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FULL-LENGTH REPORT

Parent–adolescent attachment and peer attachment associated with Internet Gaming Disorder: A longitudinal study of first-year undergraduate students

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ABSTRACT

Background and aims: Given that Internet Gaming Disorder (IGD) has tentatively been included in DSM-5 as a psychiatric disorder, it is important that the effect of parental and peer attachment in the development of IGD is further explored. *Methods:* Utilizing a longitudinal design, this study investigated the bidirectional association between perceived parent–adolescent attachment, peer attachment, and IGD among 1,054 first-year undergraduate students (58.8% female). The students provided demographic information (e.g., age, gender) and were assessed using the nine-item Internet Gaming Disorder Scale and the Inventory of Parent and Peer Attachment. Assessments occurred three times, six months apart (October 2017; April 2018; October 2018). *Results:* Cross-lagged panel models suggested that IGD weakly predicted subsequent mother attachment but significantly negatively predicted father attachment. However, father and mother attachment did not predict subsequent IGD. Moreover, peer attachment had a bidirectional association with IGD. Furthermore, the model also demonstrated stable cross-sectional negative correlations between attachment and IGD across all three assessments. *Discussion and conclusions:* The findings of the present study did not show a bidirectional association between parental attachment and IGD, but they did show a negative bidirectional association between peer attachment and IGD. The results suggested previous cross-sectional associations between IGD and attachment, with larger links among males than females at the first measurement point. We found that peer attachment negatively predicted subsequent IGD, which indicates that peer attachment plays an important role in preventing addictive gaming behaviors for university students.

KEYWORDS

parental attachment, peer attachment, Internet Gaming Disorder, problematic gaming, game addiction, longitudinal study

INTRODUCTION

Problematic internet gaming has been reported in many countries worldwide and is increasingly common among a small minority of adolescents (Cheng, Cheung, & Wang, 2018; Feng, Ramo, Chan, & Bourgeois, 2017; Kuss, & Griffiths, 2012). Internet Gaming Disorder (IGD) has been defined as a behavioral addiction and was included in Section III of the DSM-5 as a tentative disorder requiring further research (American Psychiatric Association, 2013). During adolescence and emerging adulthood, the prevalence rates of IGD among nationally representative samples have ranged between 1.2% and 8.5%, leading to a

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number of gaming-related problems (Griffiths, Kuss, & Pontes, 2016; World Health Organization, 2019). IGD is associated with negative mental health (e.g., depression, social anxiety, stress), and with serious withdrawal reactions for people if they are unable to play (Allison, Von Wahlde, Shockley, & Gabbard, 2006; Kaptsis, King, Delfabbro, & Gradisar, 2016; Kuss, & Griffiths, 2012).

Given these negative effects of IGD, some previous research has addressed family therapy as a form of treatment (Bonnaire, Liddle, Har, Nielsen, & Phan, 2019). Research has suggested that a family factor– parent–child attachment– is associated with the severity of problematic gaming (e.g., Kim & Kim, 2015; Kim, Son, Yang, Cho, & Lee, 2007; Monacis, de Palo, Griffiths, & Sinatra, 2017). However, previous studies have largely comprised cross-sectional designs, so we still know little about the cause or effects of attachment on IGD. Therefore, this study examined security attachment (with father, mother, and peers) in the development of IGD and the bidirectional effect between attachment and IGD in a longitudinal sample of first-year undergraduate students.

Attachment

Parent–child attachment is critical for a child's positive development. According to Bowlby's (1982) *attachment theory*, parents' initial response to children's needs creates a secure connection between parents and children. When children explore the surrounding environment and encounter danger and stress, parents provide a base of safety for their children. Secure attachment develops "internal working models" between children and important others, which provides positive healthy development in adolescence and adulthood (Grossmann, Grossmann, Kindler, & Zimmermann, 2008). Parent–child attachment remains into adolescence alongside peer attachment and is critical for children's psychosocial functioning in adolescence and adulthood (Laursen & Collins, 2009). Parental attachment and peer attachment are regarded as secure bonds between adolescents and their parents and peers, with positive effects on the development of psychological wellbeing (Armsden, & Greenberg, 1987; Raja, McGee, & Stanton, 1992). However, poor or insecure attachment (e.g., less trust, lower levels of communication, and higher levels of alienation) has negative effects on the development of internalizing problems, such as depression (Armsden, McCauley, Greenberg, Burke, & Mitchell, 1990) and anxiety (van Eijck, Branje, Hale, & Meeus, 2012), and externalizing problems, such as aggressive and delinquent behavior (de Vries, Hoeve, Stams, & Asscher, 2016), bullying (Murphy, Laible, & Augustine, 2017), and internet addiction (Yang, Zhu, Chen, Song, & Wang, 2016).

The evidence above suggests that parental attachment and peer attachment are negatively associated with engagement in various kinds of problem behaviors. IGD is often conceptualized as an addiction which can also be regarded as a behavioral problem, especially with increasing rates of IGD in adolescents. Therefore, it is of significance to explore the association between attachment and IGD.

Attachment and IGD

Some cross-sectional studies have examined the specific relationship between parental attachment, peer attachment, and IGD in late adolescence. A few studies have reported weak or no direct association between parental attachment and IGD (e.g., King & Delfabbro, 2017; Throuvala, Janikian, Griffiths, Rennoldson, & Kuss, 2019). However, most research has suggested perceived insecure attachments (e.g., lower trust, lower levels of communication, and higher levels of alienation) are more prevalent among individuals with IGD, including parental attachment (Estevez, Jauregui, & Lopez-Gonzalez, 2019; Schneider, King, & Delfabbro, 2017; Wang, Ho, Chan, & Tse, 2015; Zhu, Zhang, Yu, & Bao, 2015) and peer attachment (Estevez, Jauregui, Sanchez-Marcos, Lopez-Gonzalez, & Griffiths, 2017; Reiner et al., 2017). For example, Estevez et al. (2019), using a sample of 472 secondary education students, found both parental attachment and peer attachment were related to internet game addictions.

Other studies have found that problematic gaming may be associated with poor parental–adolescent attachment (e.g., Kim & Kim, 2015; Lee & Kim, 2017). In a sample of 624 adolescents in South Korea, addicted gamers, as compared with non-addicted gamers, were reported to have lower attachment scores, both for father– and mother–child attachment (Kim & Kim, 2015). Moreover, a few studies suggested that internet addiction (including game addiction) related to lower peer attachment (Deng & Zhu, 2018). In a sample of 507 Chinese adolescents, Deng and Zhu (2018) found that adolescents with internet addictions reported less peer attachment than non-addicted adolescents. However, these studies are largely cross-sectional in design, and the bidirectional relationship between attachment and IGD remained unclear, a research gap that this study addresses.

The bidirectional effect between attachment and IGD

Previous correlational (cross-sectional) research has revealed positive associations between poor parental (and peer) attachments and adolescent's IGD. Using a regression model, some cross-sectional studies suggested that attachment to parents and peers negatively statistically predicted IGD (Estevez et al., 2017, 2019). However, those studies did not draw the opposite conclusion, that is, that IGD statistically predicts poorer levels of attachment quality with parents and peers. To evaluate the longitudinal relationship between attachment quality and IGD, cross-lagged panel models are required; such models show the bidirectional effect between variables over time, after controlling for covariates at Time 1 (e.g., demographic information), the cross-sectional relationship between attachment relationship and IGD at each time point, and autoregressive effects over time. To the best of our knowledge, the direction of this association remains unclear because there has never been any previous research using cross-lagged panel models to examine the relationship between attachment and IGD.

Although no longitudinal study has explored the relationship between IGD and attachment, ample evidence has suggested that parental (and peer) attachments may affect adolescents' behavioral outcomes. According to attachment theory (Bowlby, 1982), insecure attachment causes feelings of not being cared for or loved, and these attachments (or, more specifically, the lack of them) influence later psychosocial functioning and contribute to the mental health problems of adolescents. For example, using four-wave longitudinal data of 1,313 Dutch adolescents, early evidence of parental attachment predicted later anxiety disorder symptoms (van Eijck et al., 2012). Recently, a longitudinal study suggested that attachment to parents and peers predicts eating disorders (Cortés-García, Hoffmann, Warschburger, & Senra, 2019). Insecure attachment (especially with relationships) is associated with the development of problematic internet use (Schimmenti, Passanisi, Gervasi, Manzella, & Famà, 2014), aggression (De Vries et al., 2016), and bullying (Murphy et al., 2017). Attachment may also be linked to IGD, one of behavioral problem outcomes, among adolescents. However, evidence from longitudinal studies examining the relationship between attachment and IGD in adolescence is lacking.

It is also likely that adolescent behavior problems may influence attachment quality between teens and others (Buist, Deković, Meeus, & van Aken, 2004), and in this sense, adolescents' IGD may affect their attachment quality with parents and peers. Although attachment built up in infancy plays a positive role in child development, parental and peer attachment can change during specific transitions such as the first semester in college (Hiester, Nordstrom, & Swenson, 2009). Some longitudinal studies have found that problem behaviors may also predict later parental attachment. For example, good parental attachment may not prevent adolescents from drinking, but drinking behavior can negatively predict parental attachment (van der Vorst, Engels, Meeus, & Deković, 2006). Furthermore, reciprocal relationships were found between parental attachment and behavioral problems (e.g., Buist et al., 2004) and between parental attachment and anxiety disorder symptoms (e.g., van Eijck et al., 2012). Consistent with these behavioral problems or disorders, IGD may also be a predictor of subsequent parental and peer attachment. For example, adolescents with gaming disorders may have poor interpersonal relationships (Ryu et al., 2018) and poor family relationships (Bonnaire et al., 2019). Furthermore, adolescents with IGD evidenced significantly more symptoms of depression, anxiety, and stress, lower life satisfaction, and attentional impulsivity (Bargeron & Hormes, 2017). If, for instance, an adolescent with IGD was punished for their excessive gaming, they may view their parents as less sensitive and responsive and thus report poor perceived attachment to their parents.

The present study

The present study investigated the longitudinal and bidirectional effect between perceived attachment quality with fathers, mothers, and peers and IGD in a sample of first-year undergraduate students. First-year undergraduate students typically have just left home and are starting to gain autonomy and independence (Kenny & Donaldson, 1991), and although college students are faced with separation-individuation, security attachment still plays a protective role in their psychological adjustment (Rice, FitzGerald, Whaley, & Gibbs, 1995). When transitioning to college life, adolescents meet additional challenges such as occupational stress, and this transition may lead to changes in attachment (Hiester et al., 2009). College students also have flexible schedules and easy access to the internet and games, and there is a higher prevalence of IGD in this group than other target groups such as children and adolescents (Kaess et al., 2017).

When examining the effect of parent–adolescent attachment in the development of behavior outcomes, previous research has predominantly focused on mothers; information concerning the function of fathers' and peers' attachment relationships are generally lacking. The present longitudinal study examined whether there was an association between perceived attachment security (with fathers, mothers, and peers) and IGD over time. Since our study is the first to examine the directionality of effects in the association between perceived attachment relationship quality and IGD, no specific hypothesis about directionality was made. Previous research suggested that father attachment anxiety leads to problematic internet use in female students, while mother attachment anxiety contributes to problematic internet use in male students (Jia & Jia, 2016); consequently, we examined gender differences further in the cross-lagged panel models. Socioeconomic status such as family income and mother's and father's education levels can also have an effect on adolescent attachment with parents and peers and IGD (e.g., Schneider et al., 2017; Sousa et al., 2011); our study controlled for those variables in the cross-lagged panel model.

METHOD

Participants and procedures

Participants comprised 1,054 first-year undergraduate students (M_{age} = 18.25 years, SD = 0.73) selected using cluster sampling from a comprehensive university in China. Data were collected three times approximately six months apart: (1) October 2017 (valid N = 1,054, 41.2% male); (2) April 2018 (valid N = 924, 36.9% male), and (3) October 2018 (valid N = 931, 38.0% male). Across time 1 (T1) to time 3 (T3), 269 participants had missing data (25.5% of total sample). More information regarding the demographic characteristics of the sample at T1-T3 can be found in Table 1.

Measures and materials

Demographic Information. Information on the following demographic characteristics were collected: age, gender, only-child status, ethnicity, home location (i.e., rural or urban area), parental divorce, family economic incomes (1 = below than 1,000 ¥; 2 = 1,001 to 3,000 ¥; 3 = 3,001 to 5,000 ¥; 4 = 5,000 to 10,000 ¥; 5 = 10,001 to 20,000 ¥; 6 = above than 20,000 ¥)

Table 1. Participants' demographic characteristics

Characteristic	(T1: N = 1,054)	(T2: N = 924)	(T3: N = 931)
Age			
17–18 years	727 (69.0%)	641 (69.4%)	642 (69.7%)
19–21 years	327 (31.0%)	283 (30.6%)	289 (30.3%)
Gender			
Males	434 (41.2%)	341 (36.9%)	354 (38.0%)
Females	620 (58.8%)	583 (63.1%)	577 (62.0%)
Only child state			
Yes	566 (53.7%)	491 (53.1%)	501 (53.8%)
No	488 (46.3%)	433 (46.9%)	430 (46.2%)
Family status			
Rural	373 (35.4%)	333 (36.0%)	333 (35.8%)
Cities and towns	681 (64.6%)	591 (64.0%)	598 (64.2%)
Parental divorce (Yes)	93 (8.8%)	84 (9.1%)	83 (8.9%)
Family economic incomes	3.31(1.20)	3.28 (1.19)	3.31 (1.19)
Parents' educational level			
Father's educational level	2.81 (1.08)	2.78 (1.07)	2.80 (1.08)
Mother's educational level	2.60 (1.10)	2.58 (1.09)	2.59 (1.10)

Note. Family economic incomes and parents' education level stand for M (SD), others stand for N (frequency).

and parents' educational degrees (1 = primary school and below; 2 = middle school; 3 = high school degree and special school degree; 4 = undergraduate degree; 5 = graduate degree and above).

Parent–Adolescent and Peer Attachment. The short 36-item version of the Inventory of Parent and Peer Attachment (IPPA; Armsden & Greenberg, 1987; Raja et al., 1992) was used to assess mother attachment, father attachment, and peer attachment. The IPPA was developed based on attachment theory (Bowlby, 1982), and concerns the cognitive-affective dimensions of trust in attachment figures in relation to accessibility and responsiveness. Previous studies on the IPPA have shown good re-test, internal reliability, and high validity of mother, father and peer attachment (Armsden & Greenberg, 1987; Raja et al., 1992).

Three subscales (each containing four items) assess three key aspects of attachment: *trust* (e.g., "My mother/father accepts me as I am" and "My friends encourage me to talk about my difficulties"), *communication* (e.g., "My mother/father helps me to understand myself better" and "When we discuss things, my friends consider my point of view") and *alienation* ("I don't get much attention from my father/mother" and "I get upset a lot more than my friends know about"). All items are assessed using a five-point Likert scale (1 = almost never to 5 = almost always). Previous research, including confirmatory factor analyses, supports the reliability and validity of scores on the Chinese version of the IPPA (Li, Delvecchio, Miconi, Salcuni, & Di Riso, 2014; Pan et al., 2017; Song, Thompson, & Ferrer, 2009). For scores in the present study, Cronbach's α for mother attachment was 0.81 (T1), 0.86 (T2), and 0.87 (T3); for father attachment, 0.85 (T1), 0.87 (T2), and 0.88 (T3); and for peer attachment, 0.84 (T1), 0.85 (T2) and 0.83 (T3).

Nine-item Internet Gaming Disorder Scale-Short Form (IGDS-SF9). IGD severity was assessed using the nine-item IGDS-SF9 (Pontes & Griffiths, 2015) which is based on the nine core IGD criteria in the DSM-5 (e.g., unsuccessful attempts to control participation in internet games). Examples of items include, "Do you feel the need to spend increasing amounts of time engaged in gaming in order to achieve satisfaction or pleasure?" All items are assessed using a five-point Likert scale (1 = never; 5 = very often). The nine items are added together to form a single global score, with higher scores suggesting higher severity of IGD.

The original scale was translated from English into Chinese and then back into English and reviewed by a bilingual researcher. However, based on pilot studies, some words were modified, taking into account cultural differences. For example, "Have you deceived any of your family members, therapists, or others about the amount of your gaming activity?" was modified to "Have you deceived any of your family members, teachers, friends, or others about the amount of your gaming activity?" Finally, a large undergraduate student sample (n = 3,610, 52.9% male, mean age = 19.48 years) were used to assess internal reliability and related validity. Previous research, including confirmatory factor analyses and related scores assessing important mental outcomes, supported the reliability and validity of scores on the IGDS-SF9 (Pontes, Macur, & Griffiths, 2016; Wu et al., 2017). For scores in the present study, Cronbach's α for the IGDS-SF9 was 0.86 (T1), 0.90 (T2), and 0.94 (T3).

Statistical analysis

Missing data. An indicator (0 = missing, 1 = complete) was created to examine whether the missing data were conditional on any of the key variables. Larger numbers of males

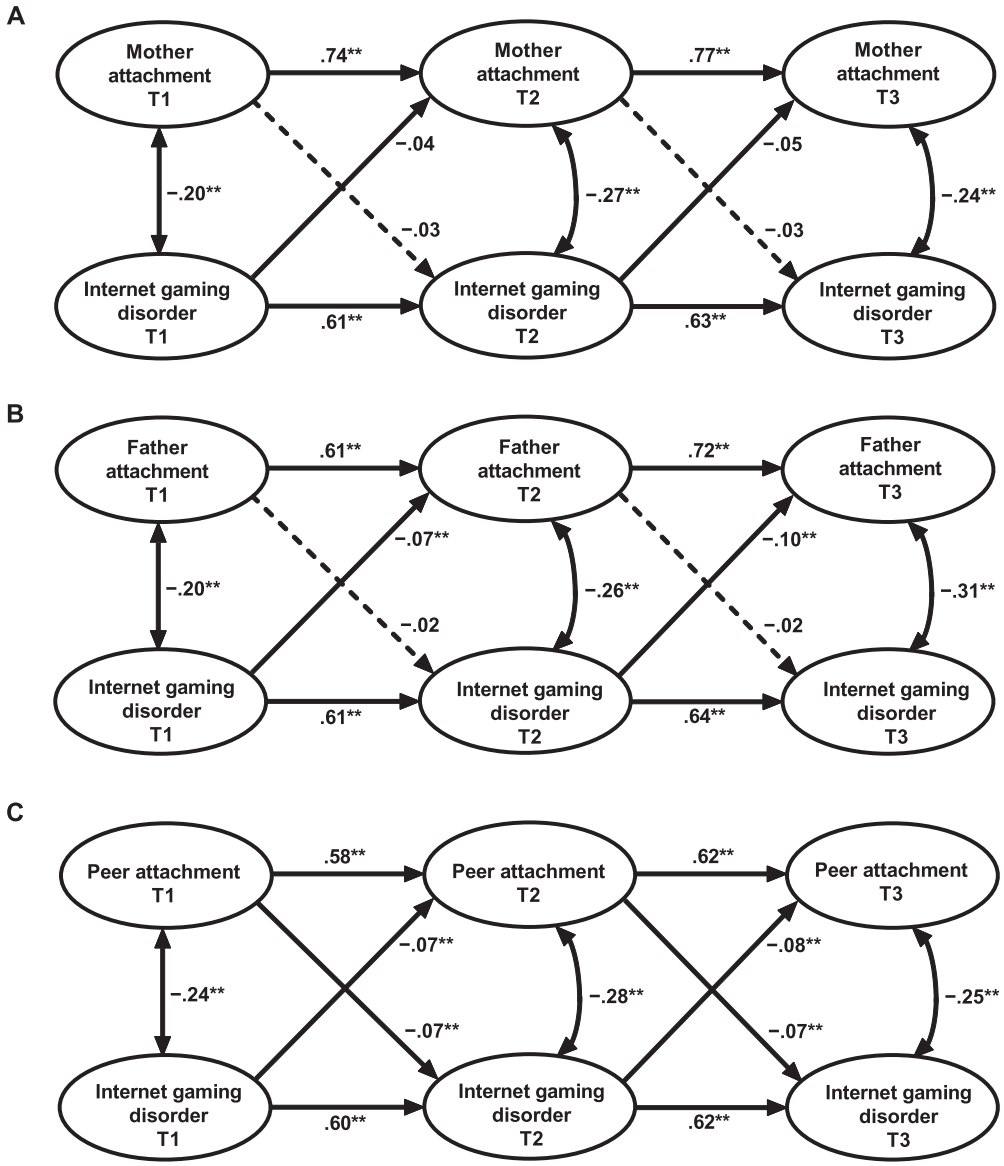

Figure 1. The cross-lagged panel model of attachment and IGD. A) Mother attachment and IGD; B) Father attachment and IGD; C) Peer attachment and IGD. *Note.* All covariates are not presented and can be seen in Table 3. All path coefficients were standardized. * $p < 0.05$, ** $p < 0.01$. Dashed lines are nonsignificant

were significantly missing ($\chi^2_{[1]} = 77.27$, $p < 0.01$), as were data relating to IGD ($t_{[389]} = 4.47$, $p < 0.01$) and peer attachment ($t_{[426]} = 2.59$, $p = 0.01$). All other variables (age, father attachment, and mother attachment) were non-significant in relation to missing data (all p-values > 0.05). Consequently, the full-information maximum-likelihood (FIML) method was used to deal with the missing data via Mplus 7.10 (Muthén & Muthén, 2012).

Cross-lagged panel model. Before conducting the cross-lagged panel model analyses, the measurement model was calculated based on stronger factor invariance. Family income and father's and mother's education levels were included as covariates in the final cross-lagged panel model. These models were also constrained within correlations, cross-lagged effects, and autoregressive coefficients over time (see Fig. 1). Although the model significance was calculated using the chi-squared statistic (χ^2), we did not rely upon it to assess model fit because it can easily reach significance due to larger effect size (Marsh, Hau, & Wen, 2004). Consequently, other standard fit indices were used, including the comparative fit index (CFI), Tucker-Lewis index (TLI), and the root mean square error of approximation (RMSEA). A CFI of >0.90, TLI of > 0.90, and RMSEA of < 0.08 indicate a good model fit (Hu & Bentler, 1999). In addition, 95% confidence intervals (CIs) were applied for the unstandardized coefficients. A 0.05 significance level was used for all path coefficients.

In order to examine gender differences, a series of multiple-group analyses were conducted, which constrained coefficients to be equal across gender. First, we computed a baseline model of χ^2, with no equality constraints between parameters of the two groups (unconstrained model).

Second, we computed a constrained model of χ^2, with equality constraints between two groups including stability and cross-lagged coefficients (constrained model). Third, we used a constrained model of χ^2 to subtract the unconstrained χ^2, which we can get by changing χ^2 (i.e., $\Delta\chi^2$) and changing *df* (i.e., Δdf); this χ^2 difference test is always used in multiple-group analyses of structural equation modeling (Muthén & Muthén, 2012). Fourth, we further used Wald χ^2 test to examine the specific path coefficient differences across gender (Muthén & Muthén, 2012).

Ethics

The study procedures were carried out in accordance with the Declaration of Helsinki. The Institutional Review Board of the Faculty of Psychology, Southwest University of China approved the study. All participants were informed about the study and provided informed consent.

RESULTS

Preliminary analyses

Participant information can be seen in Table 1. Means and standard deviations for all indicator variables are shown in Table 2. There were significantly larger mean scores for females than for males in mother, father, and peer attachment quality (all *p*-values < 0.01), apart from father attachment quality at T1 ($p = 0.608$). There were significantly larger IGD scores for males than for females across all three waves (all *p*-values < 0.01). Additionally, 56.5% (T1), 44.9% (T2), and 45.6% (T3) participants reported "never or rarely" experiencing IGD. 6.3% (66) participants in T1 reported "sometimes, or often, or very often" to at least 5 items. 9.8% (103) participants in T2 reported "sometimes, or often, or very often" to at least 5 items. 12.8% (135) participants in T3 reported "sometimes, or often, or very often" to at least 5 items.

Measurement model

Before conducting the cross-lagged panel model analyses, measurement models were calculated. We had good model fits for mother attachment and IGD model, χ^2 (543) = 1,426.30, $p < 0.001$, CFI = 0.94, TLI = 0.93, RMSEA = 0.039, 90% CI [0.037, 0.042], for father attachment and IGD model, χ^2 (543) = 1,389.87, $p < 0.001$, CFI = 0.94, TLI = 0.93, RMSEA = 0.038, 90% CI [0.036, 0.041], and for peer attachment and IGD model, χ^2 (543) = 1,468.06, $p < 0.001$, CFI = 0.93, TLI = 0.92, RMSEA = 0.040, 90% CI [0.038, 0.043]. The interrelationships between attachment and IGD are shown in Table 3. Across all three waves, mother attachment, father attachment, and peer attachment were negatively related to IGD (all *p*-values < 0.05).

Cross-lagged panel model

To increase the modeling identification in structural equation modeling (after measurement models analyses), the item parceling strategy (Bandalos, 2002; Matsunaga, 2008) was used to deal with the single-dimension IGD scale. That is, we combined the first three items for IGD1, the second three items for IGD2, and the last three items for IGD3. The cross-lagged panel models included the T1 covariates (e.g., family income, mother and father education levels) and cross-sectional correlations between attachment and IGD across the three assessment times. The results of final models are shown in Table 4.

The final model demonstrated a good fit for mother attachment, χ^2 (168) = 571.34, $p < 0.001$, CFI = 0.96, TLI = 0.95, RMSEA = 0.048, 90% *CIs* [0.043, 0.052]. Stability paths and cross-sectional correlations were also significant (all *p*-values < 0.01). IGD did not significantly predict mother attachment from T1 to T2 ($\beta = -0.04$, $p = 0.062$), or T2 to T3 ($\beta = -0.05$, $p = 0.059$), nor did mother attachment predict IGD from T1 to T2 ($\beta = -0.03$, $p = 0.223$) or T2 to T3 ($\beta = -0.03$, $p = 0.222$).

The final model showed good fit for father attachment, χ^2 (168) = 1,052.97, $p < 0.001$, CFI = 0.91, TLI = 0.88,

Table 2. Means and standard deviations of the model variables at T1, T2, and T3

Variable	Males						Females					
	T1		T2		T3		T1		T2		T3	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Trust mother	4.27	0.61	4.17	0.67	4.06	0.71	4.28	0.61	4.26	0.62	4.20	0.65
Communication mother	3.63	0.77	3.35	0.78	3.42	0.73	3.80	0.75	3.67	0.80	3.68	0.77
Alienation mother	4.40	0.43	4.19	0.66	4.04	0.81	4.45	0.44	4.30	0.59	4.26	0.66
Trust father	4.16	0.73	4.06	0.73	4.03	0.69	4.16	0.69	4.16	0.68	4.26	0.59
Communication father	3.56	0.81	3.27	0.82	3.23	0.75	3.58	0.84	3.44	0.89	3.48	0.72
Alienation father	4.35	0.48	4.11	0.73	3.60	0.75	4.38	0.51	4.21	0.67	3.78	0.65
Trust peer	4.03	0.68	3.82	0.66	3.73	0.72	4.27	0.60	4.14	0.64	4.07	0.64
Communication peer	3.57	0.77	3.44	0.75	3.45	0.74	3.97	0.69	3.86	0.70	3.82	0.69
Alienation peer	4.25	0.44	3.72	0.59	3.58	0.69	4.32	0.39	3.90	0.56	3.81	0.59
IGD1	1.67	0.66	1.94	0.78	2.09	0.91	1.23	0.41	1.40	0.56	1.39	0.58
IGD2	1.80	0.76	2.00	0.82	2.16	0.94	1.31	0.51	1.45	0.61	1.50	0.68
IGD3	1.80	0.75	1.95	0.78	2.07	0.91	1.29	0.47	1.42	0.58	1.43	0.59

Note. Alienation subscale had been converted scoring, IGD = internet gaming disorder.

Table 3. Correlations between model variables for the total sample

Variable	1	2	3	4	5	6	7	8	9	10	11
1. Attachment mother T1	—										
2. Attachment mother T2	0.65**	—									
3. Attachment mother T3	0.58**	0.66**	—								
4. Attachment father T1	0.69**	0.43**	0.38**	—							
5. Attachment father T2	0.47**	0.69**	0.47**	0.61**	—						
6. Attachment father T3	0.39**	0.47**	0.74**	0.44**	0.58**	—					
7. Attachment peer T1	0.42**	0.29**	0.29**	0.44**	0.29**	0.33**	—				
8. Attachment peer T2	0.31**	0.48**	0.38**	0.26**	0.45**	0.39**	0.54**	—			
9. Attachment peer T3	0.29**	0.36**	0.56**	0.24**	0.30**	0.63**	0.46**	0.57**	—		
10. IGD T1	−0.16**	−0.17**	−0.19**	−0.15**	−0.16**	−0.17**	−0.27**	−0.22**	−0.20**	—	
11. IGD T2	−0.09**	−0.24**	−0.19**	−0.08*	−0.22**	−0.17**	−0.19**	−0.33**	−0.23**	0.57**	—
12. IGD T3	−0.11**	−0.16**	−0.29**	−0.08*	−0.13**	−0.34**	−0.18**	−0.25**	−0.36**	0.49*	0.57**

Note. IGD = internet gaming disorder, T1 = Time 1, T2 = Time 2, T3 = Time 3.
*$p < 0.05$, **$p < 0.01$.

RMSEA = 0.071, 90% CIs [0.067, 0.075]. Stability paths and cross-sectional correlations were also significant (all p-values < 0.01). IGD negatively predicted father attachment quality from T1 to T2 ($\beta = -0.07$, $p < 0.001$), and T2 to T3 ($\beta = -0.10$, $p < 0.001$). However, father attachment quality did not significantly predict IGD from T1 to T2 ($\beta = -0.02$, $p = 0.311$) or T2 to T3 ($\beta = -0.02$, $p = 0.313$).

The final model showed good fit for peer attachment, χ^2 (168) = 909.10, $p < 0.001$, CFI = 0.92, TLI = 0.90, RMSEA = 0.065, 90% CIs [0.061, 0.069]. Stability paths and cross-sectional correlations were also significant (all p-values < 0.01). IGD negatively predicted peer attachment quality from T1 to T2 ($\beta = -0.07$, $p = 0.002$), and T2 to T3 ($\beta = -0.08$, $p = 0.001$). Peer attachment quality also significantly predicted IGD from T1 to T2 ($\beta = -0.07$, $p = 0.002$) and T2 to T3 ($\beta = -0.07$, $p = 0.003$).

Gender differences

No gender differences were found in the stability paths and cross-lagged effects for the mother attachment model ($\Delta\chi^2$ [8] = 14.64, $p = 0.067$). However, a significant gender difference was found for the father attachment model ($\Delta\chi^2$ [8] = 24.09, $p = 0.002$), with only one path of T2 father attachment on T3 IGD (Wald $\chi^2 = 6.09$, $p = 0.014$, $b_{males} = -0.21$, $p = 0.022$ vs. $b_{females} = 0.03$, $p = 0.364$), and peer attachment model ($\Delta\chi^2$ [8] = 20.37, $p = 0.009$). More specifically, two paths were significantly different across gender, (1) autoregressive coefficient of peer attachment at T1 to T2 (Wald $\chi^2 = 4.96$, $p = 0.025$, $\beta_{males} = 0.50$, vs. $\beta_{females} = 0.61$); and (2) cross-lagged effect of T2 peer attachment on T3 IGD (Wald $\chi^2 = 4.05$, $p = 0.044$, $\beta_{males} = -0.14$, $p = 0.010$, vs. $\beta_{females} = -0.03$, $p = 0.410$). Moreover, significant gender differences were found in cross-sectional correlations for the mother model ($\Delta\chi^2$ [3] = 12.21, $p = 0.006$), with the only correlation at T1 (Wald $\chi^2 = 9.21$, $p = 0.002$, $r_{males} = -0.27$, $p < 0.001$, vs. $r_{females} = -0.11$, $p = 0.028$), for the father model ($\Delta\chi^2$ [3] = 11.25, $p = 0.010$), with the only correlation at T1 (Wald $\chi^2 = 5.36$, $p = 0.021$, $r_{males} = -0.23$, $p < 0.001$, vs. $r_{females} = -0.14$, $p = 0.006$), and for the peer attachment model ($\Delta\chi^2$ [3] = 11.25, $p = 0.010$), with the only correlation at T1 (Wald $\chi^2 = 5.36$, $p = 0.020$, $r_{males} = -0.31$, $p < 0.001$, vs. $r_{females} = -0.11$, $p = 0.027$).

Combined cross-lagged panel model

For completeness, a final constraint model was run that included mother attachment, father attachment, peer attachment, and IGD into a single model. There was a good fit for this model, χ^2 (603) = 1,808.18, $p < 0.001$, CFI = 0.94, TLI = 0.93, RMSEA = 0.044, 90% CI [0.041, 0.046]. This cross-lagged model significantly predicted IGD on subsequent mother attachment ($b = -0.06$, 95% CI [−0.10, −0.03]), father attachment ($b = -0.07$, 95% CI [−0.11, −0.04]), and peer attachment ($b = -0.11$, 95% CI [−0.15, −0.07]). IGD was not predicted by early mother attachment ($b = 0.03$, 95% CI [−0.03, 0.09]) and father attachment ($b = -0.01$, 95% CI [−0.06, 0.05]); however,

Table 4. Cross-lagged path analyses of perceived attachment relationship quality with mothers, fathers, peers, and IGD

Attachment	Mother model		Father model		Peer model	
	b (95% CI)	*β*	*b* (95% CI)	*β*	*b* (95% CI)	*β*
Covariates						
Father education → Attachment quality T2	0.02 (−0.01, 0.05)	0.04	−0.01 (−0.04, 0.03)	−0.01	−0.01 (−0.05, 0.03)	−0.01
Mother education → Attachment quality T2	−0.01 (−0.05, 0.02)	−0.03	−0.01 (−0.05, 0.03)	−0.02	0.01 (−0.03, 0.05)	0.01
Family economic incomes → Attachment quality T2	−0.04 (−0.06, −0.02)	−0.09**	−0.02 (−0.04, 0.01)	−0.04	−0.05 (−0.08, −0.03)	−0.10**
Father education → IGD T2	0.00 (−0.03, 0.03)	0.00	−0.04 (−0.08, −0.01)	0.01	−0.01 (−0.04, 0.03)	−0.01
Mother education → IGD T2	0.01 (−0.02, 0.05)	0.02	0.00 (−0.04, 0.04)	0.02	0.01 (−0.02, 0.05)	0.02
Family economic incomes → IGD T2	0.04 (0.01, 0.06)	0.07*	−0.06 (−0.08, −0.03)	0.07*	0.04 (0.01, 0.06)	0.07*
Father education → Attachment quality T3	−0.03 (−0.07, 0.01)	−0.06	−0.03 (−0.06, 0.01)	−0.05	−0.02 (−0.06, 0.02)	−0.03
Mother education → Attachment quality T3	0.02 (−0.02, 0.05)	0.03	0.02 (−0.02, 0.05)	0.03	−0.01 (−0.05, 0.03)	−0.02
Family economic incomes → Attachment quality T3	−0.01 (−0.02, 0.02)	−0.01	−0.01 (−0.03, 0.02)	−0.02	−0.01 (−0.04, 0.02)	−0.01
Father education → IGD T3	−0.01 (−0.04, 0.04)	−0.01	-0.01 (−0.04, 0.04)	-0.01	−0.01 (−0.04, 0.04)	−0.01
Mother education → IGD T3	0.01 (−0.03, 0.05)	0.02	0.01 (−0.03, 0.05)	0.02	0.02 (−0.02, 0.06)	0.02
Family economic incomes → IGD T3	0.02 (−0.01, 0.05)	0.04	0.02 (−0.01, 0.05)	0.04	0.02 (−0.01, 0.05)	0.03
Stability paths						
IGD T1→T2	0.75 (0.69, 0.81)	0.61**	0.75 (0.69, 0.81)	0.61**	0.73 (0.67, 0.79)	0.60**
IGD T2→T3	0.75 (0.69 0.81)	0.63**	0.75 (0.69 0.81)	0.64**	0.73 (0.67, 0.79)	0.62**
Attachment quality T1→T2	0.84 (0.79, 0.88)	0.74**	0.64 (0.59, 0.68)	0.61**	0.64 (0.60, 0.69)	0.58**
Attachment quality T2→T3	0.84 (0.79, 0.88)	0.77**	0.64 (0.59, 0.68)	0.72**	0.64 (0.60 0.69)	0.62**
Cross-sectional correlations						
IGD ↔ T1 Attachment quality T1	−0.05 (−0.06, −0.04)	−0.20**	−0.06 (−0.07, −0.05)	−0.20**	−0.07 (−0.09, −0.06)	−0.24**
IGD ↔ T2 Attachment quality T2	−0.05 (−0.06, −0.04)	−0.27**	−0.06 (−0.07, −0.05)	−0.26**	−0.07 (−0.09, −0.06)	−0.28**
IGD ↔ T3 Attachment quality T3	−0.05 (−0.06, −0.04)	−0.24**	−0.06 (−0.07, −0.05)	−0.31**	−0.07 (−0.09, −0.06)	−0.25**
Cross-lagged effects						
IGD T1→Attachment quality T2	−0.04 (−0.08, −0.01)	−0.04	−0.08 (−0.11, −0.04)	−0.07**	−0.09 (−0.13, −0.04)	−0.07**
IGD T2→Attachment quality T3	−0.04 (−0.08, −0.01)	−0.05	−0.08 (−0.11, −0.04)	−0.10**	−0.09 (−0.13, −0.04)	−0.08**
Attachment quality T1→IGD T2	−0.04 (−0.08, 0.01)	−0.03	−0.03 (−0.07, 0.02)	−0.02	−0.08 (−0.12, −0.04)	−0.07**
Attachment quality T2→IGD T3	−0.04 (−0.08, 0.01)	−0.03	−0.03 (−0.07, 0.02)	−0.02	−0.08 (−0.12, −0.04)	−0.07**

Note. IGD = internet gaming disorder, T1 = time 1, T2 = time 2, T3 = time 3.
*$p < 0.05$, **$p < 0.01$.

IGD was weakly predicted by early peer attachment ($b = -0.06$, 95% CI [−0.10, −0.01]).

DISCUSSION

The present study provides novel insights concerning the longitudinal associations between attachment quality and IGD among a sample of Chinese participants in late adolescence. Results suggested that there were stable and significant cross-sectional relationships between parental and peer attachment quality and IGD. However, the cross-lagged effects suggested that IGD negatively predicted subsequent attachment with father and peers, and peer attachment predicted subsequent IGD, but father attachment did not predict subsequent IGD. IGD also weakly predicted subsequent mother attachment, but there was no significant effect of mother attachment in predicting IGD. Moreover, gender differences in the cross-sectional relationships between IGD and attachment at T1 showed males having larger cross-sectional correlations than females in both parental and peer attachment models.

Consistent with previous research (Estevez et al., 2019, 2017; Reiner et al., 2017; Schneider et al., 2017; Wang et al., 2015), our findings indicated stable cross-sectional relationships between attachment quality and IGD. These robust relationships suggested that adolescents with higher levels of attachment to parents and friends reported lower levels of IGD, which was also consistent with attachment theory (Bowlby, 1982), stronger or secure attachment being associated with fewer behavioral problems.

Nevertheless, our findings suggested that no effect of parental attachment predicts subsequent IGD. This result was in line with previous longitudinal studies focused on parental attachment predicting alcohol use (Van der Vorst et al., 2006) and substance disorder (Overbeek, Vollebergh, Meeus, de Graaf, & Engels, 2004). Both their results and ours show the same directionality; parental attachment cannot predict subsequent behavioral problems. However, we found peer attachment negatively predicted subsequent IGD, which indicates that peer attachment plays an important role in preventing addictive gaming behaviors for university students, perhaps because university students' classmates and friends become their main relationships after they leave home. Compared with parental attachment, peer attachment has larger negative association with adolescent internet addiction (e.g., Yang et al., 2016). However, it should be noted that parental attachments are not unimportant in the development of university students' IGD, even though there was no effect of parental attachments on IGD in our sample of Chinese first-year university students. According to attachment theory (Bowlby, 1982), parental attachment may play a protective role in preventing mental health problems in childhood, adolescence, and adulthood. Further study should examine the effect of attachment in other samples of adolescents and compare various behavioral outcomes associated with parental attachment.

Interestingly, our findings suggested that IGD might predict subsequent father attachment and peer attachment and weakly predict mother attachment. The direction of this prediction was consistent with results of other longitudinal studies (Buist et al., 2004; Van der Vorst et al., 2006; van Eijck et al., 2012) showing that behavioral problems can predict parental attachments. Adolescents with IGD tend to reduce their interpersonal interaction with parents and friends over time, because they are always focused on game activity and have unrealistic perceptions about their relationships (Allison et al., 2006). IGD might negatively predict supportive parental-child relationships (particularly father-child relationships; Su et al., 2018), the foundation for generating secure attachments (Thompson, 2016). However, IGD weakly predicted mother attachment quality, perhaps because (compared with fathers) mothers are more often the main caregivers for their children in early daily life (Shek, 2002) and focus emotional and affective care on their children, irrespective of problem behaviors (Fosco, Stormshak, Dishion, & Winter, 2012). It is also likely that in a Chinese cultural context, when children have excessive exposure to games, their mothers accept their behavior, indulging and perhaps even spoiling their children (Chen, Sun, & Yu, 2017). In any case, adolescents with IGD still perceived a higher attachment to mothers than to father or friends, and this dynamic merits future research.

In addition, our study found that, compared to females, males had stronger negative links between IGD and attachments with mothers, fathers, and peers at T1. This gender difference was in line with previous research (Ko, Yen, Chen, Chen, & Yen, 2005) showing that males have significantly stronger negative associations between psychosocial factors (like self-esteem and life satisfaction) and gaming addiction than females. Evidence also suggested that significant associations between peer attachment and excessive gaming were only found in boys, not girls (Reiner et al., 2017).

Strengths and limitations

To the best of our knowledge, this is the first study to use the IGD-SF9 to assess game addiction behaviors in Chinese first-year undergraduate students. Most previous studies used cross-sectional designs; ours is the first such longitudinal study conducted among Chinese first-year undergraduate students. It is also the first to compare three kinds of security attachment quality (mother, father, and peer) with IGD over time. Moreover, we used the cross-lagged panel model to examine whether attachment is the cause or effect of IGD in late adolescence.

Our study has several limitations. First, as in many longitudinal studies, only self-reported data were used, which could have been affected by any shared-method variance as well as biases (such as social desirability and memory recall). However, the cross-lagged panel models partly controlled for such effects by controlling for initial correlations and correlated change. Future research should consider combining various methods of data collection, such

as ratings by teachers or parents or evaluation by experts. Second, only between-personal variance of attachments and IGD was used in the cross-lagged model. As noted by Hamaker, Kuiper, and Grasman (2015), cross-lagged models may not necessarily represent actual within-person relationships over time. Therefore, further studies should use multilevel models to separate the between-person and within-person effects (Curran & Bauer, 2011). Third, only a 12-month longitudinal design was used to explore the effects of perceptions of attachment, which might be too short a time to explore the effect of attachments fully. Therefore, future studies should include a longer period of time for studying the patterns of transmission from early adolescence to late adolescence. This would help clarify both the change in perceptions of attachments and their effect on IGD. Finally, only the direct effect between attachments and IGD were examined. As suggested by previous research, peer attachment may be a mediator between parental attachments and addictions (Yang et al., 2016). In future research, individual and external mediators (e.g., self-control, school connections) should also be examined within models or measures, either as potential contributors to attachment development or as moderators to prevent IGD.

CONCLUSIONS

In light of the DSM-5 including IGD as a tentative behavioral addiction, the finding of this study revealed that only peer attachment significantly predicted subsequent IGD. However, IGD negatively predicted subsequent attachment quality, and the effects were greater for peers and fathers than for mothers. These different prediction models suggested, although with limitations, that the longitudinal bidirectional association was not supported for parental attachment and IGD and was only found in peer attachment and IGD. However, a stable cross-sectional association between IGD and attachment was supported, with male students showing stronger links than female students at T1. Given the close cross-sectional relationships between parental attachments and IGD and the accompanying gender differences, such relationships should be explored in family therapy with disordered gamers (Bonnaire et al., 2019).

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