RELATIONSHIP BETWEEN LONELINESS AND GPIU IN CHINESE UNIVERSITY STUDENTS: A LONGITUDINAL CROSS-LAGGED ANALYSIS

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The present study was to examine the reciprocal relationship between loneliness and generalized pathological Internet use (GPIU) in a Chinese sample. A number of 361 university freshmen (141 boys, Mean age = 18.47 years) participated in this study. A fully cross-lagged panel design was used in which loneliness and GPIU were assessed at three time points separated by 3 months. The results indicated that: (a) GPIU had a higher level of stability than loneliness did. (b) the relationship between loneliness and GPIU was dynamic and bidirectional, specifically, loneliness positively predicted GPIU across time; T2 GPIU positively predicted T3 loneliness; the link between T1 loneliness and T3 loneliness was mediated through the increased GPIU at T2.

In China, Internet use is one of the most popular leisure time activities among adolescents aged 10–21 years (Liu, Fang, Deng, & Zhang, 2012). More than 287 million adolescents use Internet, making this age cohort the largest population of Internet users (China Internet Network Information Center [CNNIC], 2016). Studies conducted in China have identified approximately 8% of adolescents as pathological Internet users (Fan et al., 2008; Lei & Yang, 2007; Liu et al., 2012). Because of the concern that an increasing number of adolescents are using the Internet, numerous studies have explored the possible adverse effects of pathological Internet use on academic achievement, socialization, and well-being among adolescents (Lei & Yang, 2007; Luo & Peng, 2008; Fan et al., 2008).

Studies have demonstrated that "the undergraduate Internet users who reported they often feel lonely, they were also problematic Internet users" (Morahan-Martin & Schumacher, 2000; Lu & Yeo, 2015). Lonely individuals tend to use the Internet to find social support from people with similar interests or for entertainment. Morahan-Martin and Schumacher (2000) found that, when online, lonely people become more friendly and open and always look for new friends and seek social support. As their social networks expand, lonely individuals obtain more belonging and companionship through the Internet. Thus, the Internet may attract lonely people who are

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dissatisfied with their offline relationships by providing them with new social interaction patterns. Although these new social interaction patterns modulate negative experiences related to loneliness, they may encourage adolescents to use the Internet. Therefore, loneliness and generalized pathological Internet use (GPIU) may influence each other over time.

To the best of our knowledge, few studies have evaluated the directionality of the relationship between loneliness and GPIU. Recently, a Chinese study examined the reciprocal relationship between loneliness and GPIU, and the results showed that GPIU could increase loneliness over time (Yao & Zhong, 2014). This study enhanced previous research by using a cross-lagged panel design. However, this study still has some limitations. First, the two-week time span between the two surveys was too short to detect stable changes in GPIU and loneliness over time. Moreover, because a cross-lagged panel design with two time points was used, the dynamic relationship between GPIU and loneliness could not be examined over time. For example, T1 loneliness may positively predict T2 GPIU, whereas T2 loneliness could not predict T3 GPIU. Second, the observed variables were used to examine the relationship between GPIU and loneliness. This method may increase the measurement error in a later cross-lagged analysis, because the measurement error over time cannot be tested and controlled.

Additionally, Heinrich and Gullone (2006) suggested "loneliness have assigned special importance to adolescence, which continues to be regarded as a period of life when loneliness is particularly prevalent". Especially, "the freshmen in college who are shitting from a relatively greater reliance on parents for support and interaction to a reliance on interpersonal relationships" (not only including family relationships, but also more peer relationships and social relationships). The decline in communication with parents may made them suffer more loneliness than other period of adolescence, which made them be more likely to use the Internet for belonging and companionship. Additionally, past studies have demonstrated that "heavy Internet use is related to a decline in family communication and supervision" (Park, Kim, & Cho, 2008; Liu, Fang, Deng, & Zhang, 2012). Therefore, the decline in communication with parents tends to place university students at risk of developing PIU. Furthermore, "owing to abundant leisure time and unlimited Internet access through a range of wireless tools, contemporary university students tend to spend large amounts of time online, and are therefore very likely to experience symptoms of PIU" (Morahan-Martin & Schumacher, 2000). Hence, we believe that university freshmen are more likely to develop GPIU than other type school students. The aim of the present study is to examine the reciprocal relationship between loneliness and GPIU over a three-wave longitudinal study in university freshmen, and we hypothesize loneliness and GPIU influence each other across time: initial loneliness positively predict later GPIU, and initial GPIU positively predict later loneliness.

METHOD

PARTICIPANTS

The initial number of young people available for participation was 500 participants (279 females and 221 males). All were university students from two educational institutions in Eastern China. The measurements were taken at the beginning of the university year (T1), 3 months later (T2), and 6 months later (T3). Of the initial sample, 139 adolescents did not complete the third wave of measurements (participation rate: 72.20%). The lack of participation was almost entirely owing to sickness or absence. Consequently, the final sample comprised 361 adolescents (223 females and 138 males), with a mean age at the beginning of the study of 18.57 years (standard

deviation [*SD*] = 0.88).

MEASURES

Loneliness. Loneliness was measured using the Chinese adaptation (Wang, 1995) of the Cheek and Russell Loneliness Scale (Russell, Peplau, & Ferguson, 1978). This scale consists of 20 self-statements concerning people's satisfaction with their interpersonal relationships. The statements are answered on a 4-point scale for how often (1 = *never*, 4 = *often*) subjects feel the statements apply to themselves, with high scores indicating greater perceived loneliness. Cronbach's α values for loneliness for the three time points were .88, .87, and .92.

GPIU. GPIU was measured using the Chinese adaptation (Bai & Fan, 2005) of the Internet Addiction Test (Young, 1998), which assesses the degree to which Internet use affects people's daily routines, social life, academic and occupational productivity, sleep patterns, feelings, and online activities (time spent on games, chatting, and shopping) by asking 20 questions. Student rated their agreement with the items on a 6-point Likert scale ranging from 1 (*never*) to 6 (*always*). Cronbach's α values for GPIU across three time points were .82, .88, and .86.

ANALYTICAL APPROACH

A cross-lagged panel design was employed. The general model included measures of shyness, interpersonal relationship and loneliness at T1, T2, and T3. Structural Equation Modeling was used to test the hypothesis of the study. All of the models were tested via maximum likelihood (ML) estimation using MPLUS 7.0. In cross-lagged models, change in each variable over time is modeled using the stability coefficients between time-adjacent measures of each variable (e.g., T1 loneliness predicts T2 loneliness, and T2 loneliness in turn predicts T3 loneliness), and the cross-lagged relations between GPIU and loneliness are captured by the cross-lagged effects between two variables (e.g., T1 loneliness predicts T2 GPIU and T1 GPIU predicts T2 loneliness).

RESULTS

The means, standard deviations and correlations among all variables are shown in Table 1. Correlations among T1, T2, and T3 measures of loneliness were in the .41–.67 range. Correlations among T1, T2, and T3 measures of GPIU were in the .61–.74 range. Additionally, the relationship between the measures of loneliness and GPIU was in the expected direction. That was, loneliness was positively correlated with GPIU.

TABLE 1

CORRELATIONS OF LONELINESS AND GPIU ACROSS TIME (*N* = 361)

Variable	*M*	*SD*	1	2	3	4	5	6
1. T1 Loneliness	39.51	8.51	1					
2. T1 GPIU	34.95	10.08	.32**	1				
3. T2 Loneliness	41.51	18.88	.41**	.17**	1			
4. T2 GPIU	36.86	11.85	.32**	.74**	.22**	1		
5. T3 Loneliness	41.51	9.65	.67**	.31**	.41**	.37**	1	
6. T3 GPIU	37.68	11.78	.31**	.61**	.24**	.71**	.44**	1

*p < .05. **p < .01 (2-tailed).

Pairwise comparisons indicated that loneliness and GPIU at T2 and T3 significantly greater

than T1 (see Table 2).

TABLE 2

COMPARISON OF LONELINESS AND GPIU ACROSS TIME

Items	T1 (*M*, *SD*)	T2 (*M*, *SD*)	T3 (*M*, *SD*)	*F* (1, 360)	Pairwise comparisons
Loneliness	39.51(8.51)	41.51(18.88)	41.51(9.65)	26.03**	T1<T2 = T3
GPIU	34.95(10.10)	37.35(11.85)	37.68(11.78)	28.31**	T1 < T2 = T3

*$p < .05$. **$p < .01$ (2-tailed).

A longitudinal confirmatory factor analysis was undertaken, which included all observed and latent variables from each time with freely estimated parameters (all the observed indicators of latent variables and the errors of each indicator were specified to covary over time). The measurement model consisted of six latent variables corresponding to the two variables of the study being measured three times. This measurement model exhibited good fit indexes: $\chi^2(120) = 401$, $p< .001$, RMSEA = .04, TLI = .97, and CFI = .96. This model was compared with a more restrictive model in which all the indicators of latent variable factors were specified as being equal across time: $\chi^2 (131) = 419$, $p< .001$, RMSEA = .04, TLI = .97, and CFI = .96.The chi-squared test of difference indicated that the model without metric invariance fit the datas well as the unconstrained model did ($\Delta\chi^2 =18$, $\Delta df = 11$, $p = .07$). Thus, the unconstrained model was then used for the subsequent analysis.

The next step was to test an autoregressive model, which included autoregressive paths between T1, T2, and T3 measures of loneliness and GPIU. All autoregressive paths were significant and are displayed in Fig. 1. Fit indices were excellent for the autoregressive model: $\chi^2 (123) = 403$, $p< .001$, RMSEA = .05, TLI = .95, and CFI = .96.

Building on the above autoregressive model, the fit of the hypothesized model was tested. It included cross-lagged predictive paths from loneliness to GPIU and from GPIU to loneliness. Fit indices were excellent for this model: $\chi^2 (125) = 417$, $p< .001$, RMSEA = .05, TLI = .95, CFI = .97 (only significant relationships are retained). The results indicate that the relationship between loneliness and GPIU was dynamic and bidirectional: loneliness positively predicted GPIU across time ($R^2 = .54$), whereas increased GPIU at T2 negatively predicted later loneliness($R^2 = .59$) (Fig. 1).

The above paths were indicative of some mediational mechanisms. The link between T1 loneliness and T3 loneliness was mediated through the increased GPIU. The significance of these mediational paths was tested via bootstrapping. With this aim, 1,000 bootstrap samples were created from the original data set by random sampling with replacement. According to Shrout and Bolger's (2002) proposal, an mediational effect is significant at the .05 level if the 95% confidence level does not include zero. The results indicated that all mediational paths was statistically significant: the indirect effect of T1 loneliness on T3 loneliness via T2 GPIU (95% CI: .12–.15).
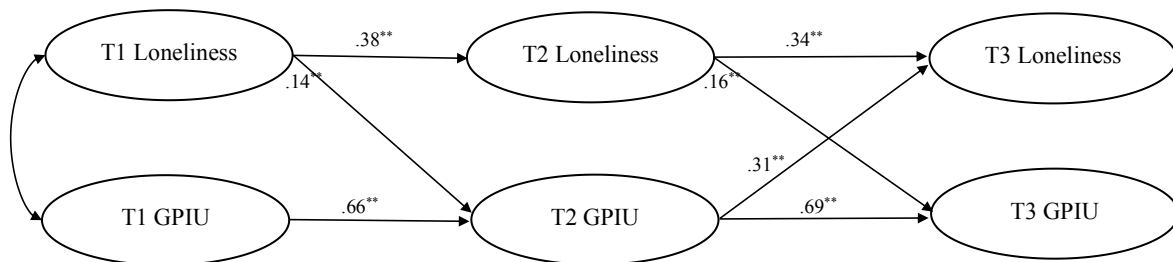
Figure. 1. Cross-lagged relationships between loneliness and GPIU.

Note. Only significant relationships are displayed. Coefficients represent standardized values.

DISCUSSION

To our knowledge, this was the first longitudinal study to examine the reciprocal relationship between loneliness and GPIU were assessed at three time points. The results can be summarized as follows: First, GPIU (.66–.69) had a higher level of stability than loneliness (.34–.38) did. Second, the relationships between loneliness and GPIU were dynamic and bidirectional, specifically, loneliness positively predicted GPIU across time; T2 GPIU positively predictedT3 loneliness; the link between T1 loneliness and T3 loneliness was mediated through the GPIU at T2.

The aforementioned results address some formation mechanisms of how loneliness and GPIU influence each other across time. First, loneliness and GPIU were somewhat stable at the beginning of university life, suggesting that emerging individual differences persist over time (Guo, Sun, Breitsmith, Morrison, & Connor, 2014). It is also noteworthy that GPIU had a comparatively higher level of stability than loneliness did. A construct with a higher level of stability is considered to be more "trait-like," whereas a construct with a lower level of stability is more "state-like". Accordingly, the differential stability across loneliness and GPIU may be caused by the fact that—compared GPIU—loneliness is more likely depend on ecological settings (e.g., setting and social culture).

However, this study does not conclusively demonstrate that loneliness is causal pathway of GPIU, owing to their relationship being dynamic and bidirectional. Some studies have identified that the cycle of loneliness and PIU involves individual with loneliness using the Internet to compensate for offline social interaction thereby developing PIU, however, PIU and lack of social interactions in real life then exacerbate their feelings of loneliness (Yao & Zhong, 2014). This means that the freshmen who are lack of parental supervision and have weaker social ties may experience greater loneliness which leads to GPIU. With decreased face-to-face social interaction and deficient communication (Huan, Ang, Chong, & Chye, 2014), these freshmen may feel lonely which prompts them to go online to seek new friendship networks and social relationships (Morahan-Martin & Schumacher, 2000). Unfortunately, all these mechanisms may contribute to the creation of a "snowball" or "cascade" effect at the beginning of university life, which is a developmental stage at which the occurrence of loneliness predicts increased GPIU. GPIU in turn increases the likelihood of experiencing further loneliness. Consequently, GPIU stabilizes into trait-like risks (.67 → .69), whereas interpersonal relationships (.46 → .43) and loneliness tend toward unstable "state-like" risks (.39 → .35).

The result of the present study was not consistent with the findings of previous studies. Yao

and Zhong (2014) found that excessive GPIU can increase the feeling of loneliness over time. These inconsistent findings may be due to the following reasons. First, different samples were used. In our study, university freshmen with a mean age of 18.57 years were followed, whereas the mean age of the subjects investigated by Yao and Zhong was 21.63 years. Because the relationship between loneliness and GPIU is dynamic, age differences may yield different relationships. Second, different concepts of GPIU were used. In the present study, GPIU was considered a social phenomenon, whereas Yao and Zhong focused on emotional and mental states, which are adversely affected by Internet overuse. Finally, different analysis methods were used. In this study, the measurement invariance of GPIU and loneliness was initially tested using a measurement model, which ensures invariance in the measurement of GPIU and loneliness over time. However, the observed GPIU and loneliness were used directly in the study conducted by Yao and Zhong. This method cannot ensure the measurement invariance of GPIU and loneliness over time and thus may produce measurement errors in a later cross-lagged analysis.

These findings have implications for the treatment and prevention of GPIU in university freshmen. The results show a transactional, dynamic set of association between loneliness and GPIU which combine to produce a feedback loop that perpetuates GPIU. This finding suggests that interventions can break this chain by targeting initial loneliness. Previous studies have found that decreased social interaction is related to loneliness (Yao & Zhong, 2014; Huan, Ang, Chong, & Chye, 2014). Thus, periodic collective counseling and collective activities have been advocated, particularly for university freshmen experiencing a decline in family communication and supervision. These activities can assist students to engage in positive interactions such as respecting, encouraging, and helping each other, thereby facilitating positive interpersonal relationships and reducing loneliness.

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