention bias is the proximal sufficient cause of the formation and maintenance of internet addiction (Davis, 2001). Individuals with negative attention bias tend to pay more attention to negative stimuli or negative information in life (Bodenschatz et al., 2019), and their hypersensitivity to negative stimuli or threats directly leads to increasing anxiety and tension (Bar-Haim et al., 2007). To alleviate their own discomfort and deal with pressures, such individuals may try to express their emotions through mobile phone use (Oberst et al., 2017). Once individuals' feelings of anxiety or depression can be temporarily relieved through mobile phone use, this situation inevitably leads to excessive internet use in terms of duration and frequency. However, it does not fundamentally solve the problems underling individuals' negative emotions, resulting in a vicious cycle and ultimately leading to PMPU (Bozkurt et al., 2013). Thereby, it is reasonable to expect that sense of security may be related to negative attention bias, which in turn is associated with PMPU.

The moderating role of relatedness needs satisfaction on the mediating effect of negative attention bias

Although a low sense of security may increase problematic mobile phone use among freshmen through the mediation of negative attention bias, not all freshmen who exhibit negative attention bias due to a low sense of security face an increased risk of PMPU. Studies have shown that individual motivation factors (the behavioral activation/inhibition system) moderate the relationship between maladaptive cognition and behavior (Zhen et al., 2016). This finding suggests that relatedness needs satisfaction may moderate the association between negative attention bias and PMPU. In this study, we examined whether the mediated relationship between sense of security and PMPU through negative attention bias is moderated by relatedness needs satisfaction. Relatedness needs are a kind of powerful, foundational, and pervasive human motivation, that represents a satisfying alternative and directs people's emotions, cognition, and behaviors (Wang et al., 2018). The main feature of relatedness needs lies in individuals' need to maintain a certain frequency of positive interpersonal interaction with others (Shen et al., 2013). Relatedness needs satisfaction refers to a sense of belonging and connection in life, involving factors such as loving and caring and being loved and cared for (Deci & Ryan, 2000; Shen et al., 2013). To some extent, relatedness needs satisfaction entails that individuals have more stable and positive interpersonal relationships and can feel accepted and recognized by the group (Liu et al., 2021). To satisfy their relatedness needs, individuals construct beliefs regarding what others think about them that are based on being accepted and perceiving people's fondness for them (Zhen et al., 2017). Prior studies have shown that whether basic needs are satisfied in social interpersonal contexts may alter an individual's motivation to search for compensatory

satisfaction through the internet, which ultimately leads to internet addiction (Erwin et al., 2004; Li et al., 2016). Therefore, different levels of relatedness needs satisfaction may influence PMPU to different degrees.

According to the risk buffering model, protective factors can buffer or weaken the adverse effects of risk factors (Fergus & Zimmerman, 2005). Research has shown that relatedness needs satisfaction as a protective factor plays a significant moderating role in moderating individuals' behavioral problems (Li et al., 2017; Wan et al., 2016; Hong et al., 2019; Guo et al., 2014, 2021). Specifically, individuals with negative attention bias due to their lack of a sense of security are more likely to be dissatisfied with themselves or their real lives, leading to the increasing anxiety and tension (Bar-Haim et al., 2007) and such individuals may choose to use their smartphones to communicate with others online or watch videos for entertainment. During this process, if their relatedness needs are still not satisfied, individuals with negative attention bias due to their lack of a sense of security are likely to experience more negative emotions, ultimately becoming disgusted with the world. In regard to internet use, the compensatory model holds that the prerequisite for repeated and continuous internet use is that online services are capable of compensating for individuals' negative emotions (Kardefelt-Winther, 2014). Therefore, such individuals may become immersed in the virtual world of mobile phones, leading to a tendency toward PMPU. Conversely, individuals with higher relatedness needs satisfaction experience more positive emotions as a result of being accepted and perceiving people's fondness for them (Zhen et al., 2017). Such individuals believe that the real world is better and are more willing to invest more time and energy in the task of adapting to society. As a result, relatedness needs satisfaction serves as a significant protective factor that weakens the effects of sense of security on PMPU (Liu et al., 2016). Therefore, at the same level of cognition, individuals with low relatedness needs satisfaction exhibit a higher degree of PMPU than individuals with high relatedness needs satisfaction. Accordingly, we believe that the second half of the pathway of sense of security through the mediating role of negative attention bias on PMPU is moderated by relatedness needs satisfaction.

The present study

Based on the relationships described above, we can know that the intrinsic mechanism of this relationship has rarely been studied. Therefore, based on the cognitive-behavioral model of pathological Internet use and the risk buffering model, this study aimed to investigated the roles of negative attention bias as a mediator and relatedness needs satisfaction as a moderator in the relationship between sense of security and PMPU (see in Fig. 1). Moderated mediation analyses can provide ample and valuable information for better understanding the relationship between focused variables. In other words, a moderated mediation model can simultaneously reflect how and when sense of security may affect PMPU. To sum up, this research can provide valuable references for prevention of PMPU and its related intervention. Specifically, three assumptions were proposed:

Hypothesis 1: Sense of security will be negatively associated with PMPU.
Hypothesis 2: Negative attention bias will mediate the relationship between sense of security and PMPU.
Hypothesis 3: The second half of the pathway of sense of security through the mediating role of negative attention bias on PMPU is moderated by the relatedness needs satisfaction.

Method

Participants

We recruited 478 freshmen from a university in Henan province, China. After excluding participants whose answer time was less than 300s (Wang et al., 2023) or with extreme values (according to standardized values (±3.00); Tabachnick & Fidell, 2012), in total, 458 (349 female) participants were included in the full analyses with an effective recovery of 95.82%. There were no missing data as the survey program automatically required the entry of all responses. The mean age of the participants was 19.58 years ($SD = 1.03$, range = 16–23) (Table 1).

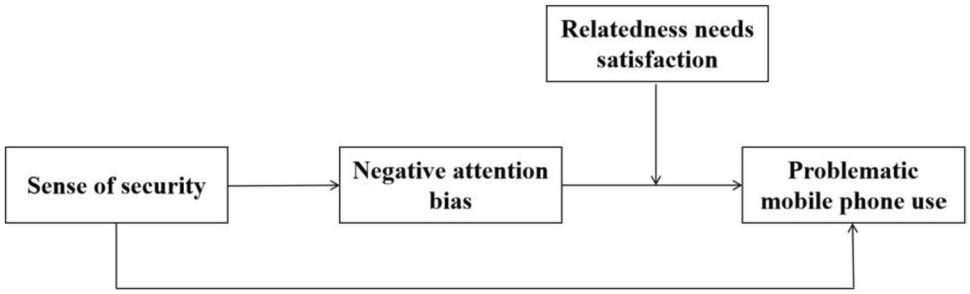

Fig. 1 Conceptual model of this study

Table 1 Background characteristics of the Chinese freshmen ($N = 458$)

Characteristics	*n*	%
Gender		
Female	349	76.20
Male	109	23.80
Age ($M \pm SD$)	19.58 ± 1.03	
Residence		
Countryside	242	52.84
City	216	47.16

Measures

Sense of security

Sense of security was assessed using the sense of security scale developed by Cong and An (2004). This scale comprised 16 items for assessing two factors named interpersonal security and sense of control. An example item was as follows: "I never dare to take the initiative to speak my mind." Participants rated the items on a 5-point scale (1 = Not true at all to 5 = Completed true). The mean of the 16 items was calculated, with higher scores indicating higher security. Cronbach's alpha coefficient for the present study was 0.94.

Negative attention bias

The attention of negative inventory subscale (ANI) is derived from The Attention of positive and negative inventory (APNI), which was originally developed by Noguchi et al. (2006) and was later translated into a Chinese version by Dai et al. (2015). In this study, we used the attention of negative inventory subscale in a Chinese version, which has been tested for reliability (0.86), to measure the negative attention bias. A representative item was "I pay special attention to the bad news on TV news". Participants rated the items on a 5-point scale (1 = Not true at all to 5 = Completed true). The mean of the 10 items was calculated, with higher scores indicating higher attention bias level of negative information. Cronbach's alpha coefficient for the present study was 0.87.

Relatedness needs satisfaction

The relatedness needs satisfaction subscale is derived the basic psychological needs satisfaction scale (BPNS) for adolescents, which was originally developed by Gagné (2003) and was later translated into a Chinese version by Liu et al. (2013). In this study, we used the relatedness needs satisfaction subscale in a Chinese version, which has been tested for reliability (0.72), to measure the relatedness needs satisfaction. The measure consisted of 7 items (e.g. I really like the people I interact with). Participants response to the items on a 7-point scale (1 = Not true at all to 7 = Completed true). The mean of the 19 items was calculated, with higher scores indicating higher relatedness needs satisfaction. Cronbach's alpha coefficient for the present study was 0.87.

Problematic mobile phone use

PMPU was assessed using the scale of mobile phone addiction index, which developed by Leung (2008) and revised by Huang et al. (2014). In this study, we used the Chinese version, which has been tested for reliability (0.91). Mobile phone addiction index consisted of 17 items (e.g. Your friends and parents complained about your use of mobile phone), including 4 dimensions (Inability to control craving, Anxiety and feeling lost, Withdrawal and escape, Productivity loss). The mean of the 17 items was calculated, with higher scores indicating higher PMPU. Cronbach's alpha coefficient for the current study was 0.89.

Procedure

The study was approved by the Institutional Review Board of the first's author's university. Informed consent was obtained from the freshmen before data collection. In order to standardize the data collection process, well-trained researchers described the study, answered students' questions, and monitored the whole assessment process. Students completed a set of questionnaires with basic demographic information (e.g., gender, age) anonymously online at the end of 2021 in their regular classrooms. To encourage honest and accurate responding, the authenticity, independence, and integral of all answers were emphasized to the participants. The participants received a gift as incentives. It took approximately 10 min to complete the questionnaires.

Data analysis

Statistical analyzes were conducted using SPSS 22.0 software with the PROCESS 3.2 plug-in. The data analysis proceeded in three steps in the current study. Firstly, data were analyzed using descriptive statistics and correlation analysis. We calculated bivariate relations among sense of security, negative attention bias, relatedness needs satisfaction, and PMPU. Then, Hayes' (2013) PROCESS macro (Model 4) was used to examine the mediation effect of negative attention bias. Finally, we further explored whether the latter half of the indirect path was moderated by relatedness needs satisfaction using Hayes' (2013) PROCESS macro (Model 14). And in present study, we generated 95% bias-corrected accelerated confidence intervals (CI) based on

Table 2 Descriptive statistics and correlations for all variables

	M	*SD*	1	2	3	4
1. Gender	_	_	_			
2. Sense of security	53.60	12.01	−0.06	_		
3. Negative attention bias	45.73	6.85	−0.02	−0.51***	_	
4. Relatedness needs satisfaction	20.84	5.86	−0.04	0.04	0.01	_
5. PMPU	48.67	11.19	0.08	−0.37***	0.29***	0.03

*$p < .05$, **$p < .01$, ***$p < .001$; the same below

Table 3 Regression analysis

Dependent variable	Independent variable	*R*	R^2	*F*	*SE*	*β*	*t*
PMPU	Sense of security	0.37	0.14	37.18***	0.04	−0.37	-8.43***
	Gender				0.10	0.12	1.28
Negative attention bias	Sense of security	0.51	0.26	79.48***	0.04	−0.48	-12.59***
	Gender				0.08	−0.11	-1.36
PMPU	Sense of security	0.40	0.16	28.21***	0.05	−0.30	-5.80***
	Negative attention bias				0.05	0.16	2.99**
	Gender				0.10	0.14	1.48

5,000 bootstrap samples to calculate the indirect effect, and the 95% CI without zero indicates statistical significance. To obtain the standardized regression coefficient, we transformed all the raw scores to z-scores before testing the mediated moderation effect. In all analyses, we controlled for gender by entering it into the models as covariate. According to Aiken et al. (1991) in simple slop test, the function was graphed for two levels of independent variable and moderator: 1 SD above the mean and 1 SD below the mean.

Results

Common method bias

Common method bias refers to the systematic error caused by the survey data coming from the same group of subjects and being tested in the same environment, as well as some other interfering factors. In this study, all participants were given the same instructions in an anonymous way. In addition, harman's single-factor test was used to address the issue of common method variance (Podsakoff et al., 2003). Following principal component analysis, the results showed that 13 factors had eigenvalues > 1, and only 18.26% of the variance could be explained by the first factor, which is less than the critical standard of 40%. Consequently, common method biases were negligible in present study.

Descriptive analyses

In Table 2 the descriptive statistics and correlation matrix of variables were presented. Specifically, sense of security was negatively associated with PMPU ($r = -.37$, $p < .001$) and sense of security was negatively associated with negative attention bias ($r = -.51$, $p < .001$). Additionally, negative attention bias was positively associated with PMPU ($r = .29$, $p < .001$) However, relatedness needs satisfaction was not correlated with other variables ($ps > 0.05$).

Table 4 Mediation analysis

	Effect	*SE*	LLCI	ULCI	Mediation effect
Direct effect	−0.29	0.05	−0.40	−0.20	78.38%
Indirect effect	−0.08	0.03	−0.13	−0.02	21.62%
Total effect	−0.37	0.04	−0.46	−0.29	—

Testing for mediation

Mediation was tested using the PROCESS macro (model 4) in SPSS (Hayes, 2013). As shown in Tables 3 and 4, after controlling gender, sense of security was negatively associated with PMPU ($\beta = -0.37$, t = -8.43, $p < .001$). In addition, there was a significant indirect effect of sense of security on PMPU via negative attention bias (indirect effect = −0.08, $SE = 0.03$, 95% CI = [-0.13, −0.02]). Sense of security was negatively associated with negative attention bias ($\beta = -0.48$, t = -12.59, $p < .001$), which, in turn, negative attention bias was positively associated with PMPU ($\beta = 0.16$, $t = 3.00$, $p < .01$). At the same time, the residual direct relationship between sense of security and PMPU in freshmen was significant ($\beta = -0.30$, t = -5.80, $p < .001$). The mediation effect accounted for 21.62% of the total effect. Thus, hypothesis 1 and hypothesis 2 were supported.

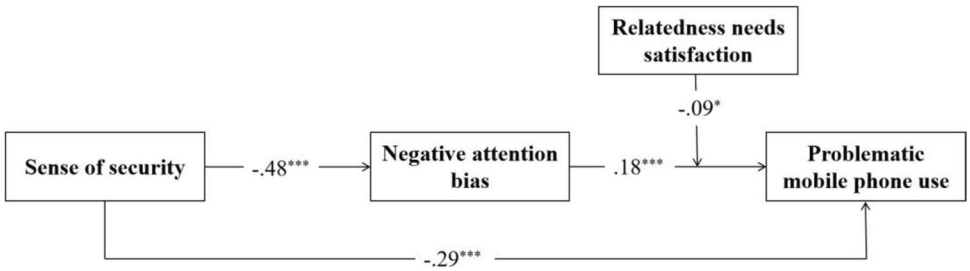

Fig. 2 Relatedness needs satisfaction moderated the mediation of negative attention bias

Table 5 Multiple regression analyses

Dependent variable	Equation 1 Negative attention bias			Equation 2 PMPU		
	SE	*β*	*t*	*SE*	*β*	*t*
Gender	0.08	−0.11	-1.36	0.09	0.15	1.54
Sense of security	0.04	−0.48***	-12.59	0.05	−0.29***	-5.69
Relatedness needs satisfaction				0.04	0.03	0.63
Negative attention bias				0.05	0.18***	3.34
Negative attention bias × Relatedness needs satisfaction				0.04	−0.09*	-2.11
R^2	0.26			0.17		
F	79.48***			18.13***		

Testing for moderated mediation

We next tested for the moderating role of relatedness needs satisfaction between negative attention bias and PMPU. Model 14 in PROCESS (Hayes, 2013) was used to test moderate mediation effect. Gender was also controlled in this analysis. Overall testing models are presented in Fig. 2, and the specific indirect effects are presented in Table 5. Results showed that sense of security was negatively associated with negative attention bias ($\beta = -0.29$, t = -5.69, $p < .001$). Negative attention bias was positively correlated with PMPU ($\beta = 0.18$, $t = 3.34$, $p < .001$). The interaction between negative attention bias and relatedness needs satisfaction on PMPU was also significant ($\beta = -0.09$, t = -2.11, $p < .05$). This suggested that the path between negative attention bias and PMPU was significantly moderated by relatedness needs satisfaction. Thus, hypothesis 3 was supported.

Then, simple slop test (Aiken et al., 1991) showed that the relation between negative attention bias and PMPU weakens as the level of relatedness needs satisfaction increases. As demonstrated in Fig. 3, for freshman with low relatedness needs satisfaction, negative attention bias was positively associated with PMPU ($\beta = 0.27$, $t = 3.59$, $p < .001$). However, this was not the case for freshman with high relatedness needs satisfaction ($\beta = 0.09$, $t = 1.46$, $p > .05$). Therefore, the positive relationship between negative attention bias and PMPU was much weaker for freshmen with high levels of relatedness needs satisfaction.

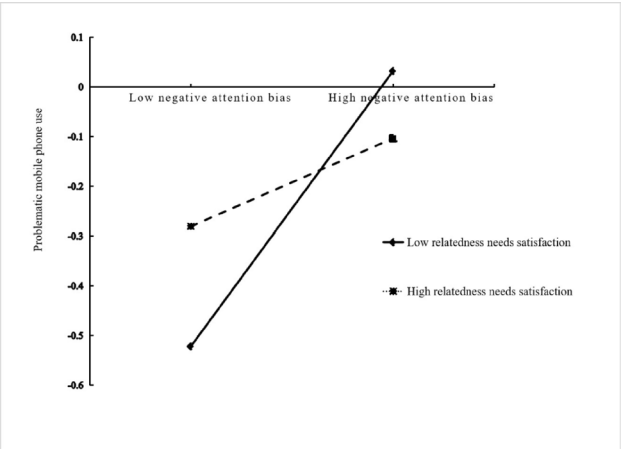

Fig. 3 The interaction between negative attention bias and relatedness needs satisfaction

Table 6 The mediating effect of negative attention bias in different levels of relatedness needs satisfaction

Mediation variable	Relatedness needs satisfaction	Effect	*SE*	LLCI	ULCI
Negative attention bias	Low (M-1SD)	−0.13	0.04	−0.22	−0.06
	Medium (M)	−0.09	0.03	−0.15	−0.03
	High (M + 1SD)	−0.04	0.04	−0.12	0.02

In addition, according to Edwards and Lambert's (2007) recommendation, The effect size of mediation should be further examined under different levels of the moderator.

The results in Table 6 showed that the conditional indirect effect was stronger for Chinese freshmen with low relatedness needs satisfaction (Effect = −0.13, *SE* = 0.04, 95% CI [-0.22, −0.06]) than those with high relatedness needs satisfaction (Effect = −0.04, *SE* = 0.04, 95% CI [−0.12, 0.02]) (see Table 6). It can be seen that high levels of relatedness needs satisfaction could weaken the effect of low sense of security on problematic mobile phone use through negative attention bias. In other words, the mediation effect was moderated by the relatedness needs satisfaction. Thus, hypothesis 3 was supported.

Discussion

Despite some empirical research has shown that the positive impact of sense of security on PMPU (Jia et al., 2018; Young et al., 2011), the mediating and moderating mechanisms underling the association remained obscure. To address these gaps, the current study tested a complex theoretical model that explored both mediating (i.e., negative attention bias) and moderating (i.e., relatedness needs satisfaction) mechanisms in the association between sense of security and PMPU among freshmen. On the one hand, the present study expanded upon prior evidence by identifying the mediating role of negative attention bias between sense of security and PMPU, supporting hypotheses 2. That is, sense of security affects PMPU through the mediating effect of negative attention bias, suggesting that negative attention bias may help explain why freshmen with low sense of security subsequently experience more PMPU. On the other hand, one salient highlight of the current study examined the moderating role of relatedness needs satisfaction between sense of security and PMPU, supporting hypotheses 3. These findings demonstrate how relatedness needs satisfaction acts as a buffer against PMPU associated with negative attention bias. The key contribution of this study is to advance our understanding of how and when sense of security is associated with PMPU. On the whole, in some way this study can help people understand the relationship between sense of security and PMPU. Consequently, current research has theoretical value for deepening the understanding of PMPU and enriching the researches of PMPU. Meanwhile, this work also provides a broad perspective toward the prevention and intervention of PMPU.

Sense of security and PMPU

As hypothesized 1, this study found that sense of security was significantly negatively associated with PMPU among freshmen, in line with previous findings (Wu et al., 2019; Zhang et al., 2022; Jia et al., 2018). The results supported the claim that with regard to an individual's psychological feelings concerning the level of danger and risk posed by their surroundings, low sense of security is a salient risk factor for social adaptation among freshmen (Cao, 2022; Jia et al., 2018). This finding verified self-determination theory (Deci & Ryan, 2000), that is the claim that the satisfaction of security needs is a basic requirement for a person's healthy growth and development (Maslow et al., 1945). If individual's sense of security is threatened, this situation can result in negative relational self-system beliefs such as negative perceptions of interpersonal relationships and low control over that individual's life, which in turn increase subsequent maladjustment.

Two possible explanations can account for this finding. First, freshmen with lower levels of sense of security often perceive their interpersonal relationship to be poor and are not capable of handling problems in life. In order to make up for their unfulfilled psychological needs, they tend to seek satisfaction through virtual networks, which further strengthens their dependence on their mobile phones, ultimately leading to mobile phone addiction (Nikdel & Nasab, 2022; Shapira et al., 2000). Secondly, individuals with a low sense of security tend to remain alert, feel isolated, and often experience tension (Maslow et al., 1945). Prolonged security vigilance depletes the psychological resources of freshmen and decreases their self-control for freshmen (Davies et al., 2013). Freshmen with lower self-control are at higher risk of PMPU due to their hope of escaping from reality (Halfmann, 2021; Tangney et al., 2004). Hence, it is difficult for such freshmen to resist the various temptations posed by the internet, and their risk of PMPU increases accordingly. This result corroborates the claim that, In summary, sense of security may offer an explanation of PMPU among college students. To sum up, the current findings provide a powerful point of departure for investigations of how to prevent and mitigate PMPU, and they thus have practical significance for attempts to promote social adaptation among freshmen.

The mediating role of negative attention bias

As hypothesized 2, this study found that sense of security was negatively associated with negative attention bias, which in turn triggered PMPU. Therefore, negative attention bias is an important mechanism underlying the relationship between sense of security and PMPU. This finding further supports the cognitive-behavioral model of pathological internet addiction, which posits that remote factors (i.e., sense of security) play a role in internet addiction through proximal factors (maladaptive factors, i.e., negative attention bias). Negative attention bias is a predictor of PMPU, and its mediating effect confirmed that it represents an important risk factor for individuals' PMPU, a result which is in line with the findings of previous studies on Chinese college students (Tian et al., 2023; Chen et al., 2022).

Specifically, freshmen are a special population undergoing a transition from high school to university, who thus face a critical period that involves exploration of campus and socialization with peers. This transformation of their identity puts pressure on them and thus represents a challenge (Praharso et al., 2017). When college freshmen transition from a familiar environment to a new environment, this shift forces them to face the pressure of readjusting to their new environment and rebuilding interpersonal relationships, and they are thus vulnerable to problems with psychological security (Hiester et al., 2009; Li et al., 2021). Hence, on the one hand, freshmen with low sense of security are likely to feel anxious (Babicki et al., 2021; Pan et al., 2018; Cummings et al., 2012), and tend to experience more negative emotions, which are continuously strengthened through the process of receiving negative feedback in response to negative events (Henricks et al., 2022). The theory of the emotional consistency effect posits that when individuals experience negative emotions, they tend to prioritize negative information (Villalobos et al., 2021), which in turn aggravates the negative emotions in question, and causes individuals with low sense of security to feel constantly threatened state. On the other hand, previous studies have indicated that maintaining and preserving a sense of security is the most basic task of an individual (Davies et al., 2016). In particular, freshmen usually face interpersonal stress and academic adjustments, which could have led to security crises in the form of interpersonal insecurity and uncertainty in control. As a result, freshmen in this context may also have exhibited attention bias toward threatening information with the goal of avoiding psychological harm (Sharma, 2014). When such freshmen perceive that they are in a negative and threatening environment, they may use the internet, which provides them with a nonthreatening virtual space (Young et al., 2011) that can compensate for their decreased psychological security or mitigate their sense of insecurity (Kardefelt-Winther, 2014). The anonymous virtual environment provided by the internet can be used as a security base, that enables such freshmen to avoid trouble in real life temporarily and alleviate their negative emotions or mitigate their sense of insecurity (Jia et al., 2017; Wang et al., 2022).

Unfortunately, temporary escape from the real world and seeking support from the virtual environment not only fail to solve the problem, but also lead freshmen to experience a false sense of security (Jia et al., 2018; Young et al., 2011). That is, although mobile phone addicts seek support in the virtual online world, they fail to obtain more social support and happiness through the social interactions in which they engage on the mobile internet (Wu et al., 2019; Fu et al., 2020), ultimately leading to PMPU. Thus, it is more important for college freshmen to face problems in their lives actively and to seek real support to enable them to adjust well to the situations they face. The mediating effect of negative attention bias enlightens us that negative attention bias may be an individual risk factor leading for PMPU among freshmen. Therefore, identifying and paying attention to individuals with negative attention bias may represent a key step in the prevention of PMPU among freshmen and the development of relevant interventions.

The moderating role of relatedness needs satisfaction on the mediating effect of negative attention bias

Consistent with hypothesized 3, the moderated mediation analysis indicated that the indirect association between sense of security and PMPU through negative attention bias was moderated by relatedness needs satisfaction. In particular, the moderating role of relatedness needs satisfaction on the relationship between negative attention bias and mobile phone addiction was significant. Negative attention bias predicts PMPU more effectively in freshmen with lower relatedness needs satisfaction than in freshmen with high relatedness needs satisfaction, thus indicating that negative attention bias may have an increased influence on the behavior of freshmen with lower relatedness needs satisfaction. In other words, relatedness needs satisfaction mitigated the adverse impact of negative attention bias on PMPU. This finding supports the risk buffering theory (Fergus & Zimmerman, 2005), which postulates that relatedness needs satisfaction is a protective factor, that can mitigate the negative impacts of risk factors.

A possible explanation for this finding is that such a sense of belonging in interpersonal relationships is very important for Chinese people, who are oriented toward collectivist values (Datu et al., 2018). A good interpersonal relationship is also one of the most prominent needs exhibited by freshmen (Li et al., 2021; Orben et al., 2020). It is particularly important for freshmen to integrate into their new lives and establish new interpersonal relationships. During this period, college freshmen begin to define themselves in terms of their social relations and become more concerned about their social value and acceptance by others (Tian et al., 2019). Therefore, during this period, college freshmen pay a great deal of attention to their new classmates and friends and invest high levels of time and energy in such relationships (Arnett, 2014). Nevertheless, some freshmen with negative attention bias often prioritize negative information and thus experience more negative emotions as a result of their lack of a sense security; they also usually face interpersonal pressures and threats, thus making it difficult for them to develop positive and lasting social connections and thereby failing to meet their relatedness needs in real life. This process motivates such freshmen to use the internet, particularly social networking sites accessed on their mobile phones, to slow down negative emotions and compensate for their unmet

relatedness needs in the real world (Reissmann et al., 2018; Sheldon et al., 2011), further increasing the potential risk of problematic use (Liu et al., 2016). In other words, lower levels of perceived relatedness needs satisfaction represent a strong risk factor for the potential negative effects of vulnerability on PMPU.

Conversely, as the degree to which relatedness needs are satisfied increases, the negative effect of negative attention bias on PMPU among freshmen ceases to be significant, thus indicating that relatedness needs satisfaction may be a protective factor that can reduce the negative effect of negative attention bias resulting from a weak sense of security on PMPU. Interpersonal theory and the belongingness hypothesis propose that people living in the world exhibit a need to belong and a tendency to form and maintain social and emotional connections (Baumeister & Leary, 1995). When the relatedness needs of freshmen are met, they may experience fewer negative emotions and exhibit better interpersonal relationships. Correspondingly, the satisfaction of such needs reduces the frequency and intensity of their use of this specific service. In summary, if freshmen with negative attention bias resulting from a weak sense of security can succeed in satisfying their relatedness needs, they are unlikely to invest excessive time and energy in the internet, thereby decreasing the risk of problematic use. Therefore, first, we should pay attention and identify individual risk factors in this context (low sense of security, negative attention bias). Second, we should exert our best efforts to establish a good atmosphere that is conducive to teacher-student and student−student relationships, with the goal of ensuring that the relatedness needs of college students can be met and PMPU can be reduced.

Limitation and future direction

This study faces certain limitations, and directions for future research should be clarified. First, although the present study used a cross-sectional design based on previous theoretical and empirical research, causal inferences regarding the relationships among variables and the corresponding mediating effects cannot be drawn. Future research should conduct longitudinal and experimental studies to better validate the paths found in the current study more effectively. Second, this study relied primarily on freshmen self-report measures to collect data. The results of Harman's one-factor test (the first factor explained only 18% of the variance) and the significant moderation effect (common-method bias has been shown to decrease the sensitivity of moderation analysis; Siemsen et al., 2010) suggested that common method bias might not be a serious threat in the present study. Nevertheless, future studies would benefit from employing multimethod and multi-informant methods to collect more comprehensive information and to better address shared-reporter variance more effectively. Third, this study focused only on the cognitive factors associated with individual negative attention bias in terms of the mediating mechanism, and given that negative attention bias only partially mediated the relation between sense of security and PMPU, the potential mediating role of other cognitive factors (self-focus, rumination, etc.) need to be confirmed in future research. Finally, only Chinese students were included in this study, and the current findings are limited to freshmen from Henan, China. Consequently, caution is needed when generalizing these results to other cultures or age groups. Future studies should examine whether our findings can be generalized to students in other grades, other stages of development, other regions, and other cultures.

Practical implications

Despite these limitations, the study has research value and significance. Meanwhile, our findings have important implications for the prevention of PMPU among freshmen and the development of relevant interventions. First, the present study investigated the effect of sense of security on PMPU from the perspective of basic psychological needs, thereby providing empirical support for the self-determination theory (Deci & Ryan, 2000) and the psychological decompensation hypothesis of internet addiction (Gao & Chen, 2006). In light of the significant impact of sense of security on PMPU among freshmen, enhancing their sense of security may be an effective way to reduce PMPU. Previous studies have demonstrated that teaching parents, teachers, and administrators to identify individuals with low sense of security, training people to recognize the significance of sense of security, and implementing group counseling to foster on social support, peer relations, and social recognition can help to promote sense of security (Heather, 2012). Moreover, given the pervasiveness of the internet, it is especially important to teach students new media literacy and digital citizenship skills that can enhance their critical thinking about the content they upload and download as they navigate digital media (Collier, 2012). Second, this study is also the first to identify the mediating role of negative attention bias and the moderating role of relatedness needs satisfaction in the association between sense of security and PMPU. Moderated mediation pathways were examined in the present study, which facilitates the process of comparison and choosing a more effective pathway for the prevention of PMPU and the development of relevant interventions in the future. Specifically, this study found that sense of security was negatively associated with negative attention bias, which in turn triggered PMPU. Given that negative attention bias is an important mechanism linking sense of security with PMPU, identifying and focusing on freshmen with negative attention bias may help practitioners

improve the efficiency of PMPU interventions. Furthermore, one salient highlight of our study was that the mediation of negative attention bias was moderated by the degree of relatedness needs satisfaction. That is, with an increase in relatedness needs satisfaction, the path leading from sense of security to PMPU through negative attention bias became much weaker. Our study thus indicates that relatedness needs satisfaction may help protect freshmen against the PMPU associated with negative attention bias resulting from low sense of security. Given the protective role of relatedness needs satisfaction in this context, one crucial component of intervention programs aimed at mitigating PMPU among freshmen is the establishment of an atmosphere, that can meet their relatedness needs. It is important to note, however, that the protective role of relatedness needs satisfaction should not be overstated as this protective capacity may be overwhelmed in response to increased levels of negative attention bias. Finally, this study proposes that interventions shaped around sense of security, negative attention bias and relatedness needs satisfaction may be useful with regard to decreasing PMPU. Nevertheless, our moderated mediation model suggests that there is the existence of complex interactions among individual and environmental factors. Hence, simply focusing on one aspect of factors may be insufficient to achieve the optimal effect. Instead, our findings highlight the importance of systematic and comprehensive intervention programs that target multiple factors associated with PMPU among freshmen.

Conclusion

In sum, this study contributes to the literature by examining a moderated mediation model, which provides a unique perspective to understanding how and when sense of security relates to freshmen PMPU. It provides evidence that the link between sense of security and freshmen PMPU was mediated by negative attention bias. In addition, the findings revealed that high relatedness needs satisfaction mitigated the adverse impact of negative attention bias on PMPU. These findings advance the current understanding of the mechanisms linking sense of security and freshmen PMPU. In addition, it holds great implications for the prevention and treatment of Internet addiction for college. It is important for education agencies and families to reinforce colleges' sense of security, relatedness needs satisfaction and decrease negative attention bias in various ways.

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Data availability The data that has been used is confidential.

Declarations

Ethical approval All subjects and their legal guardians provided appropriate informed assent and consent for this study. The study protocol was approved by the Institutional Review Boards at University of Henan University in China (IRB 20210902001). All methods were performed in accordance with the relevant guidelines and regulations.

Competing interest The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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