Nomophobia and relationships with latent classes of solitude

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Recently, nomophobia (separation anxiety from mobile phone) has become a common phenomenon. The authors' main purpose was to explore latent classes of solitude behaviors and how they are related to nomophobia. Chinese versions of the Nomophobia Scale and the Solitude Behaviour Scale were used in a sample of college students (351 female and 327 male). Latent class analysis, analysis of variance, and regression analysis were employed to classify solitude behaviors and explore the relationship between solitude and nomophobia. A six-class model best fit the data (BIC = 60086.49). Significant differences among the classes were found on nomophobia. Loneliness, social avoidance, and eccentricity significantly predicted nomophobia. Solitude behaviors of college students can be divided into six latent classes. The classes with a high response preference for solitude scored higher on nomophobia, especially the fear of losing an Internet connection. Not self-determined solitude and negative-solitude had a positive effect on nomophobia. (*Bulletin of the Menninger Clinic, 86[1], 1–19*)

Keywords: nomophobia, mobile phones, solitude behavior, loneliness, latent class analysis, latent classes

With the development of technology, the mobile phone has become essential in daily life. Currently, the number of mobile

phone users worldwide has reached to 3.5 billion and is forecast to further grow by several hundred million in the next few years (Statista.com, 2021). According to the 44th statistical report on the development of the Chinese Internet, the number of mobile phone users is about 854 million (Yu, 2019). Although mobile phones provide convenience, excessive use becomes a problem for some people. Nomophobia (no mobile phone phobia) is a new mobile phone use disorder that refers to pathological fear, anxiety, and discomfort when being out of touch with mobile devices (King et al., 2013). Nomophobia is related to negative psychological outcomes, such as stress, anxiety, and increased heart rate and blood pressure (Clayton et al., 2015; Tams et al., 2018).

Nomophobia

Nomophobia, which is a maladaptive aspect of mobile phone use, has been discussed in recent years. Nomophobia refers to the feeling of discomfort or anxiety when losing contact with one's mobile phone (King et al., 2010, 2013, 2014). The definition indicates a dependency on virtual environments for communication. Some researchers considered it as a by-product caused by excessive mobile phone use (Yildirim & Correia, 2015). Nowadays, mobile phones are essential communication tools, and people also suffer from "fear of missing out," which can worsen mental health when an individual lacks mobile phone access (Elhai et al., 2021).

Although nomophobia is a newly proposed construct, its prevalence is increasing (Nagpal & Kaur, 2016). Nomophobia has caused many negative effects on daily life. King et al. (2013) showed that individuals with nomophobia relied on mobile phones to avoid direct social communication. In the case of nomophobia, individuals experience intense feelings of anxiety and stress, which can endanger health (Olivencia-Carrión et al., 2018; Tams et al., 2018). Nomophobia also negatively affects students' academic outcomes (Adnan & Gezgin, 2016). Excessive mobile phone use impacted students' attention and learning, and those higher in nomophobia performed worse on quiz material in classrooms (Mendoza et al., 2018). Given these findings, nomophobia is on the rise and impacts daily life, and thus is of important significance.

Loneliness and nomophobia

Mobile phones were initially designed for communication. Therefore, it is logical that loneliness should be related to mobile phone use. Loneliness would significantly predict mobile phone usage preferences (Lee et al., 2014). Yıldız Durak (2018) found that loneliness and nomophobia were highly correlated and that loneliness could positively predict nomophobia. Individuals also attempt to use mobile phones to compensate for loneliness and social anxiety (Kim, 2018; Nicol, 1999). Individuals who have feelings of loneliness may be vulnerable to excessive use of Internet technology, and they are more likely to struggle with discomfort if they are not able to use a mobile phone (Enez Darcin et al., 2016). In addition, loneliness may lead to excessive use of mobile phones through the mediating effect of motivation for escapism (Shen & Wang, 2019). Therefore, loneliness is an important predictive factor of nomophobia.

Social avoidance and nomophobia

Another psychopathological construct that correlates with mobile phone usage is social avoidance, that is, the tendency to avoid social interaction (Watson & Friend, 1969). Individuals with high levels of avoidance were more likely to engage in excessive mobile phone use (Flynn et al., 2018). Social avoidance also has a close connection to social anxiety, and a common way for people with social anxiety to cope with potentially distressing social situations is to avoid them (Deller et al., 2020). A recent review showed that severe social anxiety was related to problematic smartphone use (Elhai et al., 2019). Mobile phones appeared to be a useful mechanism for avoiding the outside world, and individuals who wanted to avoid society were less able to stay away from mobile phones (Mei et al., 2018; Potash, 2016). Thus, social avoidance is also an important predictive factor of nomophobia.

Self-determined theory for solitude

Loneliness and social avoidance are often conceptualized as causes of problematic mobile phone use, and each of them is a

type of solitude behavior (X. L. Chen et al., 2012). Winnicott (1985) suggested that solitude behavior is a complex phenomenon that develops on the basis of loneliness after experiencing worldly affairs. There have been two opposing views about the value of solitude behaviors. One view holds that solitude is a state of lacking social interaction and contributes to alienation and distress. The other view supports the idea that solitude satisfies developmental needs and serves creative insight and positive self-discovery (Buchholz & Chinlund, 1994; Larson, 1990; Nguyen et al., 2017). Nicol (1999) revised previous work and developed the Motivation for Solitude Scale, which classified solitude into self-determined solitude and not self-determined solitude according to self-determination theory. On the basis of Nicol's classification, X. L. Chen and colleagues (2012) classified solitude behaviors further into four dimensions: positive solitude, eccentricity, social avoidance, and loneliness. Positive solitude represents positive self-determined solitude (Dai et al., 2011; Maslow, 1943). Eccentricity is a negative self-determined solitude described as the desire to be alone and refusing to talk with others (Dai et al., 2011). Social avoidance and loneliness both represent not self-determined solitude behavior. Social avoidance was defined as a behavior involving avoidance of being with others, not talking to others, or escaping from others for any reason (X. L. Chen et al., 2012; Watson & Friend, 1969). Loneliness is subjective social isolation, described as unpleasant experiences with or inadequate quality of social relationships (de Jong-Gierveld, 1987). Whereas positive solitude is associated with positive emotional experience and is triggered by self-determined motivation, eccentricity, social avoidance, and loneliness are associated with negative emotional experiences.

Different types of solitude behaviors can arise together. Individuals who show similar solitude behaviors may have different internal motivations. In previous studies, loneliness and social avoidance were often discussed together (Johnson et al., 2001). Loneliness and social avoidance were both psychological problems and premorbid problems in social communication (Enez Darcin et al., 2016). Eccentricity and loneliness were found when an individual lacked a group environment in childhood

(K. Chen, 1985). Positive solitude was related to students' achievement (Bao & Dai, 2012). The motivation of individuals' solitude is complex, and the relationships among different solitude behaviors are still unclear. Therefore, it is valuable to clarify the specific classes of solitude according to individuals' solitude patterns.

In sum, nomophobia is a pathological phenomenon that develops as a result of problematic mobile phone use. Previous studies have found relationships between some solitude behaviors and nomophobia, but the specific relationships remain unclear. Some studies also have indicated that there may be distinct solitude classes depending on the response patterns of solitude. In addition, self-determined theory provides a new perspective to understand different types of solitude and how these types affect nomophobia. Thus, based on the problems described above, the following research hypotheses are proposed:

H1: There will be distinct latent classes of solitude among individuals, and individuals in different solitude classes will manifest different experiences of nomophobia.

H2: Self-determined solitude has a negative effect on nomophobia, while not self-determined solitude has a positive effect on nomophobia.

H3: Positive-solitude relates negatively to nomophobia, while negative-solitude relates positively to nomophobia.

Methods

Participants

The study sampled undergraduate students from Tianjin Normal University, Tianjin, China. In this study, 678 participants (351 female and 327 male) were recruited online from Chinese social networking platforms such as WeChat and QQ. Participants ranged from college freshmen to seniors (212 freshmen, 193 sophomores, 186 juniors, and 87 seniors). There were no missing data because all data were collected through online questionnaires with a required answer format. No outliers were detected after preliminary analysis in SPSS.

Measures

Solitude Behaviour Scale. On the basis of Nicol's (1999) Self-Determined Motivation for Solitude and Relationship Scale, X. L. Chen et al. (2012) developed the Solitude Behaviour Scale (SBS). This scale includes four subscales: Positive Solitude, Eccentricity, Social Avoidance, and Loneliness. The scale contains 34 items, and each item is scored on a 5-point scale (1 = *strongly disagree*, 2 = *disagree*, 3 = *neither agree nor disagree*, 4 = *agree*, and 5 = *strongly agree*). Cronbach's αs of the subscales were above 0.76, and retest reliability after a 4-week interval was above 0.65. The result of exploratory factor analysis for SBS supported a four-factor model, and the four factors explained 44.25% of the variance. Two criterion scales, the Social Avoidance and Distress scale (Watson & Friend, 1969) and the UCLA Loneliness scale (Russell et al., 1980), had significant positive correlations with Eccentricity, Social Avoidance, and Loneliness, three subscales from the SBS (*r* from 0.31 to 0.82).

Nomophobia Scale (NMPS). We used the Chinese version (Ren et al., 2020) of Yildirim and Correia's (2015) original nomophobia questionnaire. It contains 16 items and four dimensions: fear of being unable to obtain information, fear of losing convenience, fear of losing contact, and fear of losing Internet connection. Cronbach's α of the whole scale was 0.93 and Cronbach's αs of the four dimensions were above 0.78. The result of confirmatory factor analysis found that the construct of four factors was stable (χ^2/df = 3.91, TLI = 0.941, CFI = 0.952, SRMR = 0.04, RMSEA = 0.067). The correlation between the nomophobia scale and the mobile phone addiction tendency scale (Xiong et al., 2012) was 0.63.

Statistics

Latent class analysis. To clarify different classes of college students' solitude behaviors, latent class analysis (LCA) was conducted in Mplus 8.0. The maximum likelihood estimator was used for LCA. In LCA, there were two major parameters: latent class probabilities and conditional probabilities. Latent class probabilities ($P(c = k)$) refers to the proportion of the *k-th* class

in the total and the probability that any participants belong to the *k-th* class. Conditional probability ($P(y_i = b_j|c = k)$) refers to the probability that participants of the *k-th* class take the value of b_j on the *j-th* item. The probability of participants at a certain answer level is equal to the sum of the product of potential class probability and conditional probability of the answer level. The formula is as follows:

$$P\left(y_j = b_j\right) = \sum_{k=1}^{K} P\left(c = k\right) P\left(y_j = b_j | c = k\right) \qquad (1)$$

LCA was conducted with the SBS. The solitude items were treated as ordinal. For college students, four dimensions of solitude behaviors may exist concurrently, so we analyzed all four dimensions in order to explore in more detail latent classes of solitude by LCA.

One-way analysis of variance and t test. To further explore performance of latent classes of solitude on nomophobia scores, one-way *analysis of variance* (ANOVA) and *t* tests were used in SPSS 24.0. After LCA, participants' patterns of solitude behaviors had been classified into different classes.

Regression analysis. Through regression analysis, the predictive effect of independent variables on dependent variables can be determined. Therefore, to find out which solitude behavior had a greater impact on nomophobia, regression analysis was subsequently conducted.

Results

Correlation analysis between solitude and nomophobia

After an initial analysis of the data, 678 college students were included (male = 327, 48.2%; female = 351, 51.8%). The participants were equally sampled from four academic grade levels (freshmen = 212, 31.3%; sophomores = 193, 28.5%; juniors = 186, 27.4%; seniors = 87, 12.8%).

Means, standard deviations, and Pearson correlation coefficients of variables for all participants are presented in Table 1. Eccentricity, social avoidance, and loneliness had significant

Table 1. Correlations between variables of solitude and nomophobia

Variable	M	SD	1	2	3	4	5	6	7	8	9	10
1. Solitude	100.25	19.29	—									
2. Positive Solitude	34.61	7.69	.65**	—								
3. Eccentricity	21.65	7.87	.75**	.22**	—							
4. Social Avoidance	20.95	4.82	.68**	.26**	.36**	—						
5. Loneliness	23.04	6.71	.77**	.27**	.46**	.50**	—					
6. Nomophobia	58.96	19.27	.58**	.24**	.40**	.43**	.61**	—				
7. Information	15.1	5.23	.50**	.25**	.33**	.40**	.49**	.80**	—			
8. Convenience	13.71	6.01	.52**	.19**	.38**	.41**	.55**	.87**	.65**	—		
9. Contact	16.82	5.86	.42**	.30**	.17**	.29**	.46**	.81**	.52**	.57**	—	
10. Internet Connection	13.34	6.17	.48**	.07	.45**	.32**	.54**	.84**	.52**	.65**	.58**	—

Note. Variable 1, "Solitude," refers to total scores of the Solitude Behaviour Scale, and variables 2–5 are four subscales from the Solitude Behaviour Scale; variable 6, "Nomophobia," refers to total scores of the Nomophobia Scale, and variables 7–10 are four subscales from the Nomophobia Scale; "Information" indicates "fear of being unable to obtain information"; "Convenience" indicates "fear of losing convenience"; "Contact" indicates "fear of losing contact"; "Internet Connection" indicates "fear of losing Internet connection." $**p < .01$.

positive correlations with nomophobia and its four dimensions. Positive solitude had significant positive correlations only with nomophobia, fear of being unable to obtain information, fear of losing convenience, and fear of losing contact.

Latent class analysis of solitude behavior

To find the best-fitting-model of solitude behavior, six LCA models (2-, 3-, 4-, 5-, 6-, and 7-class models) were computed. Log-likelihood G^2, Akaike information criterion, and Bayesian information criterion (BIC) indices were used to test model fit (McCutcheon, 1985). The results are shown in Table 2. The 6-class model had the lowest BIC value (60086.49), indicating that based on BIC, this model fit best.

Portraying six latent classes of solitude. LCA divided participants into six classes by their patterns of response probabilities for the SBS. Specifically, average probabilities of endorsing each item's response option were calculated separately, used to profile the response tendencies of six solitude classes across four dimensions (see Figure 1).

For the convenience of illustration, there are three subplot panels (Figure 1a, 1b, 1c) in Figure 1. These three panels combine six classes into three types. The types are low solitude (Figure 1a), moderate solitude (Figure 1b), and high solitude (Figure 1c). Therefore, each type consisted of two classes of participants: typical participants and inclined participants.

Participants from Class 1 and Class 2 belong to Type 1 (Figure 1a). Responses of Classes 1 and 2 tended to "disagree" in the dimensions of Eccentricity, Social Avoidance, and Loneliness. Therefore, we named Type 1 "low solitude." Compared with participants in Class 1, participants in Class 2 had a slight tendency to choose "agree" in the dimensions of Social Avoidance and Loneliness, so we named Class 1 "typical low solitude" and Class 2 "inclined low solitude." It is worth noting that the low solitude type did not tend to choose "disagree" completely in the dimension of Positive Solitude, and especially, Class 2 was more likely to demonstrate higher willingness than Class 1 to choose "agree."

Table 2. **The indexes of model fit**

Model	Latent classes	G^2	AIC	BIC
C2	2-class	–31516.02	63578.04	64811.77
C3	3-class	–29641.41	60102.82	61955.67
C4	4-class	–28618.39	58330.78	60802.76
C5	5-class	–27892.79	57153.59	60244.68
C6[a]	6-class	–27367.13	56376.27	60086.49
C7	7-class	–26940.65	55797.29	60126.63

Note. [a]6-class model had the lowest BIC value. AIC = Akaike information criterion; BIC = Bayesian information criterion.

Classes 3 and 4 belong to Type 2 (Figure 1b). The responses of Classes 3 and 4 tended to "neither agree nor disagree" in four dimensions from the SBS. Therefore, we named Type 2 "moderate solitude." Compared with Class 3, Class 4 was more likely to choose to "neither agree nor disagree," so we named Class 3 "inclined moderate solitude" and Class 4 "typical moderate solitude."

Classes 5 and 6 belong to Type 3 (Figure 1c). The responses of Classes 5 and 6 tended to "agree" in four dimensions from the SBS. Therefore, we named Type 3 "high solitude." Compared with Class 5, Class 6 was more likely to choose "agree" in four dimensions of solitude behavior, so we named Class 5 "inclined high solitude" and Class 6 "typical high solitude."

Results of t tests for solitude behaviors among six classes. According to Table 3, there were significant differences between Classes 1 and 2 on four dimensions of solitude. Class 2 (inclined low solitude) scored higher than Class 1 (typical low solitude) on total scores and four dimensions of solitude. There were significant differences between Classes 3 and 4 only on "positive solitude" and "eccentricity." Class 3 (inclined moderate solitude) scored higher than Class 4 (typical moderate solitude) on "positive solitude" and scored lower than Class 4 on "eccentricity." Significant differences were only found on "positive solitude," "eccentricity," and "loneliness" between Classes 5 and 6. Class 5

1a. Participants from Classes 1 and 2.
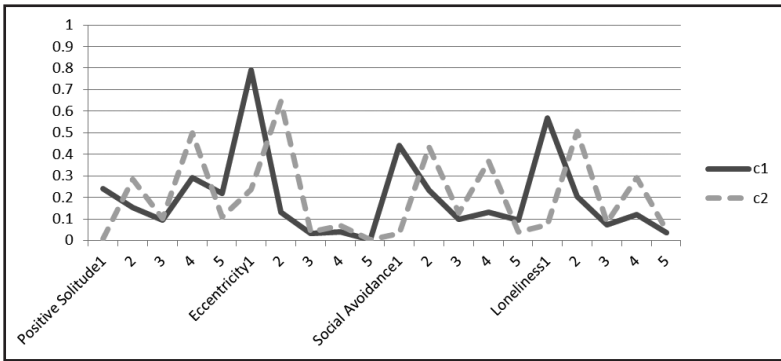
1b. Participants from Classes 3 and 4.
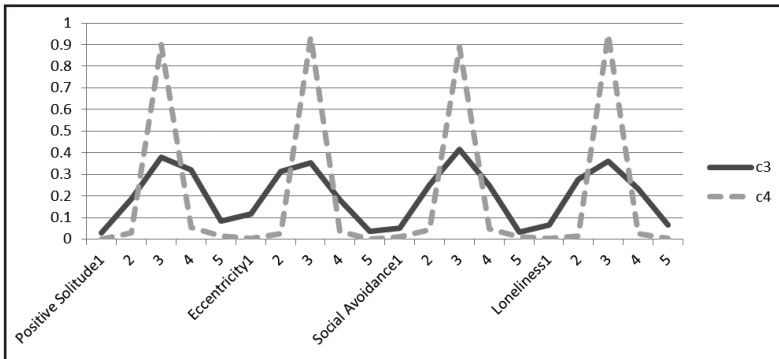
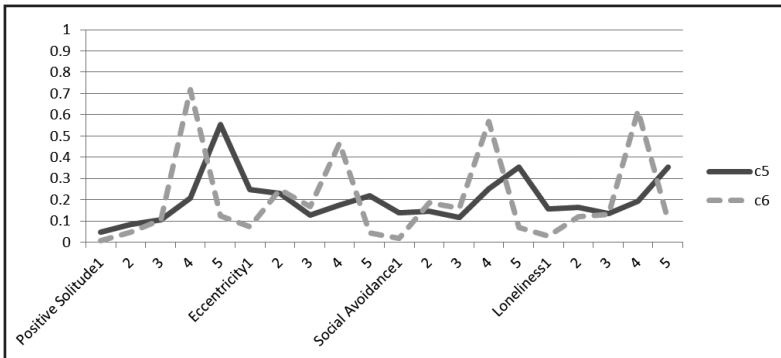*1c.* Participants from Classes 5 and 6.

Figure 1. The profiles of average response probabilities for the Solitude Behaviour Scale. The values on the x-axis refer to scale scores and the y-axis refers to probability.

Table 3. **The differences on solitude behavior between every two latent classes of individuals**

Variable	*t* test for C1 and C2			*t* test for C3 and C4			*t* test for C5 and C6		
	t	*MD*	*SE*	*t*	*MD*	*SE*	*t*	*MD*	*SE*
Solitude sum score	–12.55**	–20.99	1.67	–1.97	–1.64	0.83	–0.79	–1.54	1.96
Positive Solitude	–2.73**	–3.25	1.19	4.38**	1.89	0.43	2.81**	2.29	0.81
Eccentricity	–12.05**	–5.51	0.46	–6.44**	–2.75	0.43	–2.04*	–2.41	1.19
Avoidance	–9.96**	–5.15	0.52	–1.10	–0.27	0.25	0.72	0.45	0.62
Loneliness	–11.15**	–7.08	0.64	–1.37	–0.51	0.37	–2.05*	–1.86	0.91

Note. "Solitude sum score" indicates total scores of "Solitude Behavior"; "Positive Solitude" indicates scores of "Positive Solitude"; "Eccentricity" indicates score of "Eccentricity"; "Avoidance" indicates scores of "Social Avoidance"; "Loneliness" indicates scores of "Loneliness." *MD*: mean difference; *SE*: standard error. *p < .05. **p < .01.

scored higher than Class 6 only on "positive solitude" and lower than Class 6 on "eccentricity" and "loneliness."

The comparison of nomophobia scores among six classes of solitude behaviors

ANOVA results. According to LCA results, there were three major types and six classes of solitude behaviors. To explore between-class differences on nomophobia scores among these six classes, one-way ANOVA was used. There were significant differences on total scores among six classes, $F(5, 672) = 44.17$, $p < .001$, $\eta^2 = 0.247$. For fear of being unable to obtain information, there were significant differences among six classes, $F(5, 672) = 29.52$, $p < .001$, $\eta^2 = 0.180$. For fear of losing convenience, there were significant differences among six classes, $F(5, 672) = 35.80$, $p < .001$, $\eta^2 = 0.210$. For fear of losing contact, there were significant differences among six classes, $F(5, 672) = 16.64$, $p < .001$, $\eta^2 = 0.110$. And for fear of losing Internet connection, there were also significant differences among six classes, $F(5, 672) = 38.53$, $p < .001$, $\eta^2 = 0.223$.

Results of t tests for nomophobia's dimensions among six classes. According to ANOVA results, individuals among six classes showed significant differences on total scores and

dimensions of nomophobia. As shown in Table 3, every two classes from three solitude types had some different response patterns. In order to assess the relationship between these two classes and nomophobia, t tests were executed based on dimensional scores from the Nomophobia Scale (see Table 4).

According to Table 4, there were significant differences between Classes 1 and 2 on the four dimensions of nomophobia. Class 2 (inclined low solitude) scored higher than Class 3 (typical low solitude) on "fear of being unable to obtain information," "fear of losing convenience," "fear of losing contact," and "fear of losing Internet connection." For moderate solitude type, there were no significant differences between Classes 3 and 4 on the four dimensions of nomophobia. For high solitude type, significant differences were only found on "fear of losing Internet connection" between Classes 5 and 6. Class 6 (typical high solitude) scored higher than Class 5 (inclined high solitude) on "fear of losing Internet connection."

To further examine the association between solitude behaviors and nomophobia, regression analysis was conducted. Loneliness, social avoidance, and eccentricity (but not positive solitude) positively predicted nomophobia ($R^2 = 0.407$, $\Delta R^2 = 0.405$, $p < .05$). The regression equation was: nomophobia = 8.62 + 1.39 loneliness + 0.55 social avoidance + 0.32 eccentricity.

Discussion

The main purpose of this study was to explore latent classes of solitude and to confirm relations between solitude and nomophobia. Solitude total scores, eccentricity, social avoidance, and loneliness had moderate positive correlations with nomophobia. Positive solitude had a low positive correlation with nomophobia and no significant correlation with fear of losing Internet connection. Although it was not consistent with the hypothesis that positive solitude negatively predicted nomophobia, the low (and even nonsignificant) positive correlation could mean that positive solitude was not a major factor in nomophobia.

LCA was an attempt to identify homogeneous groups based on individuals' response patterns. There were three major types of solitude among college students (see Figure 1). These types

Table 4. **The differences on nomophobia between every two latent classes of individuals**

Variable	t test for C1 and C2			t test for C3 and C4			t test for C5 and C6		
	t	*MD*	*SE*	*t*	*MD*	*SE*	*t*	*MD*	*SE*
Information	−6.25**	−3.94	0.63	−1.47	−0.85	0.58	0.04	0.03	0.76
Convenience	−8.16**	−5.18	0.63	−1.23	−0.81	0.66	−0.97	−0.88	0.91
Contact	−4.26**	−3.27	0.77	0.37	0.21	0.58	−1.17	−1.02	0.87
Connection	−6.57**	−4.09	0.62	−1.88	−1.04	0.56	−2.05*	−2.13	1.04

Note. "C1-C6" represents "Class 1-Class 6" of Solitude's latent classes;" "Information" indicates "fear of being unable to obtain information"; "Convenience" indicates "fear of losing convenience"; "Contact" indicates "fear of losing contact"; "Connection" indicates "fear of losing Internet connection." *MD*: mean difference; *SE*: standard error. *$p < .05$. **$p < .01$.

are the low solitude type, the moderate solitude type, and the high solitude type, and each type consisted of two classes. For the low solitude type, Class 2 scored higher than Class 1 on total scores and four dimensions. For the moderate solitude type, Class 4 scored significantly lower on positive solitude and significantly higher on eccentricity than Class 3. For the high solitude type, Class 6 also scored significantly lower on positive solitude and significantly higher on eccentricity and loneliness than Class 5. These results revealed that the sum scores were not the optimal indices to reflect the differential response patterns. Those individuals with similar levels of solitude (no significant differences on sum score) performed diversely on four different solitude behaviors. For example, moderate solitude individuals consisted of two classes of individuals, one with higher positive solitude and the other with higher eccentricity. In conclusion, the diversity of motivation behind solitude behaviors was discovered in this study.

ANOVA results revealed how classes of solitude behavior related to nomophobia. The significant differences were found on total scores and dimensions of nomophobia among six classes. Individuals with a higher degree of solitude were more afraid of losing their mobile phones (see Table 4). The most crucial shaping factor was that individuals who experience solitude attempted to compensate through mobile phone use. One study also showed that when people were in an alienated environment or experienced negative emotion, they would turn to the Internet or other media to meet their needs indirectly (Ye et al., 2017).

Therefore, individuals of the high solitude type scored higher on nomophobia. Class 6 scored higher than Class 5 on fear of losing Internet connection, while there were no significant differences between Classes 3 and 4 on the Nomophobia Scale. Compared with Classes 3 and 4, the response difference for SBS between Classes 5 and 6 was reflected more in loneliness. It indicated that individuals' loneliness was more related to fear of losing connectedness. Yildirim and Correia (2015) proposed that viewing notifications and staying connected to one's online identity were important features of the fear of losing connectedness. Davies (1996) pointed out that "compulsive sociability" was a common strategy for those who feel distressed when alone. Nowadays, the function of a mobile phone connection has provided convenience for compulsive sociability. This may be why individuals of the high solitude type have a greater need to ensure that they are online and can receive online notifications at any time.

The severity of solitude behaviors will strengthen an individual's nomophobia. In order to further verify which kinds of solitude played a major role in nomophobia, regression analysis was carried out. Only the loneliness, social avoidance, and eccentricity dimensions were related to nomophobia, and loneliness had the greatest impact (see regression equation). This finding provides support for the finding that negative solitude, especially loneliness, is the main factor related to nomophobia. Previous studies have also shown that individuals with feelings of loneliness and avoidance might become vulnerable to nomophobia because of excessive mobile phone use (Enez Darcin et al., 2016). Some research findings have also suggested that loneliness makes people rely more on mobile phone use to be connected with and obtain excessive reassurance from others (Elhai et al., 2020). At the same time, these individuals also struggle with more discomfort when they are lacking in mobile phone use (Kim, 2018). It is worth noting that, besides negative solitude, positive solitude had no effect on nomophobia. This result could reflect the benefit of solitude. According to self-determination theory, individuals who can enjoy and value solitude as a meaningful experience will build closer relationships with others and feel less lonely (Nguyen et al., 2019).

In sum, there were three major findings. First, we used LCA to identify six latent classes of solitude. Solitude behaviors were

not modeled as a single behavior, and positive and negative solitude could exist concurrently, which suggests the complexity of motivations behind high solitude. Second, when people had a high degree of solitude behavior, their scores on nomophobia also increased. This could be explained by "fear of missing out" and compensatory Internet use theory. Third, loneliness, social avoidance, and eccentricity played a major role in nomophobia, while positive solitude had no effect on nomophobia. Self-determination theory could provide a better explanation. Nicol (1999) suggested that positive and negative values of solitude are assumed to be reflected in motivation underlying the behavior. When the motivation of solitude is based on discomfort or social anxiety, social activity does not foster true connection and may instead contribute to serious loneliness. Therefore, individuals with not self-determined (or negative) solitude will struggle with more anxiety when they lack access to a mobile phone.

These results can promote discussion of solitude classes and the causes of nomophobia. At the same time, the study also had some limitations. First, we used a college student sample, which limits generalizability to the general population. Second, we used a Chinese sample, and it is unclear how results would generalize to the Western population. Third, we relied on self-report methodology rather than using interview-based or behavioral measures. Finally, future research should examine whether these relationships had independent constructs. Nonetheless, these findings offer a contribution to research on classes of solitude behavior and predictors of nomophobia.

Implications for practice

The following conclusions can be obtained from this study:

First, solitude behaviors of college students can be divided into six classes: typical low solitude, inclined low solitude, inclined moderate solitude, typical moderate solitude, inclined high solitude, and typical high solitude. Students in classes with a high response preference for solitude scored higher on nomophobia, especially on fear of losing Internet connection.

Second, not self-determined solitude had a positive effect on nomophobia.

Third, negative solitude related positively to nomophobia.

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