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Research paper

Mobile phone addiction and psychological distress among Chinese adolescents: The mediating role of rumination and moderating role of the capacity to be alone

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ARTICLE INFO

Keywords:

mobile phone addiction
rumination
the capacity to be alone
psychological distress
moderated mediation model

ABSTRACT

Background: With the increasing incidence of mobile phone addiction, mobile phone addiction has been considered to be related to adolescents' psychological distress. However, the underlying mechanisms of this relation were still unclear. The present study tested the mediating role of rumination and the moderating role of the capacity to be alone in the relation between mobile phone addiction and psychological distress.

Methods: 754 middle school students were recruited to complete measures of mobile phone addiction, rumination, the capacity to be alone, psychological distress and demographic variables.

Results: Mobile phone addiction was significantly and positively associated with psychological distress, and this link could be mediated by rumination. Moreover, the direct effect of mobile phone addiction on psychological distress and the indirect effect of rumination in this link were moderated by the capacity to be alone. Both these two effects were stronger for adolescents with lower capacity to be alone.

Limitations: The present study is limited in terms of its sample selection, cross-sectional design, and self-reported instruments.

Conclusions: The present study advances our understanding of how and when or for whom mobile phone addiction is related to serious psychological distress. Education professionals and parents should pay special attention to the psychological distress of adolescents suffering from mobile phone addiction, particularly for those with lower capacity to be alone.

Introduction

With the popularity of mobile Internet devices, mobile Internet has profoundly changed human thinking habits, and also influenced individuals' behavioral and psychosocial adaptation (Barr, Pennycook, Stolz, & Fugelsang, 2015; Yang, Zhou, Liu, & Fan, 2019). As the most popular mobile Internet terminal, mobile phone has become an essential medium to reshape the way of human existence and live. Globally, 90% of people own mobile phones, of which 59% are smartphones (Pew Research Center, 2018). In China, the number of mobile phone users has reached 847 million, and the population of mobile phone users is still

increasing (CNNIC, 2019). Mobile phones not only change the ways of social interaction, leisure and entertainment, and information acquisition for adolescents, but also shape their behavioral modes, such as mobile payment, online finance, and online shopping. The multiple functions of mobile phones bring various conveniences and benefits to adolescents' everyday life.

Under this background, more and more individuals spend most of their spare time on mobile phones to satisfy their multiple needs (Han, Kim, & Kim, 2017; Weller, Shackelford, Dieckmann, & Slovic, 2013), which greatly enhances the user stickiness of mobile phones. Namely, people form a habit of carrying or using mobile phones anytime and

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<https://doi.org/10.1016/j.jad.2020.10.005>

Received 28 March 2020; Received in revised form 5 September 2020; Accepted 4 October 2020

Available online 7 October 2020

0165-0327/© 2020 Published by Elsevier B.V.

anywhere (Kwon et al., 2013), which further increases the risk for mobile phone addiction. Recent research also revealed that more and more adolescents cannot live without mobile phones (Han, Kim, & Kim, 2017; Volkmer & Lerner, 2019), and even become addicted to mobile phones (Chen et al., 2016). These adolescents showed the similar symptoms of non-material addiction in their use of mobile phones (Al-Barashdi & Jabur, 2015; Kwon et al., 2013; Min, Dai-Jin, Hyun, Soo, & Doo-Sup, 2013; Leung, 2008). Data from multiple countries also showed that the incidence of mobile phone addiction among adolescents was 30% (He et al., 2012). Therefore, mobile phone addiction, as a significant risk factor of adolescents' mental health, has aroused the common concern of researchers and the public (Lian, Liu, Sun, & Zhou, 2018; Liu et al., 2017).

Mobile phone addiction has been considered as an important inducement for a variety of psychological and behavioral adaptation problems (Lee et al., 2016; Seo et al., 2016; Soni et al., 2017; Yang, Zhou, Liu, & Fan, 2019). For instance, Lepp et al. (2014) showed that mobile phone users may experience great anxiety and poor academic performance. Soni et al. (2017) demonstrated that adolescents were not only addicted to smartphone usage but were also developing significant sleep and behavior problems owing to excessive smartphone usage. Among these unfavorable outcomes, psychological distress, as the most direct psychological problem induced by excessive or uncontrolled use of mobile phones, has attracted more and more researchers' attention (Chen et al., 2016; Yang, Zhou, Liu, & Fan, 2019). Prior studies have shown that mobile phone addicts not only experience more sleep disorders, but also have more procrastination (Lian, Liu, Sun, & Zhou, 2018; Liu et al., 2017). Poor sleep quality and procrastination have been proved to be associated with depression, anxiety and stress (Steel, 2007; Woods & Scott, 2016). Therefore, adolescents addicted to mobile phones may have more psychological distress owing to their poor sleep quality and high levels of procrastination induced by excessive or uncontrolled use of mobile phones. Besides, addictive mobile phone users may have more interpersonal problems, which are associated with psychological distress (Chen et al., 2016). In addition, Bandura's concept of reciprocal determinism in social cognitive theory (Bandura, 1986) demonstrated that individual' behavioral problems can affect their emotions. The cognitive-behavioral model (Davis, 2001) also pointed that individuals' cognitions and emotions could be affected by their behavioral problems. Empirical studies also showed that adolescents suffering from mobile phone addiction have more psychological distress, especially depressive symptoms and anxiety symptoms (Yang, Zhou, Liu, & Fan, 2019). Therefore, mobile phone addiction may be positively associated with psychological distress.

Although the positive association between mobile phone addiction and psychological distress has been proved, few studies have focused on the underlying mediating and moderating mechanisms in this relation. In other words, the questions about *how* (or *why*), and *when* (i.e., under what conditions) mobile phone addiction is related to psychological distress remain unclear. Addressing these questions can provide efficient practical guidance for adolescents as well as for educators to develop intervention strategies. Therefore, the present study begins to open the black boxes of how (or why) and when mobile phone addiction can be related to psychological distress. Specifically, this study proposed a moderated mediation model to reveal the underlying mechanisms between mobile phone addiction and psychological distress. Given that rumination has been considered as an effective role linking risk factors to individuals' psychological problems (Feinstein, Bhatia, & Davila, 2014; Liu et al., 2017; Michl, McLaughlin, Shepherd, & Nolen-Hoeksema, 2013), this study will analyze rumination as a mediator to clarify the mechanisms of mobile phone addiction resulting in psychological distress. Moreover, the capacity to be alone has been proved to be a powerful buffer, which could mitigate the adverse effects of risk factors on individuals' psychological adaptation (Larson & Lee, 1996; Wu & Chen, 2006). This study will shed light on the moderating role of the capacity to be alone to reveal the conditional direct and

indirect effect of mobile phone addiction on psychological distress. In summary, this study could improve our understanding of how mobile phone addiction causes psychological distress, and under what condition or for whom the direct and indirect effects would be more significant.

Rumination as a mediator

As a style of coping with negative mood and other negative life events, rumination is characterized by repetitive and passive focus on the causes and consequences of one's symptoms of distress without engagement in active coping or problem solving to alleviate dysphoric mood (Nolen-Hoeksema, 1987; Treynor, Gonzalez, & Nolen-Hoeksema, 2003). According to the response style theory, rumination may prolong and exacerbate the negative effects of negative mood and other negative experiences by increasing negative thinking, deteriorating coping behaviors, and interacting with pessimistic cognitive process (Nolen-Hoeksema, 1991). Numerous studies suggest that rumination is prospectively associated with depressive symptoms, anxiety, perceived stress, and suicidal ideation (Feinstein, Bhatia, & Davila, 2014; Michl, McLaughlin, Shepherd, & Nolen-Hoeksema, 2013; Tucker et al., 2013). Given that depression, anxiety and stress are significant indicators of psychological distress (Alfonsson, Wallin, & Maathz, 2017), rumination may induce and exacerbate psychological distress. Studies on the direct link between rumination and psychological distress also verified that rumination was an important predictor of psychological distress (Geiger & Kwon, 2010; Morrison & Rory, 2005). For instance, a longitudinal study conducted by Morrison and Rory (2005) showed that rumination could positively predict psychological distress over time.

Given that rumination is among the most robust risk factors for psychological distress (O'Connor, O'Connor, & Marshall, 2007), various factors that may predict rumination have been concerned about. A large number of studies have revealed the predictive effects of stressful life events (Michl, McLaughlin, Shepherd, & Nolen-Hoeksema, 2013), low self-esteem (Kuster, Orth, & Meier, 2012), cyber-victimization (Feinstein, Bhatia, & Davila, 2014), and negative social comparison on Facebook (Feinstein et al., 2013) on rumination. Although few studies pay attention to the direct relationship between mobile phone addiction and rumination, it is reasonable to demonstrate the influence of mobile phone addiction on rumination.

First, adolescents suffering from mobile phone addiction are more likely to be engaged into academic and interpersonal problems, which in turn causes rumination. Previous studies showed that mobile phone addicts may experience more stressful life events, such as high levels of academic procrastination (Jung & Han, 2014), poor interpersonal competence (Kwon & Paek, 2016), and more interpersonal problems (Chen et al., 2016). These stressful life events were associated with lower self-esteem (Samaha & Hawi, 2016; Sirois, 2013). According to stress reactive model and related empirical research, rumination could be induced by low self-esteem and stressful life events (Kuster, Orth, & Meier, 2012; Michl, McLaughlin, Shepherd, & Nolen-Hoeksema, 2013; Robinson & Alloy, 2003). Thus, rumination may be induced by negative events or experience resulting from mobile phone addiction. Second, adolescents suffering from mobile phone addiction usually spend lots of time on social networking sites (Cha & Seo, 2018; Salehan & Negahban, 2013). Excessive engagement in social networking sites may lead to rumination. For instance, social networking sites use has been proved to trigger rumination (Feinstein et al., 2013; Shaw, Timpano, Tran, & Joormann, 2015). Therefore, mobile phone addicts may experience more rumination owing to the negative social comparison on Facebook they are involved in. Besides, the stress reactive model of rumination also illustrated that negative life event was an important inducing factor of rumination (Robinson & Alloy, 2003). Therefore, mobile phone addicts experiencing more negative life events may ruminate more about their unsatisfactory state of life. In addition, a recent study further explored the direct relation between mobile phone addiction and

rumination, and confirmed that adolescents suffering from mobile phone addiction may have more rumination after using cell phones over time (Liu et al., 2017).

Besides, previous studies also found that rumination could mediate both the relation between perfectionism cognitions and psychological distress (Flett, Madorsky, Hewitt, & Heisel, 2002) and the relation between negative social comparison on social networking sites and depression (Feinstein et al., 2013). A prior study also demonstrated that rumination could play a mediating role in the link between mobile phone addiction and sleep quality (Liu et al., 2017). As far as this study is concerned, mobile phone addicts may ruminate more about their negative mobile phone experience, which, in turn, makes them have more psychological distress. Therefore, the present study hypothesized that rumination may act as a mediator in linking mobile phone addiction to psychological distress (Hypothesis 1).

The capacity to be alone as a moderator

The capacity to be alone is not only one of the most important indicators of emotional maturity, but also nearly synonymous with emotional maturity (Winnicott, 1958). It was characterized by freedom from distraction and the possibility of focused attention, which may provide a unique opportunity to examine and clarify one's current stress and life situation (Fiske, 1980). The concept of the capacity to be alone was put forward by Larson and Lee (1996) based on deliberately structured solitude. Larson and colleagues argued that solitude refers to the absence of all of aspects of being with others, and divided solitude into involuntary solitude and constructive solitude (Larson & Lee, 1996). Involuntary solitude refers to the situation in which individuals yearned for company were forced to be alone; whereas constructive solitude refers to the state of solitude with high autonomy accompanied by more positive experience. They also considered that structured solitude, as the core connotation of the capacity to be alone, consists of two parts: solitary comfort (the degree to which an individual feels comfortable when he or she is alone) and solitary coping (the ability to cope with stress by using one's time being alone). The latest research suggested that solitude and alone were two different states (Nguyen, Weinstein, Ryan, & Deci, *in press*). Alone refers to the state of a person without any other person around physically. Whereas solitude is a specific type of alone, one having the features of being both physically alone and free of specific activities. In other words, solitude means the absence of immediate social demands, constraints, and scrutiny, as well as the absence of the opportunity for relating, social engagement, and mutual enjoyment. According these views, Larson and colleagues seemed to have ignored the connotation difference of alone and solitude, when they used the phrase "the capacity to be alone" to describe the two states of solitude coping and solitude. But this does not affect our understanding of the meaning of the capacity to be alone. It refers to the capacity of individuals handling stress and feeling emotional comfort using the time being alone in daily life (Larson & Lee, 1996). Individuals with high capacity to be alone may benefit more from their time being alone and have good psychological adaptation (Detrixhe, 2011). Numerous studies have demonstrated that time being alone may serve as both cognitive function and emotional function, providing an opportunity for individuals to evaluate the adverse situation they faced and reestablish emotional homeostasis (Cohen & Hoberman, 1983; Winnicott, 1958). Considering that high capacity to be alone means more time being alone, it is reasonable for us to infer that the capacity to be alone can have a positive effect on individual's psychological adaptation through both the cognitive and emotional processes. Empirical research has also proved that the capacity to be alone was positively associated with adolescents' mental health (Larson & Lee, 1996; Wu & Chen, 2006). Besides, a study conducted by Wu and Chen (2006) also showed that the capacity to be alone could moderate the adverse effect of subjective life pressure on mental health, with this effect being stronger for individuals with low capacity to be alone. Therefore, the capacity to be

alone may also exert a moderating effect on both the link between mobile phone addiction and psychological distress and the link between mobile phone addiction and rumination.

First, the capacity to be alone may buffer the adverse effect of mobile phone addiction on psychological distress. Individuals with a high level of capacity to be alone may feel a higher sense of control, happiness, relaxation, freedom, and optimism. Also, they use their time to cope with stress more effectively when they are alone (Larson & Lee, 1996). Instead, individuals with a low level of capacity to be alone may involve in other activities to distract their attention when being alone, and fail in releasing their negative emotions and deal with the problems they faced (Larson & Lee, 1996). Thus, when suffering from mobile phone addiction, individuals with a high level of capacity to be alone could benefit more from being alone. They are good at using the time being alone to renew their emotion in a short time and take measures to cope with the adverse consequences of mobile phone addiction quickly. Whereas, individuals with low capacity to be alone may be trapped in the adverse consequences of mobile phone addiction and experience more depression, anxiety, and stress since they could not use the time being alone to adjust their negative emotional state. Besides, according to displacement theory (Kraut et al., 1998), adolescents with a compulsive need to use mobile phones may experience more social isolation and social exclusion owing to the decline of both their face-to-face social communication and their social circle size. Chen et al. (2016) also showed that interpersonal problems (such as social isolation) could be a psychological mechanism underlying the strong link between mobile phone addiction and negative emotions, such as depression and social anxiety. Suffering from the social isolation and other interpersonal problems resulting from excessive or uncontrolled use of mobile phones, individuals with a high level of capacity to be alone will be more able to accept the state of social isolation and enjoy their time to be alone, resulting in less psychological distress than those with a low level of capacity to be alone. In addition, Larson and Lee (1996) also considered that the capacity to be alone may play as a buffer, alleviating the adverse effect of stress on individuals' mental health. Therefore, the capacity to be alone may serve as a buffer in the relation between mobile phone addiction and psychological distress.

Second, the capacity to be alone may also alleviate the influence of mobile phone addiction on rumination. Larson and Lee (1996) considered that some people prefer to spend their time alone in a more constructive and autonomous way, and thus have more positive experiences. Whereas, when the other people yearned for company are forced to be alone, they tend to have more negative experiences. Individuals with a low level of the capacity to be alone may involve in more experience of being forced to be alone and have more negative emotions. By contrast, individuals with a high level of the capacity to be alone may spend their time alone more constructively and autonomously and have more positive experiences (e.g., deepening self-knowledge and improving self-recovery). Given that negative experience is an effective booster for rumination (Michl, McLaughlin, Shepherd, & Nolen-Hoeksema, 2013), individuals with a low level of capacity to be alone may ruminate more after perceiving adverse consequences of mobile phone addiction. Besides, according to stress reactive model of rumination, individuals suffering more negative experience may ruminate more about their life status and emotional states (Robinson & Alloy, 2003). Therefore, the capacity to be alone may act as an alleviator in the link between mobile phone addiction and rumination.

Above all, the present study supposed that the capacity to be alone may play a moderating role in the mediation model of mobile phone addiction, rumination and psychological distress (Hypothesis 2).

The present study

Considering the prevalence of mobile phone addiction and the severe consequences of psychological distress, it is imperative to examine the

mechanisms underlying the link between mobile phone addiction and psychological distress. Previous studies mainly focused on the effects of mobile phone addiction on adolescents' negative emotions and sleep quality (Chen et al., 2016; Liu et al., 2017; Yang, Zhou, Liu, & Fan, 2019), however, limited attempts have been paid to how and when mobile phone addiction can affect adolescents' psychological distress. Given that rumination plays a bridge role in the relation between problematic mobile devices use and individuals' psychological adaptation (Feinstein et al., 2013; Liu et al., 2017), the current study would attempt to examine the mediating effect of rumination on the association between mobile phone addiction and adolescents' psychological distress. Besides, the capacity to be alone has been considered as an effective buffer to weaken the effects of stress and other risk factors on individuals' mental health (Larson & Lee, 1996; Wu & Chen, 2006). Therefore, the capacity to be alone was tested as a moderator to reveal when the direct and indirect relations between mobile phone addiction and adolescents' psychological distress are stronger or weaker. The proposed model was illustrated in Fig. 1.

Method

Participants and Procedure

Convenience sampling was adopted to recruit 754 middle school students (48.10% female), who have experiences of using mobile phone, to participate in this study. All the participants were recruited from two junior middle schools, which located in two cities (Shangqiu and Wuhan) in China. The mean age of the participants was 12.92 years old ($SD = 0.90$), with an age range of 11–15 years old. Three hundred and forty-nine (46.30%) of them were Grade 7 students; two hundred and seventy-six (36.60%) of them were Grade 8 students; one hundred and twenty-nine (17.10%) of them were Grade 9 students. Participants were informed of the requirements of this survey by using standard instructions, emphasizing the authenticity, independence, and integrity of all answers. All of the questionnaires were conducted in the form of paper-and-pencil in different classrooms taking a class as a unit in 30 minutes. A signed consent form was collected after the Ethical Committee for Scientific Research of correspondence author approved this study.

Measurements

Mobile phone Addiction

Mobile phone addiction was assessed using Mobile Phone Addiction Index (MPAI; Leung, 2008), which has been used in Chinese adolescents and young adults with good reliability and validity (Chen et al., 2016; Liu et al., 2017). This scale includes seventeen items that assess four factors related to mobile phone addiction including inability to control cravings, anxiety and feeling lost, withdrawal and escape, as well as productivity loss (e.g., "You have attempted to spend less time on your mobile phone but are unable to"). Participants responded on a

Likert-type scale ranging from 1 (*never*) to 5 (*always*). Responses were averaged to form a measure of students' mobile phone addiction, with higher scores indicating greater mobile phone addiction. The items also demonstrated high reliability in the present study (Cronbach's $\alpha = 0.88$).

Psychological distress

Psychological distress was assessed by the Chinese version of Depression Anxiety Stress Scale-21 (DASS-21; Wang, Shi, Geng, Zou, & Chan, 2015), which has been widely used to measure individuals' psychological distress (Alfonsson, Wallin, & Maathz, 2017). Twenty-one items measured the symptoms of depression, anxiety and stress (e.g., "I found it hard to wind down") on a scale from 0 (*did not apply to me at all*) to 3 (*applied to me very much or most of the time*). Higher scores represent more serious psychological distress. Cronbach's α for the DASS-21 was 0.90.

Rumination

The Chinese short version of Ruminative Response Scale (Lei et al., 2017) was used in this study. Participants responded to the 10 items on a Likert-type scale ranging from 1 (*never*) to 4 (*always*) (e.g., "Go someplace alone to think about your feelings"). Higher scores reflect higher tendency to respond to negative factors with a ruminative response style. This scale has been used in a sample of Chinese middle students with good reliability and validity (Lian, Sun, Niu, & Zhou, 2017). In the current study, the items demonstrated acceptable reliability (Cronbach's $\alpha = 0.82$).

The capacity to be alone scale

The capacity to be alone was measured by the Chinese version of the capacity to be alone scale (Wu & Chen, 2006), which was revised from the original version developed by Larson (1990). The Chinese version of the capacity to be alone scale has been used in Chinese students with good reliability and validity (Jiang & Zhao, 2017). This scale consists of two intercorrelated 10-item subscales, named as solitary coping scale and solitary comfort scale. Participants responded on a Likert-type scale ranging from 1 (*never*) to 4 (*always*). The solitary coping scale concerns the specific use of solitude to handle stress (e.g., "Being alone is not healing for me"). The solitary comfort scale concerns a person's emotional comfort or discomfort in being alone (e.g., "I can't have fun unless I'm with someone"). Cronbach's α for the whole scale was 0.84. The reliability coefficients were 0.74 for solitary coping and 0.74 for solitary comfort. Given that there was a significant and positive high correlation between solitary coping and solitary comfort ($r = 0.646, p < 0.001$), we averaged the scores of all items from these two subscales to measure adolescents' general capacity to be alone.

Control variables

Gender, age and time spending on mobile phone per day were included as control variables in the present study, as previous studies

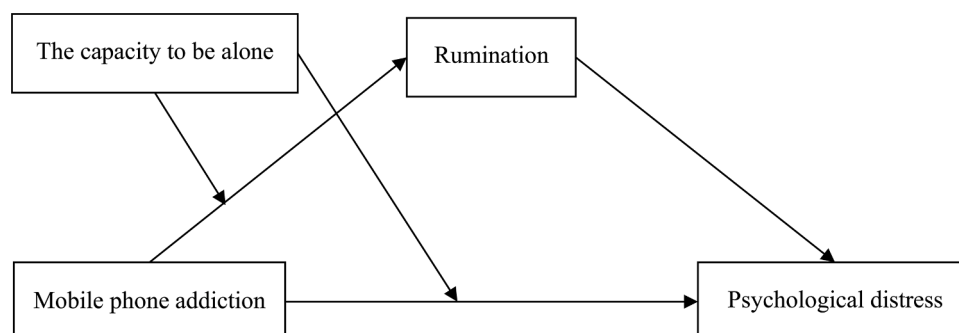


Fig 1. The proposed moderated mediation model.

found that they were closely related to the main variables in this study (Bayram & Bilgel, 2008; George, Russell, Piontak, & Odgers, 2018; Larson, 1997; Larson & Richards, 1991).

Statistical analyses

Firstly, we conducted descriptive statistics and Pearson correlations to examine the means, standard deviations and bivariate associations for all research variables. Secondly, we used the SPSS macro PROCESS (model 8) suggested by Hayes to test the proposed moderated mediation model (Hayes, 2013). This SPSS macro has been used to test mediating and moderating models in several studies, in which this SPSS macro showed higher statistical testability (Lian et al., 2018; Liu et al., 2017; Zhou, Liu, Niu, Sun, & Fan, 2017). In addition, all the potential significant interaction effects were decomposed by simple slopes analyses (Toothaker & Larry, 1994).

Results

Preliminary analyses

Table 1 presented the means, standard deviations, and correlations for all of the observed variables. As hypothesized, mobile phone addiction was positively correlated with rumination and psychological distress and has no significant correlation with the capacity to be alone. Rumination was positively correlated with psychological distress and the capacity to be alone. The capacity to be alone was positively correlated with psychological distress. Gender was positively correlated with the capacity to be alone. Time spending on mobile phone per day was positively correlated with mobile phone addiction and psychological distress. Whereas, age showed no significant correlation with all of the core observed variables.

Testing for the proposed moderated mediation model

Hayes’s (2013) SPSS macro PROCESS was adopted to examine the proposed moderated mediation model. Table 2 presented the main results.

As expected, the total effect model ($F(3, 750) = 47.92, R^2 = 0.16, p < 0.001$), the mediator variable model ($F(5, 748) = 24.79, R^2 = 0.15, p < 0.001$) and dependent variable model ($F(6, 747) = 35.86, R^2 = 0.22, p < 0.001$) were all significant after controlling students’ gender, age and time spending on mobile phone per day. In specific, mobile phone addiction positively predicted rumination ($\beta = 0.24, p < 0.001$) and psychological distress ($\beta = 0.21, p < 0.001$). Rumination positively predicted psychological distress ($\beta = 0.17, p < 0.001$). Furthermore, Sobel test was employed to examine the significance of the indirect effect of mobile phone addiction on psychological distress via rumination. The results indicated that rumination significantly mediated the relationship between mobile phone addiction and psychological distress ($z = 3.75, p < 0.001$). These results provided compelling evidence that mobile phone addiction was associated with increasing in psychological

distress and that this relation was mediated by rumination. Thus, Hypothesis 1 was supported.

In order to examine Hypothesis 2, two interaction effects were analyzed with PROCESS macro (Model 8) by Hayes (2013). There was a significant mobile phone addiction \times the capacity to be alone interaction effect on rumination ($B = -0.22, p < 0.001$) in mediator variable model. A significant mobile phone addiction \times the capacity to be alone interaction effect on psychological distress ($B = -0.12, p < 0.05$) in the dependent variable model. These findings indicated that both the association between mobile phone addiction and psychological distress and the association between mobile phone addiction and rumination were moderated by the capacity to be alone.

Additionally, simple slope analyses were conducted to illustrate these significant interactions and explore whether slopes for the high-capacity to be alone group (1 SD above the mean) were different from slopes for the low-capacity to be alone group (1 SD below the mean) in the two models. The results were plotted in Fig. 2 and Fig. 3. As shown in Fig 2, the effect of mobile phone addiction on rumination was stronger for students with lower capacity to be alone ($B = 0.34, t = 9.23, p < 0.001$) than for those with higher capacity to be alone ($B = 0.14, t = 3.73, p < 0.001$). As shown in Fig 3, the effect of mobile phone addiction on psychological distress was stronger for students with lower capacity to be alone ($B = 0.33, t = 10.34, p < 0.001$) than for those with higher capacity to be alone ($B = 0.18, t = 5.22, p < 0.001$). In other words, mobile phone addiction interacted with the capacity to be alone, such that students with higher levels of capacity to be alone had fairly similar rumination and psychological distress across low and high levels of mobile phone addiction. Students who had lower levels of capacity to be alone, however, reported higher levels of rumination and psychological distress when they suffering from mobile phone addiction. Likewise, students with higher levels of capacity to be alone reported lower psychological distress regardless of their levels of rumination, while students with lower levels of capacity to be alone reported strong psychological distress because of strong rumination.

Furthermore, the results of two conditional analyses showed that no matter what levels of capacity to be alone are, all of the direct and indirect effects were positively and significantly different from zero. Namely, both the direct effect of mobile phone addiction on psychological distress and the indirect effect of rumination in this link were stronger for students with lower capacity to be alone.

Discussion

In current mobile Internet era, mobile phones have even been regarded as an organic part of the everyday lives of adolescents (Oksman & Rautiainen, 2003), and more and more adolescents are walking on the edge of mobile phone addiction (Liu et al., 2017; Yang, Zhou, Liu, & Fan, 2019). Therefore, the antecedents and potential adverse consequences of mobile phone addiction have been explored in a large number of domains. However, limited attention has been paid to the relation between mobile phone addiction and adolescents’ psychological distress and its underlying mechanisms. This study was designed to examine

Table 1
Descriptive statistics and interrelations among all of the observed variables.

Variables	M	SD	1	2	3	4	5	6	7
1. Gender	1.481	0.499	1						
2. Age	12.920	0.902	-0.087*	1					
3. Time spending on mobile phone per day	44.36	52.035	-0.044	0.008	1				
4. Mobile phone addiction	2.303	0.755	-0.024	0.064	0.285**	1			
5. Rumination	2.169	0.578	0.021	0.021	0.024	0.308**	1		
6. psychological distress	0.759	0.497	0.042	-0.037	0.101*	0.396**	0.330**	1	
7. The capacity to be alone	2.664	0.464	0.093*	-0.024	-0.001	0.033	0.202**	0.157**	1

Note. N = 754.

** p < 0.01,

* p < 0.05.

Table 2
Regression results for the conditional indirect effects (moderated mediation).

<i>Model</i>										
<i>Model 1: Total effect model</i>										
R	R ²	F	df ₁	df ₂	p	B	SE	t	p	
0.40	0.16	47.92	3	750	< 0.001					
Constant						0.080	0.07	1.13	>0.05	
Gender						0.051	0.03	1.53	>0.05	
Time spending on mobile phone per day						-0.0001	0.0004	-0.262	>0.05	
Mobile phone addiction						0.264***	0.02	11.45	< 0.001	
<i>Model 2: Mediator variable model</i>										
R	R ²	F	df ₁	df ₂	p	B	SE	t	p	
0.39	0.15	24.79	5	748	< 0.001					
Constant						2.19***	0.07	33.34	<0.001	
Gender						0.01	0.04	0.26	>0.05	
Time spending on mobile phone per day						-0.0007	0.0004	-1.70	>0.05	
Mobile phone addiction						0.24***	0.03	8.71	<0.001	
The capacity to be alone						0.24***	0.05	5.34	<0.001	
Mobile phone addiction × The capacity to be alone						-0.22***	0.05	-3.94	<0.001	
<i>Model 3: Dependent variable model</i>										
R	R ²	F	df ₁	df ₂	p	B	SE	t	p	
0.47	0.22	35.86	6	747	< 0.001					
Constant						0.34***	0.09	3.74	< 0.01	
Gender						0.04	0.03	1.14	>0.05	
Time spending on mobile phone per day						0.0001	0.0004	0.14	>0.05	
Mobile phone addiction						0.21***	0.02	9.05	< 0.001	
Rumination						0.17***	0.04	4.66	< 0.001	
The capacity to be alone						0.12**	0.04	2.96	< 0.01	
Mobile phone addiction × The capacity to be alone						-0.12*	0.05	-2.29	< 0.05	
<i>Conditional direct effect analysis at values of the capacity to be alone (M ± SD)</i>										
						B	SE	LLCI	ULCI	
M - 1SD (2.20)						0.27	0.03	0.21	0.34	
M (2.66)						0.21	0.02	0.17	0.26	
M + 1SD (3.13)						0.16	0.04	0.09	0.23	
<i>Conditional indirect effect analysis at values of the capacity to be alone (M ± SD)</i>										
						B	Boot SE	BootLLCI	BootULCI	
M - 1SD (2.20)						0.06	0.01	0.03	0.09	
M (2.66)						0.04	0.01	0.02	0.06	
M + 1SD (3.13)						0.02	0.01	0.01	0.04	

Note. N = 754. Unstandardized regression coefficients are reported. Bootstrap sample size = 5000. LL = low limit, CI = confidence interval, UL = upper limit.

* p < 0.05.
** p < 0.01.
*** p < 0.001.

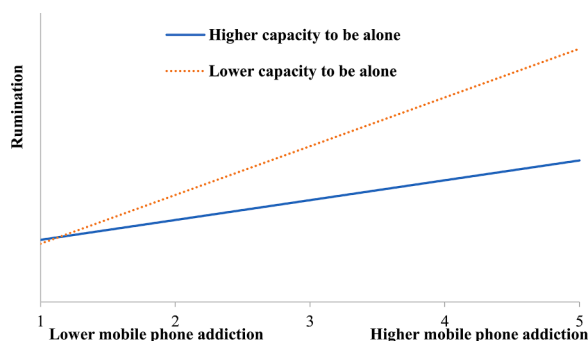


Fig 2. The capacity to be alone moderates the relation between mobile phone addiction and rumination.

how (mediating mechanisms) and when or for whom (moderating mechanisms) mobile phone addiction influences psychological distress (anxiety, depression, and stress). The moderated mediation analyses revealed that rumination mediated the association between mobile phone addiction and psychological distress. Hypothesis 1 was supported. The direct and indirect effects of mobile phone addiction on psychological distress would be exacerbated when adolescents cannot bear being alone or fail to use their time being alone to handle negative

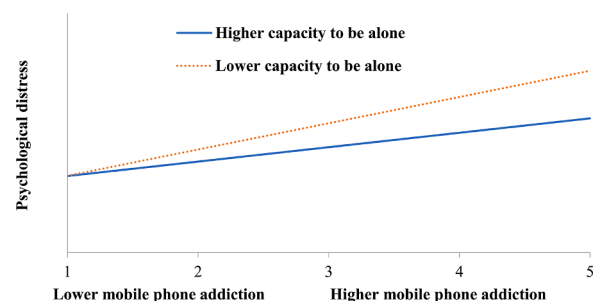


Fig 3. The capacity to be alone moderates the relation between mobile phone addiction and psychological distress.

experience induced by mobile phone addiction. In other words, adolescents with higher levels of capacity to be alone could successfully alleviate the adverse effects of mobile phone addiction on mental health. Hypothesis 2 was supported. Findings enlightened us that we could attenuate the potential adverse effects resulting from mobile phone addiction on our mental health by enhancing our capacity to be alone.

First, consistent with a previous study conducted by Yang, Zhou, Liu and Fan (2019), the present study indicated that mobile phone addiction could positively and significantly predict psychological distress among

adolescents. This finding illustrated that although mobile phone use could satisfy various psychological needs of adolescents and promote their psychological adaptation, excessive use of mobile phones may lead to adverse outcomes. Previous studies considered that the symptoms of withdrawal and daily life disturbance experienced by mobile phone addicts could induce psychological distress (Coyne, Stockdale, & Summers, 2019; Yang, Zhou, Liu, & Fan, 2019). Besides, the uncontrolled use of mobile phones accompanied by mobile phone addiction would take up the time of face-to-face interpersonal interaction, resulting in poor interpersonal and emotional adaptation (Coyne, Stockdale, & Summers, 2019; David & Roberts, 2017; Roberts & David, 2016). Moreover, mobile phone addiction has been proved to predict poor sleep quality, which was a significant predictor of emotional problems, such as depressive symptoms, anxiety symptoms and stress symptoms (Demirci, Akgönül, & Akpınar, 2015; Liu et al., 2017; Sarchiapone et al., 2014). Therefore, adolescents suffering from mobile phone addiction may have more psychological distress.

Second, rumination has been considered as an important factor leading to individual psychological distress (Morrison & Rory, 2005; Treynor, Gonzalez, & Nolen-Hoeksema, 2003). Our findings, consistent with and expanding previous studies, showed that rumination acted as a mediating role that linked mobile phone addiction to adolescents' psychological distress. This finding indicated that symptoms and maladaptive behaviors associated with mobile phone addiction lead to changes in adolescents' responses to adverse life experience, further resulting in plenty of negative mood and affects, such as depression, anxiety and stress. At the same time, as a negative response style, rumination has also been proved to be an important mediating mechanism to link mobile phone addiction to psychological problems (Liu et al., 2017).

Symptoms of mobile phone addiction, including craving, withdrawal, tolerance and preference for cyberspace-oriented relationship, may lead to loads of daily-life disturbance (Pavia, Cavani, Di Blasi, & Giordano, 2016). According to the response style theory (Nolen-Hoeksema, 1991), mobile phone addicts may engage in self-focused rumination as an attempt to reduce the daily-life disturbance caused by uncontrolled use of mobile phones. Unfortunately, rumination on daily-life disturbance following excessive use of mobile phones may persist if their rumination focuses on the causes and/or consequences of excessive use of mobile phones rather than on measures aimed to reduce their dependence on mobile phones. Therefore, rumination induced by mobile phone addiction often leads to psychological problems, especially psychological distress. Besides, surfing on social networking sites is one of the most important motivations for mobile phone addicts to keep in touch with mobile phones (Elhai et al., 2018). Motivated by fear of missing out, mobile phones were used to refresh social networking profiles in an automatic and impulsive fashion. This may increase the possibility for mobile phone addicts to experience upward social comparison, which was an important trigger of rumination (Feinstein et al., 2013). Feinstein et al (2013) demonstrated that in the context of social networking, negatively comparing oneself with others may place individuals at risk for rumination and, in turn, lead to depressive symptoms. Liu et al (2017) has also proved that rumination could be predicted by mobile phone addiction, and eventually lead to adolescents' poor sleep quality. In addition, according to the cognitive-behavioral model (Davis, 2001), rumination is not only the antecedent of mobile phone addiction, but also the consequence of mobile phone addiction. After excessive or uncontrolled use of mobile phones, mobile phone addicts may ruminate about problems associated with their mobile phone use and regret for wasting time on mobile phones, which may lead to increasing in depression, anxiety and stress. Overall, rumination was an underlying mechanism for us to understand how mobile phone addiction influences psychological distress.

In addition, one most important finding in the present study was the individual difference in the predictive effects of mobile phone addiction on rumination and psychological distress. Specifically, both the direct

effect that mobile phone addiction itself exerted on psychological distress and the indirect effect via rumination were moderated and buffered by the capacity to be alone, with these effects being stronger for adolescents with lower level of capacity to be alone. These results indicated that the capacity to be alone, as one of the signs of mental health and emotional maturity, could help us alleviate the potential adverse effects of mobile phone addiction on our response style and psychological distress.

Previous studies considered that we could turn the focus of attention from the outside to the inside, and have the opportunity to listen to our own hearts and make a deeper understanding and evaluation of ourselves when we are alone (Larson, 1990). Thus, adolescents and adults will be more excited and alert when they enter the crowd after being alone. They could also choose to stay away from others actively to release their negative emotions, which was helpful for them to renew their emotion as soon as possible. Therefore, adolescents with the higher capacity to be alone could actively choose to be alone to adjust their response style to deal with the adverse effects of excessive use of mobile phones. At the same time, they could also get rid of the psychological distress caused by mobile phone addiction through breaking away from external stimulation and focusing on their current physiological, emotional and cognitive changes (Roberts, 2011; Wu & Chen, 2006). Besides, according to mindfulness meditation (Brown, Ryan, & Creswell, 2007), the capacity to be alone is a necessary condition for mindfulness meditation, and it can promote individuals to enter the realm of mindfulness meditation. Previous studies have found that mindfulness meditation could help us to enhance our attention control and avoid getting involved in rumination, regulate our negative emotions and promote our positive emotions (Deyo, Wilson, Ong, & Koopman, 2009; Marchand, 2012; Ramel, Goldin, Carmona, & McQuaid, 2004). Therefore, the capacity to be alone could buffer the priming effect of mobile phone addiction on rumination and psychological distress. Unfortunately, adolescents with lower capacity to be alone cannot benefit from being alone. They often spend more time on the distracting activities when they are alone and describe the feeling of being alone as sadness, loneliness and depression (Long, Seburn, Averill, & More, 2003). Therefore, adolescents with lower capacity to be alone are more likely to be involved in rumination and psychological distress when they suffer from mobile phone addiction.

Limitations and implications

Although this study provides valuable findings for us to understand how and when mobile phone addiction influence adolescents' rumination and psychological distress, this study is not without limitations.

First, it was noteworthy that the capacity to be alone was positively associated with rumination and psychological distress. Given that the capacity to be alone is endowed with different values and purposes by different cultures (Long, Seburn, Averill, & More, 2003), our findings cannot be generalized to adolescents in other cultural backgrounds. Compared with individualism, collectivism emphasizes the interdependent relationship between individuals and regards the state of being alone as a violation of collective interests, or even as a manifestation of selfishness or problematic behavior. Therefore, the capacity to be alone showed a positive association with rumination and psychological distress among Chinese adolescents. Besides, different from the previous study (Larson & Lee, 1996), which took adults as subjects, this study took adolescents as subjects. This may also be the reason why the correlation between the capacity to be alone and psychological distress in our study was significant positive. Adolescence is a transition period for an individual to mature from infancy. Adolescents have not yet learned effective emotional regulation strategies and could not deal with the various growth crises and stressful life events independently (Compas, Orosan, & Grant, 1993). It is difficult for them to renew their emotions and reestablish their emotional harmony by using the time being alone. Therefore, as an expected stress buffer, the effect of the capacity to be

alone may backfire. However, this conjecture still needs further cross-culture empirical research support. It is necessary to carry out cross-cultural research to validate the buffering effect of the capacity to be alone in the process of mobile phone addiction leading to rumination and psychological distress among adolescents from different cultural backgrounds. Second, limited by cross-sectional design, the present study could not permit a strict causal relationship. Future studies could adopt longitudinal design to examine the causal direction among mobile phone addiction, rumination and psychological distress. It is also necessary to conduct intervention research to examine the role of the capacity to be alone in the pathway of mobile phone addiction influencing rumination and psychological distress by enhancing the capacity to be alone of mobile phone addicts. Moreover, data were collected from junior middle school students using only self-reported questionnaires, which might have caused social desirability bias and common method bias. Future studies should employ multidimensional scaling to collect more objective data from multiple informants including their parents and peers.

In spite of these limitations, the present study deepens previous studies by revealing the mediating and moderating mechanisms underlying the link between mobile phone addiction and psychological distress. Specifically, the present study is the first attempt to reveal the mediating role of rumination and the protective effect of the capacity to be alone to explain how and when mobile phone addiction leads to psychological distress.

Besides, practical implications could also be drawn from this study. Adolescents isolated at home during the COVID-19 pandemic have more time to be alone. Unfortunately, more and more adolescents spend most of their time alone on their mobile phones and even are addicted to mobile phones, which makes them fall into a variety of psychological crises, such as conflicts in parent-child relationship, academic problems, and all kinds of psychological distress (Sun et al., 2020). To prevent the deterioration of adolescents' psychological problems, parents and educators should guide adolescents to avoid excessive dependence on mobile phones and enjoy the time to be alone. Adolescents should also be acknowledged that the sense of bondage and social and technology overload accompanying the freedom and benefits brought by mobile phone (Choi & Lim, 2016; David & Roberts, 2017; Lee, Son, & Kim, 2016). At the same time, it is necessary for people, especially adolescents, to enhance their capacity to be alone and extricate themselves from the predicament caused by excessive use of mobile phones. Considering that the capacity to be alone is the first step to enter mindfulness meditation, measures to improve mindfulness may be effective for individuals improving their capacity to be alone. Meditation training, including body scan and yoga exercises, has been proved to be effective intervention methods to promote mindfulness (Burke, 2010). Therefore, adolescents with lower capacity to be alone could improve their capacity to be alone by participating in mindfulness training, which ultimately mitigates the negative impact of mobile phone addiction. Specifically, when being alone, adolescents with lower capacity to be alone need to try to do the following to improve their ability to be alone. First, be aware of but not judge their emotions, thoughts, body feelings, etc. Second, they should learn to coexist with their physical and mental states patiently and peacefully. Third, keeping a beginner's mind on their own state. Fourth, believing in the arrangement of nature and let it be. Fifth, just be aware of all the physical and mental phenomena that happen at the moment. Sixth, accepting the current situation and taking care of their body and mind. Seventh, letting go of all kinds of differences between likes and dislikes, and just being aware of every physical and mental phenomenon that happens every second.

In addition, given that rumination plays a bridge role in the relation between mobile phone addiction and psychological distress, parents and educators could help adolescents suffering from mobile phone addiction avoid engaging in psychological distress by decreasing their tendency to be ruminative. Prior studies showed that individuals could reduce their

rumination level by changing their non-adaptive cognitive and emotional response style (Cohen, Mor, & Henik, 2015). Cohen, Mor, and Henik (2015) found that training individuals to exert executive control when processing negative stimuli can alleviate ruminative thinking and rumination-related sad mood. Therefore, changing adolescents' non-adaptive cognitive and emotional response style may also be an effective way to decrease the negative impacts of mobile phone addiction. Specifically, adolescents can reduce the possibility of excessive use of mobile phones leading to rumination. First, controlling the time they spend on their mobile phone every day consciously. Second, trying to use the mobile phone as a tool for work and entertainment instead of being kidnapped by the mobile phone. Third, turning their attention away from the negative experience resulting from excessive or uncontrolled use of mobile phones. Fourth, avoid regret for excessive or uncontrolled use of mobile phones, do what should to do.

Conflict of Interest

All co-authors have expressed agreement with the order of authorship and contents of the manuscript. The authors have no conflicts of interests that might be interpreted as influencing the research.

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Funding

This work was supported by Project supported by social science foundation of Hubei Province, China [Project No. 2019209], Major Program of National Social Science Foundation of China [Project No. 11&ZD151] and General program of National Natural Science Foundation of China (Project No. 31872781). No competing financial interests existed.

Acknowledgments

The authors gratefully acknowledge all the participants and schools cooperated in this survey. Hereby thank all the postgraduates who cooperated with us in conducting this study.

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