Computers in Human Behavior 60 (2016) 342–350

Contents lists available at ScienceDirect

Computers in Human Behavior

journal homepage: www.elsevier.com/locate/comphumbeh

Full length article

Temperament and adolescent problematic Internet use: The mediating role of deviant peer affiliation☆

Xian Li [a], Joan Newman [a], Dongping Li [b,*], Haiyan Zhang [c]

[a] Department of Educational and Counseling Psychology, University at Albany, SUNY, Albany, NY 12222, USA
[b] School of Psychology, Central China Normal University, Wuhan, Hubei 430079, China
[c] Department of Psychology, Siena College, Albany, NY 12211, USA

ARTICLE INFO

Article history:
Received 18 March 2015
Received in revised form
15 February 2016
Accepted 18 February 2016
Available online xxx

Keywords:
Temperament
Problematic Internet use
Deviant peer affiliation

ABSTRACT

Problematic Internet use (PIU) creates psychological, social, school and/or work difficulties in a person's life. This study examined the unique roles of four dimensions of temperament (effortful control, sensation seeking, anger/frustration, and shyness) on adolescent PIU, as well as the mediating role of deviant peer affiliation (DPA) on these pathways. Participants were 2758 Chinese adolescents (46% male; mean age = 13.53 years, *SD* = 1.06) selected by stratified and random cluster sampling from 10 middle schools in southern China. After covariates were controlled, structural equation modeling (SEM) demonstrated that effortful control negatively predicted PIU, while sensation seeking, anger/frustration and shyness positively predicted PIU. SEM also identified that DPA partially mediated the pathway from all four temperament dimensions to PIU. These findings provide evidence for the relationship between specific temperament dimensions and adolescent PIU, and highlight DPA as one explanation for the prevalence of PIU.

Problematic Internet use (PIU) refers to excessive internet usage which causes negative consequences such as psychological, social, occupational and/or academic difficulties (Beard & Wolf, 2001; Block, 2008). Research on PIU continues to document severe effects of Internet use, such as anxiety/depression, academic failure and social isolation (Gentile et al., 2011; Kim & Davis, 2009; Ko, Yen, Yen, Chen, & Chen, 2012). PIU may even alter an individual's brain structure and jeopardize the ability to evaluate risk, as suggested by preliminary neuroimaging analyses (Ko et al., 2014; Lin, Dong, Wang, & Du, 2015; Lin, Zhou, Dong, & Du, 2015; Zhou et al., 2011).

Adolescents are at high risk for PIU, given their immature self-control skills (Giedd, 2008; Steinberg et al., 2008) and availability of free time (Jiang, Hardy, Ding, Baur, & Shi, 2014). Indeed, adolescent PIU has been recognized worldwide, and has become a serious public health concern in some Asian countries like China, Singapore and South Korea (Minjikian, 2012). In China, legislation was enacted in 2005 to restrict adolescent access to Internet cafes as a means of mitigating the increasing prevalence of PIU. Given the fact that the Internet is almost unavoidable nowadays, understanding the etiology of PIU will be of great public health significance. Increasing interest in PIU prevention and intervention programs has required attention to the multiple factors influencing adolescent PIU, such as intrapersonal attributes like temperament and interpersonal variables like peer influence.

1. Temperament and PIU

Although there are a number of studies that explore the links between temperament, character and PIU (Cho, Kim, Kim, Lee, & Kim, 2008; Dalbudak et al., 2013; Ha et al., 2007; Kim, Lee, Han, Suh, & Kee, 2006; Lee et al., 2008; Lee & Jung, 2012; Li, Zhang, Li, Zhen, & Wang, 2010), there are few studies that investigate the roles of specific dimensions of temperament. Temperament is defined as biologically-based individual differences in reactivity and self-regulation (Rothbart & Bates, 2006). Recent literature has identified temperament as a diathesis for the development of problem behaviors such as depression, delinquency, substance abuse, and gambling (DePauw & Mervizelde, 2010; Nigg, 2006; Rothbart & Bates, 2006). Given the maladaptive nature of PIU, temperament is likely to have a role in the etiology of PIU.

Despite the conceptual links, empirical studies of the

☆ The authors would like to thank Dr. Tse-Chuan Yang at the University at Albany-SUNY for his helpful comments and corrections.

* Corresponding author.
E-mail address: lidongping83@126.com (D. Li).

http://dx.doi.org/10.1016/j.chb.2016.02.075
0747-5632/

relationship between particular components of temperament and PIU are scarce. In the few studies that have been located, either only a single temperament dimension was investigated (Shi, Chen, & Tian, 2011; Velezmoro, Lacefield, & Roberti, 2010), or an imprecise measurement tool (the Temperament and Character Inventory or TCI) was utilized (Cho et al., 2008; Dalbudak et al., 2013; Ha et al., 2007; Kim et al., 2006; Lee et al., 2008; Lee & Jung, 2012). The impact of a range of temperament dimensions on PIU has yet to be examined in detail, ideally with a more accurate instrument.

Although there are disagreements about how temperament should be conceptualized, the temperament model developed by Rothbart and Bates (2006) is a representative and well-established one. It has been found to be particularly appropriate for Asian adolescents (Xu, Farver, Yu, & Zhang, 2009; Zhou, Main, & Wang, 2010). In recent studies (e.g., Ko, Yen, Yen, Chen, & Wang, 2008; Li et al., 2010; Odacı & Çelik, 2013), several specific dimensions of temperament, such as effortful control, sensation seeking, anger/frustration, and shyness, have been found to be associated with the occurrence of PIU.

The first dimension of temperament in the model —effortful control—is known as a core aspect of self-regulation. Rothbart and Bates (2006) defined it as "an individual's ability to regulate attention in response to situational needs". Previous research has established its beneficial role in fostering children's desirable behaviors and inhibiting children's maladaptive behaviors (see review by Eisenberg, Hofer, & Vaughan, 2007). There is also some recent research evidence suggesting that effortful control correlates negatively with problem behaviors such as game addiction (Kim, Namkoong, Ku, & Kim, 2008) and PIU (LaRose & Eastin, 2004; LaRose, Lin, & Eastin, 2003; Li, Li, & Newman, 2013).

Sensation seeking, which is a common characteristic of adolescents (Cauffman et al., 2010; Steinberg et al., 2008), is the second dimension of temperament that has been associated with PIU. Individuals high in sensation seeking tend to seek out novel and highly stimulating experiences, and are willing to take associated risks. Sensation seeking has been identified as a partial determinant of high-risk and anti-social behaviors (Zuckerman, 2007). The Internet, due to its easy accessibility, provides adolescents many opportunities and resources for sensation and excitement seeking (e.g., sexual videos, violent games, online dating and social networking sites). There is some recent evidence suggesting that sensation seeking has a positive relationship with PIU. For example, a study of Taiwanese high school students identified a significant association between excessive Internet use and high sensation seeking tendency (Lin & Tsai, 2002). Similarly, two studies of Taiwanese high school adolescents, one a large-scale cross-sectional study, the other a one-year longitudinal study, identified high sensation seeking as a powerful predictor of Internet addiction (Ko et al., 2006; Ko, Yen, Yen, Lin, & Yang, 2007). Finally, a meta-analytical study aggregated results from 37 independent studies conducted in China, Taiwan, United States, and Iran to evaluate the relationship between sensation seeking and PIU (Wang, Chen, Yang, & Gao, 2013). A moderate and positive relationship was identified between the two variables.

Anger/frustration is the third dimension of temperament that has been associated with PIU. Rothbart and Bates (2006) defined this as "an individual's tendency to experience negative affect when interrupted on an on-going task or blocked from attaining specific goals." Recent research has found that anger/frustration and similar traits of hostility are positively associated with PIU in East Asian adolescent samples. For instance, Ko et al. (2008) found that adolescents, especially boys, who were prone to frustration, were more likely to develop Internet addiction. Similarly, Yen et al. (2008) found that junior and senior high school adolescents who scored high on hostility were more likely to develop Internet addiction. These results were significant even after controlling for other maladaptive symptoms.

Shyness is the fourth dimension of temperament that has been associated with PIU. Shyness has been defined as "an individual's discomfort and inhibition of normally expected social behavior when being with strangers" (Cheek & Buss, 1981). Shy people tend to be apprehensive and anxious about being evaluated or rejected in face-to-face social encounters. As the Internet offers an alternative way to satisfy unmet social and emotional needs through its secure virtual environment, online communication might be particularly appealing for shy adolescents. Past research investigating the relationship between shyness and Internet use has yielded inconsistent results (for a review, see Saunders & Chester, 2008). For example, some researchers found PIU to be positively associated with increased shyness (Caplan, 2002; Chak & Leung, 2004; Odacı & Çelik, 2013), whereas other researchers found few or no differences between shy and non-shy people in PIU (Henderson, Zimbardo, & Graham, 2002; Mandell & Muncer, 2006).

Most of the existing studies of temperament and PIU include only a limited number of temperament dimensions (Lee & Jung, 2012; Shi et al., 2011; Velezmoro et al., 2010). Moreover, efforts to map out the differential contributions of the temperament dimensions to PIU have been hindered by lack of consistency in the construct of temperament employed. Therefore, previous research has not clarified which specific aspects of temperament are relevant for adolescents' susceptibility to PIU. One important goal of the current study is to identify the effects of specific temperament dimensions on PIU in adolescence, a developmental period during which peer influence is particularly prevalent (Steinberg & Monahan, 2007).

2. Deviant peer affiliation as a mediator

The main way temperament contributes to behavior problems is through its indirect influence on the individual's interaction with the social environment (Bates, Bayles, Bennett, Ridge, & Brown, 1991; Keenan & Shaw, 1997). Peers comprise an important component of this social environment. Social learning is one of the proposed mechanisms used to explain the association between peer influence and an individual's PIU; adolescents may acquire from peers certain norms and behaviors that are favorable to PIU (Li et al., 2013; Li et al., 2013; Zhang, Chen, Liu, Deng, & Fang, 2012). Also, peers might make Internet resources more readily available to their peers, and make Internet interactions (such as online gaming, chatting) more socially rewarding and stimulating. In these ways, peers increase the likelihood of addiction.

It is well documented that affiliating with deviant peers will increase the chance of aggressive behaviors, delinquency, and substance use (Monahan, Steinberg, & Cauffman, 2009; Mrug, Hoza, & Bukowski, 2004). Various studies have also confirmed the significant risk posed by deviant peer affiliation (DPA) in shaping adolescent PIU (Wang et al., 2011; Yang, Cheng, Wang, & Wang, 2008; Yen, Ko, Yen, Chang, & Cheng, 2009). However, an individual's tendency towards peer affiliation is largely driven by personal characteristics such as temperament. For example, Wills, Sandy, and Yaeger (2000) found that some temperaments (e.g., negative emotionality and low self-control) contribute to more substance use behaviors through increased affiliation with peer substance users.

For the joint role of temperament and peer influence on the development of problematic behaviors, DPA may serve as one pathway linking specific aspects of temperament with a behavioral outcome. Indeed, a number of investigations have demonstrated that DPA mediates the link between temperament and adolescent substance abuse (Creemers et al., 2010; Giancola & Parker, 2001;

Wills & Cleary, 1999), therefore it is reasonable to speculate that DPA may have a substantial role in mediating the relationship between temperament and PIU. The second goal of the current study is to determine this mediating link.

3. The present study

In essence, this paper focuses on both individual and environmental characteristics related to adolescent behaviors, and the process by which these factors are associated with PIU. In particular, it investigates whether temperamental factors predict DPA, which in turn predict adolescent PIU (see Fig. 1).

There is considerable evidence suggesting that effortful control may reduce adolescent antisocial behavior (Kim et al., 2008; LaRose et al., 2003), hence we hypothesize that effortful control will be negatively associated with PIU (path 1) and DPA (path 2); in addition, effortful control will reduce the likelihood of adolescent PIU through its influence in decreasing DPA (**Hypothesis 1**).

Abundant empirical studies have demonstrated that sensation seeking is a risk factor for adolescent delinquency and behavioral problems (Lin & Tsai, 2002; Wang et al., 2013; Zuckerman, 2007), so we hypothesize that sensation seeking will be positively associated with PIU (path 3) and DPA (path 4); also, sensation seeking will increase the tendency to PIU by increasing DPA (**Hypothesis 2**).

With regard to anger/frustration, we hypothesize that anger/frustration will be positively associated with PIU (path 5) and DPA (path 6); also, anger/frustration will increase the tendency to PIU by increasing DPA (**Hypothesis 3**).

Although previous literature has yielded inconsistent results regarding the role of shyness in PIU (Caplan, 2002; Chak & Leung, 2004; Roberts, Smith, & Pollock, 2000), based on the rationale that shy people tend to be apprehensive and less comfortable about in-person interaction, we hypothesize that shyness will be positively associated with PIU (path 7) but negatively related to DPA (path 8, **Hypothesis 4**). Because of the opposite direction of these two relationships, we are unable to hypothesize the indirect effect of shyness on PIU.

Our final hypothesis concerns the relationship between DPA and PIU. Based on the literature above, we expect that DPA will increase the likelihood of PIU (path 9, **Hypothesis 5**).

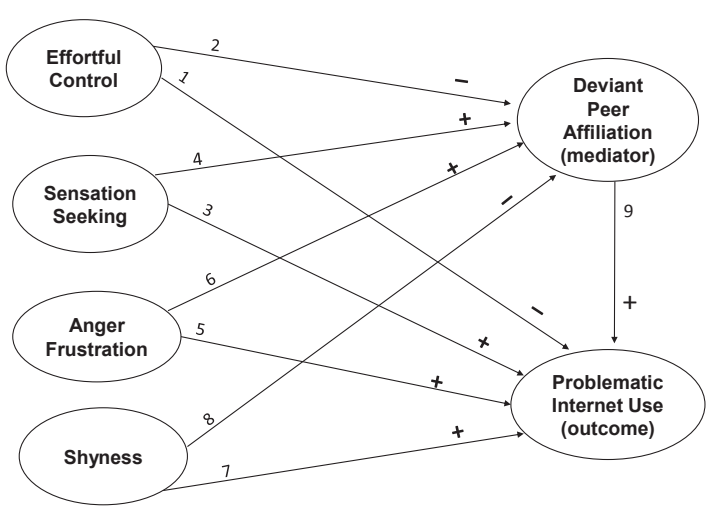
4. Method

4.1. Participants

After IRB approval was obtained, participants were recruited from 10 middle schools in southern China through stratified and random cluster sampling. The sample was first stratified by region (urban versus rural areas), then stratified by school type (academically selective schools versus regular schools). Selective schools usually have better teachers, facilities and resources, and thus attract more capable students. Both types of school were selected to achieve wide variation in student characteristics. A total of 2758 adolescents participated in this study. Forty-six percent of the participants were males. Information provided by the participants showed that 60% of their fathers and 69% of their mothers had less than a high school education; 35% of their fathers and 58% of their mothers had an unskilled or semi-skilled occupation. These statistics were comparable with the 2010 Chinese Census data, suggesting that our sample was representative of Chinese adolescents. The mean age of the participants was 13.53 years ($SD = 1.06$, range = 10–19 years). Research has shown that adolescents of this age have a moderately high tendency to engage in PIU (Dong & Lin, 2011).

4.2. Measures

All the instruments in the current study were validated for reliability and validity previously and in the present Chinese adolescent sample as described below. Because all the measures were derived from adolescents' self reports, Harman's one-factor test (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003) was used to test for common method variance. Common method variance is assumed to exist if (1) a single factor emerges from unrotated factor solutions, or (2) the first factor explains more than 40% of the variance in the variables (Podsakoff & Organ, 1986). Following this procedure, exploratory factor analysis (principle components factor analysis with no rotation) resulted in 10 factors with eigenvalues greater than 1 and the first factor accounting for only 22.06% of total variance, which indicates that common method variance was not of great concern in the current study.



Note: number refers to the path number; positive association = "+" ; negative association = "−".

Fig. 1. The Hypothesized Model. Note: number refers to the path number; positive association = "+"; negative association = "−".

4.2.1. Temperament

Adolescents responded to four specific scales of temperament. Items were rated on a 6-point scale (1 = *almost always untrue* to 6 = *almost always true*) with higher scores representing higher levels of each variable. 1) Effortful control was measured by a 16-item scale adapted from those of established Chinese and western researchers (Ellis & Rothbart, 2001; Li et al., 2010). These items pertained to activational control, attention, and inhibitory control (e.g., " I can stick with my plans and goals"). In the current study, alpha was .83 for these items. 2) Sensation seeking was measured by 6 items of a scale developed by Steinberg et al. (2008) and later revised by Li et al. (2010) (e.g., "I like doing things just for the thrill of it"). Alpha was .83 for these items in the current study. 3) Anger/frustration was measured with an 8-item scale developed by Li, Zhang, Li, Wang, and Zhen (2012) (e.g., "I get irritated when I have to stop doing something that I am enjoying"). Alpha was .75 for these items in the current study. 4) Shyness was measured with 5 items developed by Li (2012) (e.g., "I feel nervous and shy about meeting new people"). Alpha was .82 for these items in the current study.

4.2.2. DPA

Adolescent deviant peer affiliation was assessed with 8 items adapted from prior published questionnaires (Fergusson & Horwood, 1999; Kendler et al., 2007). Adolescents indicated how many of their friends had shown each of eight deviant behaviors (tobacco and alcohol abuse, cheating on school tests, stealing or shoplifting, damaging property, Internet addiction, skipping or cutting school, physical and verbal aggression) during the prior year, e.g., "How many of your friends got drunk in the last year?" Responses were rated on a 5-point scale (1 = *none* to 5 = *almost all*), with higher scores representing greater DPA. Previous research on PIU often used only one item to measure peer deviance (Wang et al., 2011; Yang et al., 2008), whereas this study used multiple items. Validity is enhanced because one single item cannot adequately capture the full meaning of the construct of interest (Evans, Li, & Whipple, 2013). In this study, we performed an exploratory factor analysis on all items and extracted only one factor with eigenvalues greater than 1. The factor accounted for 48.55% of the variance, with factor loadings of items ranging from .57 to .81. This measure demonstrated good reliability in a previous study (Song et al., 2014) and the current study ($\alpha = .83$).

4.2.3. PIU

Adolescent PIU was assessed with 10 items from Young's (1996) groundbreaking and widely used diagnostic questionnaire for screening of Internet dependency. Adolescents indicated how true each item was for them (e.g., "Do you use the Internet as a way of escaping from problems or of relieving an unhappy mood?") on a 6-point scale (1 = *not at all true* to 6 = *always true*). Responses were averaged, with higher scores representing greater PIU. This scale has demonstrated good reliability and validity in Chinese samples (Li et al., 2010, 2013; Li et al., 2013) and similar items have been used in the National Children's Study of China project (Dong & Lin, 2011). Good reliability ($\alpha = .92$) was obtained in the current study.

4.2.4. Control variables

Previous research has indicated that demographic variables such as gender, age, family SES, family functioning, school type, and neighborhood safety are correlated with adolescents' PIU (Dong & Lin, 2011; Li et al., 2013; Li et al., 2013). To clarify the distinct effect of temperament, the current study controlled these covariates.

Family socioeconomic status was expressed as a single factor derived from principal component analysis of multiple indicators (parental education, family financial status, and parental occupation status), with higher scores representing higher socioeconomic status.

Family functioning was measured with 6 items from Yang et al.'s (2013) family function questionnaire. A representative item was "We trust each other". Participants indicated how true each item was of their families (1 = *not at all true*; 4 = *very true*). The mean was calculated, with higher scores indicating better family functioning. A confirmatory factor analysis was performed to assess the single factor model, and the model adequately fit the data (RMSEA = .02, NNFI = 1.00, CFI = 1.00, SRMR = .01). The Cronbach's α coefficient was .82 for the present sample.

Neighborhood safety was measured with 7 items from Yang et al.'s (2013) neighborhood safety survey. Participants indicated the safety issues of their residential community, for example, assault, robbery, drug abuse, gambling, etc. A representative item was "How often does stealing happen in your neighborhood?" (1 = *never*; 4 = *always*). The mean was calculated, with higher scores indicating poorer neighborhood safety. The Cronbach's α coefficient was .78 for the present sample. Exploratory factor analysis was performed and revealed that only one factor could be exacted from the scale, the variance contribution rate was 45.26%, and each item's factor loading ranged from .59 to .74.

4.3. Data analytic approach

In the current study, less than 2% of the data were missing and were handled with mean imputation (Little & Rubin, 2002). To test the mediation effect, we followed a procedure suggested by MacKinnon (2008), which requires the following three conditions: (a) a significant association between each of the four temperament dimensions and DPA; (b) a significant association between DPA and PIU while controlling for adolescent temperament; and (c) a significant coefficient for the indirect path between adolescent temperament and PIU via DPA. We used bias-corrected bootstrap 95% confidence intervals (CIs) to determine whether the last condition was satisfied. The bootstrapping method reduces the size of standard error and yields stronger confirmation of the predicted mediation relationship, therefore, researchers have recommended bootstrapping as the way to estimate the indirect effect (MacKinnon, Lockwood, & Williams, 2004; Preacher & Hayes, 2008).

To examine the proposed relationships among the four temperament dimensions, DPA and PIU comprehensively, we conducted structural equation modeling (SEM) (Arbuckle, 2006) using LISREL 8.72 (Joreskog & Sorbom, 2005) for data analysis. SEM techniques were chosen for their ability to model variable relationships using maximum likelihood functions, which are considered particularly suitable when analyzing large cross-sectional data (Kline, 2015; Ullman, 2007).

Model fit was assessed using Chi-square (χ^2), the comparative fit index (CFI), the standardized root mean squared residual (SRMR), and the root mean square error of approximation (RMSEA). A non-significant Chi-square χ^2 ($p > .05$), value of .95 or greater for CFI, and values less than or equal to .08 and .06 for SRMR and RMSEA, respectively, have been deemed cutoffs of a relatively good fit between a hypothesized model and observed data (Hu & Bentler, 1999).

5. Results

5.1. Preliminary analyses

Table 1 contains univariate statistics and bivariate correlations for all study variables. Overall, DPA was positively associated with PIU ($r = .32$, $p < .001$), indicating that DPA may be a significant risk

Table 1
Univariate and bivariate statistics for all variables.

Variables	1	2	3	4	5	6	7	8	9	10	11	12
1. Gender	–											
2. Age	.00	–										
3. Socioeconomic status	.05*	−.19***	–									
4. Family functioning	−.04	−.11***	.24***	–								
5. School type	.02	.04*	−.32***	−.11***	–							
6. Neighborhood safety	−.01	.09***	−.23***	−.22***	.04*	–						
7. Effortful control	−.08**	−.20***	.14***	.37***	−.03	−.21***	–					
8. Sensation seeking	.06**	.08***	.02	−.08***	−.04	.15***	−.31***	–				
9. Anger/frustration	−.04*	.06**	.02	−.18***	−.07***	.19***	−.46***	.36***	–			
10. Shyness	−.14***	.04*	−.18***	−.13***	.08***	.07***	−.21***	−.09***	.20***	–		
11. Deviant peer affiliation	.19***	.17***	−.20***	−.22***	.18***	.32***	−.33***	.21***	.19***	.03	–	
12. PIU	.28***	.04*	−.02	−.25***	.02	.16***	−.49***	.27***	.36***	.15***	.32***	–
M	.46	13.53	.00	3.04	.58	1.33	4.14	2.98	3.57	3.17	1.55	2.47
SD	.50	1.06	1.00	.54	.49	.37	.77	1.25	.92	1.22	.54	1.02

Note. $N = 2758$. Gender was dummy coded such that 0 = *male* and 1 = *female*. School type was dummy coded such that 0 = *selective school* and 1 = *regular school*. PIU = problematic Internet use.
$^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$.

factor for PIU. Specifically, effortful control was negatively associated with PIU ($r = -.49$, $p < .001$) and DPA ($r = -.33$, $p < .001$), suggesting that effortful control was beneficial in reducing both PIU and DPA. Sensation seeking and anger/frustration were positively correlated with both PIU ($r = .27$, $p < .001$; $r = .36$, $p < .001$, respectively) and DPA ($r = .21$, $p < .001$; $r = .19$, $p < .001$, respectively), suggesting that they are risk factors for PIU and DPA. However, shyness was positively associated with PIU ($r = .15$, $p < .001$) but not correlated with DPA, suggesting that it is a risk factor for PIU only.

5.2. Testing the measurement model

A two-step structural equation modeling procedure was performed to test the model depicted in Fig. 1. The first step involved testing the measurement portion of the model, in which all 6 latent factors were allowed to correlate freely with one another, and the indicators were loaded on their respective factors. Results showed satisfactory fit for the measurement portion: CFI = .96, SRMR = .046, RMSEA = .049 (.048–051), $\chi^2 = 5153.13$, $df = 725$, $p < .001$. A non-significant Chi-square is not realistic under the large sample condition (Hau, Wen, & Cheng, 2004). The factor loadings of all indicators were significant (all *t*-values were above 1.96) and surpassed the recommended level of .40 (DeVon et al., 2007), demonstrating acceptable convergent validity. Additional validity information was provided by the finding that all indicators loaded more strongly on their corresponding construct than on the other constructs, demonstrating evidence of discriminant validity (Hau et al., 2004).

5.3. Testing the structural model

For the structural model, we first tested the unique effects of the four temperament dimensions on PIU without mediator. All four adolescent temperament variables were significantly associated with PIU but in different ways: effortful control was negatively associated with PIU ($\beta = -.34$, $p < .001$); sensation seeking was positively associated with PIU ($\beta = .10$, $p < .001$); anger/frustration was positively associated with PIU ($\beta = .14$, $p < .001$); shyness was positively associated with PIU ($\beta = .10$, $p < .001$).

Subsequently, we tested the partial mediation model which contained the mediator DPA and the direct path from the four temperament dimensions to PIU. The result revealed satisfactory data-model fit: $\chi^2 = .94$ ($df = 2$, $p = .62$), RMSEA = .001, SRMR = .0015, CFI = .99. Table 2 provides the standardized parameter estimates for the structural model.

Table 2
Unstandardized and Standardized parameter estimates for the mediation model.

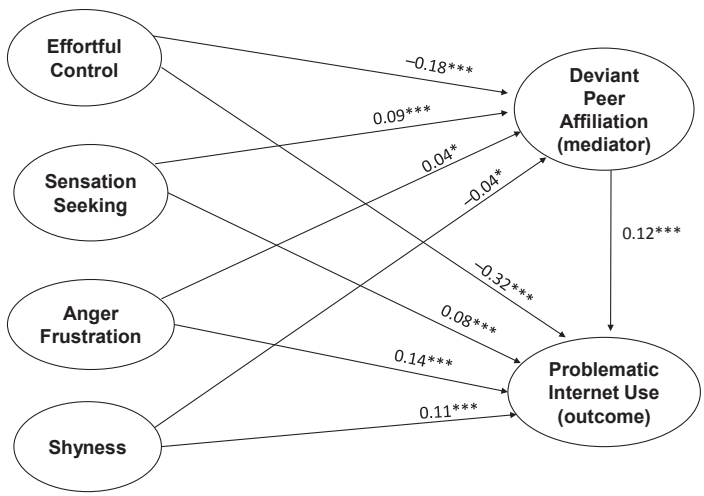
	Parameter estimates	
	Unstandardized	Standardized
Direct effects		
Effortful control → PIU	−.42(.03)***	−.31
Sensation seeking → PIU	.07(.01)**	.09
Anger/frustration → PIU	.15(.02)**	.14
Shyness → PIU	.08(.01)**	.10
Effortful control → DPA	−.13(.01)***	−.18
Sensation seeking → DPA	.04(.01)***	.09
Anger/frustration → DPA	.02(.01)*	.04
Shyness → DPA	−.02(.01)*	−.04
DPA → PIU	.23(.03)***	.12
Indirect effects		
Effortful control → DPA → PIU	−.03(.01)**	−.02
Sensation seeking → DPA → PIU	.01(.00)**	.01
Anger/frustration → DPA → PIU	.01(.00)*	.01
Shyness → DPA → PIU	.00(.00)*	.00

Note. $N = 2758$. Gender was dummy coded such that 0 = *male* and 1 = *female*. School type was dummy coded such that 0 = *selective school* and 1 = *regular school*. PIU = problematic Internet use.
$^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$.

As shown in Fig. 2, effortful control ($\beta = -.18$, $p < .001$) was negatively associated with DPA, which in turn significantly predicted adolescent PIU ($\beta = .12$, $p < .001$). The indirect effect of effortful control on PIU through DPA was significant with 95% confidence interval (CI) of −.0427–−.0205 in a 1000 bootstrap sample. Effortful control also had a residual direct association with adolescent PIU. When these results were taken together, Hypothesis 1 was supported.

Both sensation seeking ($\beta = .09$, $p < .001$) and anger/frustration ($\beta = .04$, $p < .05$) were positively related to DPA, which in turn significantly predicted adolescent PIU ($\beta = .12$, $p < .001$). Their indirect effects on PIU through DPA were also significant with 95% CIs of .0077–0177 and .0036 to .0161 for sensation seeking and anger/frustration respectively. Therefore Hypotheses 2 and 3 were supported.

Shyness ($\beta = -.04$, $p < .05$) was negatively associated with DPA, but positively predicted PIU ($\beta = .12$, $p < .001$), thus Hypothesis 4 was supported. There was inconsistent mediation (Kline, 2015; MacKinnon & Fairchild, 2009) between shyness and PIU through DPA, as suggested by the 95% CI (−.0103, −.0011), because the direction of the mediated effect was opposite to the direct effect, and



Note: N = 2758; * p < 0.05. ** p < 0.01. *** p < 0.001; $\chi^2(2)$ = .94, p = .62; RMSEA = .001; SRMR= .0015; CFI = .99

Fig. 2. The Mediating Role of DPA in the Relationship between Temperament and PIU. Note: N = 2758; $^{*}p$ < .05. $^{**}p$ < .01. $^{***}p$ < .001; $\chi^2(2)$ = .94, p = .62; RMSEA = .001; SRMR = .0015; CFI = .99.

thus these two opposite effects counteracted each other (MacKinnon, 2008; Shrout & Bolger, 2002).

It is worth noting that the effects of anger/frustration and shyness on DPA (as shown in Table 2), although statistically significant, were rather small, so the mediation effect of DPA on anger/frustration and shyness should be interpreted with caution.

5.4. Supplementary analyses

Wills and Dishion (2004) proposed that temperament may act to moderate the relation of deviant peer affiliation and addictive behaviors. To test this alternative model in the current study, we examined the interaction terms of the four temperament dimensions and DPA (DPA × Effortful Control, DPA × Sensation Seeking, DPA × Shyness, DPA × Anger/Frustration) to rule out the possibility that temperament moderated the effect of DPA on PIU. Results revealed that moderation effects were not significant (ps > .05). Therefore, the alternative model was rejected and our current mediation model was further validated.

Because students were nested within schools in the current study, it was important to check that the non-independence of the observations did not influence the results. We therefore used the fixed effect approach to account for the nested nature of the data (Cohen, Cohen, West, & Aiken, 2003). Nine dummy variables for the school variable were created and used as covariates to control for the non-independence of observations. The results revealed that the effect of school grouping on the dependent variable was not significant and did not require modification of our conclusions.

6. Discussion

Using data from a large general population sample of adolescents, the present study examined the differential effects of four temperament dimensions on PIU; it also explored a mediational model positing indirect relationships between four temperament dimensions and PIU through linkages with DPA. Results revealed the combined influence of personal characteristics (temperament) and social environment (deviant peer affiliation) on PIU.

As predicted, each of the four temperament dimensions exhibited a unique and significant influence on adolescent PIU. Effortful control was negatively related to PIU, while sensation seeking, anger/frustration, and shyness were positively associated with PIU. The relationship between shyness and PIU had been unclear in previous studies. The current findings add to previous literature about the association between temperament dimensions and PIU (Dalbudak et al., 2013; Lee & Jung, 2012; Shi et al., 2011; Velezmoro et al., 2010). It is worth noting that, by simultaneously investigating the effects of multiple temperamental dimensions on adolescent PIU, we were able to compare their effects and determine the nature of the relationships between these various temperaments and the development of PIU. Such knowledge will guide the development of optimal intervention for PIU based on children's specific temperament qualities. Moreover, these findings are compelling because the large, representative sample of the current study increases the generalizability of research findings across mainland China.

This study also examined the mediating role of DPA in the pathways from the different temperament dimensions to PIU, which is under-studied in the current PIU research. Findings from the mediation analyses indicated that temperament predicted the risk of PIU indirectly by predicting adolescents' tendency to affiliate with deviant peers. The indirect pathways set the stage for consideration of a broad array of potential prevention and intervention approaches.

A significant partial mediation indicated that effortful control predicted a decrease in DPA, which in turn predicted decreased PIU, suggesting that effortful control had a beneficial effect on PIU via decreasing the adolescent's tendency to affiliate with deviant peers. Thus, our study confirmed the positive effect of effortful control in preventing adolescents from PIU and affiliating with deviant peers. Effortful control, considered the pinnacle of executive functioning, has also been consistently and strongly linked to children's high academic performance and social competence and low problem behaviors (Eisenberg et al., 2007). Our finding suggests the need to increase parents' and educators' awareness of the importance of effortful control and the merit of boosting children's self-regulation skills, as they carry on into adulthood and contribute substantially to an individual's healthy psychosocial functioning (Rothbart & Rueda, 2005).

Additional significant partial mediation effects in the present

study indicated that sensation seeking and anger/frustration each predicted an increase in DPA, which in turn predicted increased PIU, suggesting that these temperament dimensions have adverse effects for PIU. The finding that adolescents who have tendencies to seek thrills and sensation are likely to seek out companions and peer groups who promote those tendencies is not surprising; individuals consistently seek out environmental niches that are correlated with their genetic tendencies (Rutter, 1997). Deviant peer group settings offer risky environments and provide social validation for risk seeking behavior. In addition, adolescents high in anger/frustration are more likely to experience academic failure (Zhou et al., 2010) and rejection by less problematic peers (Coplan & Bullock, 2012), which can lead them to affiliate with deviant peers (Dishion, Patterson, Stoolmiller, & Skinner, 1991) to fulfill their social needs. Deviant peers can also introduce adolescents to resources on the Internet to implement hostility or provide thrills. Sexual videos, weapons information, violent games and delinquency/crime scenarios are very easy to locate via the Internet. Thus peer groups can provide training in deviance through social modeling and peer pressures (Dishion, McCord, & Poulin, 1999; Dishion, Poulin, & Medici Skaggs, 2000). For example, Zhang et al. (2012) found that peers' Internet overuse behaviors and attitudes not only positively predicted Internet addiction, but also indirectly predicted Internet addiction through increased peer pressures.

By contrast, although the total effect of shyness on PIU was positive, an inconsistent mediation of DPA was found in the relationship between shyness and PIU; shyness negatively predicted DPA but positively predicted PIU. On one hand, adolescents who scored high on shyness were less likely to be socially competent and form peer relationships, even with deviant peers. However, unsatisfied social needs were likely to drive them to seek out social interaction through the Internet, which potentially increases the risk for PIU (Luo, Zhou, Wei, Tian, & Kong, 2013). Our results confirm the positive relationship between shyness and PIU, but also point out that not all PIU is mediated by DPA.

It has been widely acknowledged that problem behavior is the result of the interplay between a person and the socializing environment (Rutter et al., 1997; Scarr & McCartney, 1983). PIU, as one problematic behavior, provides an example of how certain temperament and social factors such as peers may elicit a particular pathology. The interplay of the three variables, temperament, DPA and PIU, shows how a behavior originates from temperament, then is maintained and amplified by exposure to similar peers who share information and resources which reinforce their worrisome characteristics.

6.1. Limitations and future directions

Several limitations need to be noted. First, our cross-sectional data limit causal inferences. Future studies should use longitudinal designs to seek evidence for the causal assumptions that are made in this study. Second, although adolescent self-report is reliable when measuring variables such as temperament (Gartstein, Bridgett, & Low, 2012; Rothbart & Bates, 2006), and Harman's one factor test (Podsakoff et al., 2003) was performed in the present study to control common method biases, a replication should use multiple informants (teachers or parents) to reduce potential effects of shared method variance. Also, although the sample was diverse in its sociodemographic background, all the participants were from mainland China, thus the generalizability of the results to other cultural populations may be limited. Finally, the effect of DPA, although significant, was small. If we had used a clinical sample composed only of individuals with acknowledged severe problems with PIU, we would expect more evidence of DPA's contribution to PIU. Meanwhile, because there is a chance that DPA might have a long-lasting effect that might not be captured adequately in this cross-sectional study, a longitudinal design is needed in future studies.

6.2. Implications

Because the consequences of PIU can interfere seriously with an adolescent's school, career and life outcomes, scholars and practitioners have developed various intervention programs, including cognitive behavioral therapy (Bai & Fan, 2007; Young, 2007) and family therapy (Gong, Wang, Ye, & Liang, 2010). The results of our study have important practical implications for the multidimensional family therapy model (Liddle, Dakof, Turner, Henderson, & Greenbaum, 2008).

Specifically, recognizing the temperament of the adolescent is the first step for the parents to reduce the likelihood of an adolescent's Internet addictive behavior. Adolescents prone to sensation seeking and anger when frustrated should be restricted or monitored in Internet use. In particular, they should not have ready access to Internet content that further incites thrill seeking or that models scenarios constructed around themes of anger and negative emotion. Moreover, parents should monitor and restrict adolescents with these temperament characteristics from contact with peers who themselves show undesirable behavior patterns. However, parents of shy adolescents need another approach. They should be aware that the Internet may be a substitute for, and means of avoiding, direct social interaction and therefore may prevent a shy adolescent from gaining improved social skills. Finally, throughout childhood and adolescence, parents should endeavor to inculcate the value of self control and provide training in self reflection with a goal of encouraging self regulated behavior. This mental habit may provide the adolescent with resistance to the pressures of deviant peers and subsequent development of PIU.

In conclusion, our study has shown that certain temperaments present risks for the development of PIU, and that deviant peer affiliation is an important vehicle for this to occur. We recommend that peer contexts should be monitored or supervised, particularly those settings that facilitate Internet usage.

References

Arbuckle, J. L. (2006). *Amos™ 7.0 user's guide*. PA: Amos Development Corporation. Spring House.

Bai, Y., & Fan, F. M. (2007). The effects of group counseling on Internet dependent college students. *Chinese Mental Health Journal, 21*, 247–250.

Bates, J. E., Bayles, K., Bennett, D. S., Ridge, B., & Brown, M. M. (1991). Origins of externalizing behavior problems at eight years of age. In D. J. Pepler, & K. H. Rubin (Eds.), *The development and treatment of childhood aggression* (pp. 93–120). Hillsdale: Lawrence Erlbaum.

Beard, K. W., & Wolf, E. M. (2001). Modification in the proposed diagnostic criteria for Internet addiction. *CyberPsychology & Behavior, 4*, 377–383.

Block, J. (2008). Issues for DSM-V: Internet addiction. *American Journal of Psychiatry, 165*, 306–307.

Caplan, S. E. (2002). Problematic Internet use and psychosocial well-being: development of a theory-based cognitive-behavioral measurement instrument. *Computers in Human Behavior, 18*, 553–575.

Cauffman, E., Shulman, E. P., Steinberg, L., Claus, E., Banich, M. T., Graham, S., et al. (2010). Age differences in affective decision making as indexed by performance on the Iowa Gambling Task. *Developmental Psychology, 46*, 193–207.

Chak, K., & Leung, L. (2004). Shyness and locus of control as predictors of Internet addiction and Internet use. *CyberPsychology & Behavior, 7*, 559–570.

Cheek, J., & Buss, A. (1981). Shyness and sociability. *Journal of Personality and Social Psychology, 41*, 330–339.

Cho, S. C., Kim, J. W., Kim, B. N., Lee, J. H., & Kim, E. H. (2008). Biogenetic temperament and character profiles and attention deficit hyperactivity disorder symptoms in Korean adolescents with problematic Internet use. *CyberPsychology & Behavior, 11*, 735–737.

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences* (3rd ed.). Mahwah: Lawrence Erlbaum Associates, Inc.

Coplan, R. J., & Bullock, A. (2012). Temperament and peer relationships. In M. Zentner, & R. L. Shiner (Eds.), *Handbook of temperament* (pp. 442–461). New

York, NY: Guilford.
Creemers, H. E., Dijkstra, J. K., Vollebergh, W. A., Ormel, J., Verhulst, F. C., & Huizink, A. C. (2010). Predicting life-time and regular cannabis use during adolescence; the roles of temperament and peer substance use: the TRAILS study. *Addiction, 105*, 699–708.
Dalbudak, E., Evren, C., Aldemir, S., Coskun, K. S., Ugurlu, H., & Yildirim, G. (2013). Relationship of Internet addiction severity with depression, anxiety, and alexithymia, temperament and character in university students. *Cyberpsychology, Behavior, and Social Networking, 16*, 272–278.
De Pauw, S. S., & Mervizelde, I. (2010). Temperament, personality and developmental psychopathology: a review based on the conceptual dimensions underlying childhood traits. *Child Psychiatry & Human Development, 41*, 313–329.
DeVon, H. A., Block, M. E., Moyle-Wright, P., Ernst, D. M., Hayden, S. J., Lazzara, D. J., & Kostas-Polston, E. (2007). A psychometric toolbox for testing validity and reliability. *Journal of Nursing Scholarship, 39*, 155–164.
Dishion, T. J., McCord, J., & Poulin, F. (1999). When interventions harm: peer groups and problem behavior. *American Psychologist, 54*, 755–764.
Dishion, T. J., Patterson, G. R., Stoolmiller, M., & Skinner, M. L. (1991). Family, school, and behavioural antecedents to early adolescent involvement with antisocial peers. *Developmental Psychology, 27*, 172–180.
Dishion, T. J., Poulin, F., & Medici Skaggs, N. (2000). The ecology of premature autonomy in adolescence: biological and social influences. In K. A. Kerns, J. M. Contreras, & A. M. Neal-Barnett (Eds.), *Family and peers: Linking two social worlds* (pp. 27–45). Westport, CT: Praeger.
Dong, Q., & Lin, C. D. (2011). *Contemporary chinese children and adolescents' psychological development: Report of the national Children's study of China*. Beijing: Science Press.
Eisenberg, N., Hofer, C., & Vaughan, J. (2007). Effortful control and its socioemotional consequences. In J. J. Gross (Ed.), *Handbook of emotion regulation* (pp. 287–306). New York: Guilford.
Ellis, L. K., & Rothbart, M. K. (2001). Revision of the early adolescent temperament questionnaire. In *Poster presented at the Biennial meeting of the society for research in child development, Minneapolis, MN*.
Evans, G. W., Li, D., & Whipple, S. S. (2013). Cumulative risk and child development. *Psychological Bulletin, 139*, 1342–1396.
Fergusson, D. M., & Horwood, L. J. (1999). Prospective childhood predictors of deviant peer affiliations in adolescence. *Journal of Child Psychology and Psychiatry, 40*, 581–592.
Gartstein, M. A., Bridgett, D. J., & Low, C. M. (2012). Asking questions about temperament: self- and other-report measures across the lifespan. In M. Zentner, & R. L. Shiner (Eds.), *Handbook of temperament* (pp. 244–273). New York: Guildford.
Gentile, D. A., Choo, H., Liau, A., Sim, T., Li, D., Fung, D., et al. (2011). Pathological video game use among youths: a two-year longitudinal study. *Pediatrics, 127*(2), e319–e329.
Giancola, P. R., & Parker, A. M. (2001). A six-year prospective study of pathways toward drug use in adolescent boys with and without a family history of a substance use disorder. *Journal of Studies on Alcohol, 62*, 166–178.
Giedd, J. N. (2008). The teen brain: insights from neuroimaging. *Journal of Adolescent Health, 42*(4), 335–343.
Gong, B. H., Wang, X. M., Ye, J. Q., & Liang, X. Q. (2010). Efficacy of family therapy on Internet addiction among adolescents. *Chinese Journal of School Health, 31*, 300–301.
Ha, J. H., Kim, S. Y., Bae, S. C., Bae, S., Kim, H., Sim, M., et al. (2007). Depression and Internet addiction in adolescents. *Psychopathology, 40*, 424–430.
Hau, K. T., Wen, Z., & Cheng, Z. (2004). *Structural equation model and its applications*. Beijing: Education Science Press.
Henderson, L., Zimbardo, P., & Graham, J. (2002). *Social fitness and technology use: Adolescent interview study*. USA: Stanford University and Shyness Institute.
Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Structural Equation Modeling, 6*, 1–55.
Jiang, X.-X., Hardy, L. L., Ding, D., Baur, L., & Shi, H.-J. (2014). Recreational screen time among Chinese adolescents: a cross sectional study. *Journal of Epidemiology, 24*(5), 397–403.
Joreskog, K., & Sorbom, D. (2005). *LISREL 8.72*. Chicago: Scientific Software International.
Keenan, K., & Shaw, D. (1997). Developmental and social influences on young girls' early problem behavior. *Psychological Bulletin, 121*, 95–113.
Kendler, K. S., Jacobson, K. C., Gardner, C. O., Gillespie, N., Aggen, S. A., & Prescott, C. A. (2007). Creating a social world: a developmental twin study of peer-group deviance. *Archives of General Psychiatry, 64*, 958–965.
Kim, H. K., & Davis, K. E. (2009). Toward a comprehensive theory of problematic Internet use: evaluating the role of self-esteem, anxiety, flow, and the self-rated importance of Internet activities. *Computers in Human Behavior, 25*(2), 490–500.
Kim, E. Y., Lee, Y. S., Han, D. H., Suh, D. S., & Kee, B. S. (2006). Temperament and genetic polymorphism in Korean male adolescents with Internet addiction tendency. *Journal of Korean Neuropsychiatry Association, 45*, 468–475.
Kim, E. J., Namkoong, K., Ku, T., & Kim, S. J. (2008). The relationship between online game addiction and aggression, self-control and narcissistic personality traits. *European Psychiatry, 23*, 212–218.
Kline, R. E. (2015). *Principle and practice of structural equation modeling*. New York, NY: Guilford Press.
Ko, C. H., Hsieh, T. J., Wang, P. W., Lin, W. C., Yen, C. F., Chen, C. S., et al. (2014). Altered gray matter density and disrupted functional connectivity of the amygdala in adults with Internet gaming disorder. *Progress in Neuro-Psychopharmacology and Biological Psychiatry, 57*, 185–192. http://dx.doi.org/10.1016/j.pnpbp.2014.11.003.
Ko, C., Yen, J. Y., Chen, C., Chen, S., Wu, K., & Yen, C. (2006). Tridimensional personality of adolescents with Internet addiction and substance use experience. *Canadian Journal of Psychiatry, 51*, 887–894.
Ko, C. H., Yen, J. Y., Yen, C. F., Chen, C. S., & Chen, C. C. (2012). The association between Internet addiction and psychiatric disorder: a review of the literature. *European Psychiatry: The Journal of the Association of European Psychiatrists, 27*(1), 1–8.
Ko, C. H., Yen, J. Y., Yen, C. F., Chen, C. S., & Wang, S. Y. (2008). The association between Internet addiction and belief of frustration intolerance: the gender difference. *CyberPsychology & Behavior, 11*, 273–278.
Ko, C., Yen, J., Yen, C., Lin, H., & Yang, M. (2007). Factors predictive for incidence and remission of Internet addiction in young adolescents: a prospective study. *CyberPsychology & Behavior, 10*, 545–551.
LaRose, R., & Eastin, M. S. (2004). A social cognitive theory of Internet uses and gratifications: toward a new model of media attendance. *Journal of Broadcasting & Electronic Media, 48*, 358–377.
LaRose, R., Lin, C. A., & Eastin, M. S. (2003). Unregulated Internet usage: addiction, habit, or deficient self-regulation? *Media Psychology, 5*, 225–253.
Lee, Y. S., Han, D. H., Yang, K. C., Daniels, M. A., Na, C., Kee, B. S., et al. (2008). Depression like characteristics of 5HTTLPR polymorphism and temperament in excessive Internet users. *Journal of Affective Disorders, 109*, 165–169.
Lee, M. S., & Jung, I. K. (2012). Comparison of temperament and character between problematic Internet users and problematic drug users in Korean adolescents. *Open Journal of Psychiatry, 2*, 228–234.
Li, D. (2012). *Multiple ecological risk factors and adolescents' social adaptation: How risks should be modeled and what are their mechanisms*. Guangzhou, China: South China Normal University (Unpublished doctoral dissertation).
Li, X., Li, D., & Newman, J. (2013). Parental behavioral and psychological control and problematic Internet use among Chinese adolescents: the mediating role of self-control. *Cyberpsychology, Behavior, and Social Networking, 16*, 442–447.
Li, D., Li, X., Wang, Y., Zhao, L., Bao, Z., & Wen, F. (2013). School connectedness and problematic Internet use in adolescents: a moderated mediation model of deviant peer affiliation and self-control. *Journal of Abnormal Child Psychology, 41*, 1231–1242.
Li, D., Zhang, W., Li, D., Wang, Y., & Zhen, S. (2012). The effects of parenting styles and temperament on adolescent aggression: examining unique, differential, and mediation effects. *Acta Psychologica Sinica, 44*, 211–225.
Li, D., Zhang, W., Li, X., Zhen, S., & Wang, Y. (2010). Stressful life events and problematic Internet use by adolescent females and males: a mediated moderation model. *Computers in Human Behavior, 26*, 1199–1207.
Liddle, H. A., Dakof, G. A., Turner, R. M., Henderson, C. E., & Greenbaum, P. E. (2008). Treating adolescent drug abuse: a randomized trial comparing multidimensional family therapy and cognitive behavior therapy. *Addiction, 103*(10), 1660–1670.
Lin, X., Dong, G., Wang, Q., & Du, X. (2015). Abnormal gray matter and white matter volume in 'Internet gaming addicts'. *Addictive Behaviors, 40*, 137–143.
Lin, S. S. J., & Tsai, C. C. (2002). Sensation seeking and Internet dependence of Taiwanese high school adolescents. *Computers in Human Behavior, 18*, 411–426.
Lin, X., Zhou, H., Dong, G., & Du, X. (2015). Impaired risk evaluation in people with Internet gaming disorder: fMRI evidence from a probability discounting task. *Progress in Neuro-Psychopharmacology and Biological Psychiatry, 56*, 142–148.
Little, R. J., & Rubin, D. B. (2002). *Statistical analysis with missing data* (2nd ed.). New Jersey: Wiley.
Luo, Q., Zhou, Z., Wei, H., Tian, Y., & Kong, F. (2013). Shyness and internet use. *Advances in Psychological Science, 21*, 1651–1659.
MacKinnon, D. P. (2008). *Introduction to statistical mediation analysis*. New York: Taylor & Francis Group.
MacKinnon, D. P., & Fairchild, A. J. (2009). Current directions in mediation analysis. *Current Directions in Psychological Science, 18*(1), 16–20.
MacKinnon, D. P., Lockwood, C. M., & Williams, J. (2004). Confidence limits for the indirect effect: distribution of the product and resampling methods. *Multivariate Behavioral Research, 39*, 99–128.
Mandell, D., & Muncer, S. (2006). Internet communication: an activity that appeals to shy and socially phobic people? *CyberPsychology and Behavior, 9*, 618–622.
Minjikian, M. (2012). *Threat talk: The comparative politics of Internet addiction*. Burlington, VT: Ashgate Pub Co.
Monahan, K. C., Steinberg, L., & Cauffman, E. (2009). Affiliation with antisocial peers, susceptibility to peer influence, and antisocial behavior during the transition to adulthood. *Developmental Psychology, 45*, 1520–1530.
Mrug, S., Hoza, B., & Bukowski, W. M. (2004). Choosing or being chosen by aggressive-disruptive peers: do they contribute to children's externalizing and internalizing problems? *Journal of Abnormal Child Psychology, 32*, 53–65.
Nigg, J. T. (2006). Temperament and developmental psychopathology. *Journal of Child Psychology and Psychiatry, 47*, 395–422.
Odacı, H., & Çelik, Ç. B. (2013). Who are problematic Internet users? an investigation of the correlations between problematic Internet use and shyness, loneliness, narcissism, aggression and self-perception. *Computers in Human Behavior, 29*, 2382–2387.
Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: a critical review of the literature and recommended remedies. *Journal of Applied Psychology, 88*, 879–903.

Podsakoff, P. M., & Organ, D. W. (1986). Self-reports in organizational research: problems and prospects. *Journal of Management, 12*, 531–544.
Preacher, K. J., & Hayes, A. F. (2008). Asymptomatic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods, 40*, 879–891.
Roberts, L. D., Smith, L. M., & Pollock, C. M. (2000). 'U r a lot bolder on the net': shyness and Internet use. In W. R. Crozier (Ed.), *Shyness: Development, consolidation and change* (pp. 121–138). New York: Routledge.
Rothbart, M. K., & Bates, J. E. (2006). Temperament. In W. Damon, & R. M. Lerner (Eds.), *Handbook of child psychology* (6th ed., Vol. 3, pp. 99–166). New York: Wiley.
Rothbart, M. K., & Rueda, M. R. (2005). The development of effortful control. In U. Mayr, E. Awh, & S. Keele (Eds.), *Developing individuality in the human brain: A tribute to Michael I. Posner* (pp. 167–188). Washington, D.C.: American Psychological Association.
Rutter, M. (1997). Nature–nurture integration: the example of antisocial behavior. *American Psychologist, 52*, 390–398.
Rutter, M., Dunn, J., Plomin, R., Simonoff, E., Pickles, A., Maughan, B., et al. (1997). Integrating nature and nurture: Implications of person-environment correlations and interactions for developmental psychopathology. *Development and Psychopathology, 9*, 335–364.
Saunders, P. E., & Chester, A. (2008). Shyness and the Internet: social problem or panacea? *Computers in Human Behavior, 24*, 2649–2658.
Scarr, S., & McCartney, K. (1983). How people make their own environments: a theory of genotype-environment effects. *Child Development, 54*, 424–435.
Shi, J., Chen, Z., & Tian, M. (2011). Internet self-efficacy, the need for cognition, and sensation seeking as predictors of problematic use of the internet. *Cyberpsychology, Behavior, and Social Networking, 14*, 231–234.
Shrout, P. E., & Bolger, N. (2002). Mediation in experimental and nonexperimental studies: new procedures and recommendations. *Psychological Methods, 7*, 422–445.
Song, J., Li, D., Gu, C., Zhao, L., Bao, Z., & Wang, Y. (2014). Parental control and adolescents' problematic Internet use: the mediating effect of deviant peer affiliation. *Psychological Development and Education, 30*, 303–311.
Steinberg, L., Albert, D., Cauffman, E., Banich, M., Graham, S., & Woolard, J. (2008). Age differences in sensation seeking and impulsivity as indexed by behavior and self-report: evidence for a dual systems model. *Developmental Psychology, 44*, 1764–1778.
Steinberg, L., & Monahan, K. C. (2007). Age differences in resistance to peer influence. *Developmental Psychology, 43*, 1531–1543.
Ullman, J. R. (2007). Structural equation modeling. In B. G. Tabachnick, & L. S. Fidell (Eds.), *Using multivariate statistics* (5th ed., pp. 676–781). Inc: Pearson Education.
Velezmoro, R., Lacefield, K., & Roberti, J. W. (2010). Perceived stress, sensation seeking, and college students' abuse of the Internet. *Computers in Human Behavior, 26*, 1526–1530.
Wang, J., Chen, J., Yang, L., & Gao, S. (2013). Meta-analysis of the relationship between sensation seeking and Internet addiction. *Advances in Psychological Science, 21*, 1720–1730.
Wang, H., Zhou, X., Lu, C., Wu, J., Deng, X., & Hong, L. (2011). Problematic Internet use in high school students in Guangdong province, China. *PLOS ONE, 6*, e19660.
Wills, T. A., & Cleary, S. D. (1999). Peer and adolescent substance use among 6th–9th graders: latent growth analyses of influence versus selection mechanisms. *Health Psychology, 18*, 453–463.
Wills, T. A., & Dishion, T. J. (2004). Temperament and adolescent substance use: a transactional analysis of emerging self-control. *Journal of Clinical Child and Adolescent Psychology, 33*, 69–81.
Wills, T. A., Sandy, J. M., & Yaeger, A. (2000). Temperament and adolescent substance use: an epigenetic approach to risk and protection. *Journal of Personality, 68*(6), 1127–1151.
Xu, Y., Farver, J. M., Yu, L., & Zhang, Z. (2009). Three types of shyness in Chinese children and the relation to effortful control. *Journal of Personality and Social Psychology, 97*, 1061–1073.
Yang, L., Cheng, X. Y., Wang, Y., & Wang, H. (2008). Analysis of the correlation factor of fascination tendency on computer game of urban primary pupils in 4 ~ 6 grades. *Modern Preventive Medicine, 35*, 4435–4438.
Yang, X., Wang, Y., Li, D., Zhao, L., Bao, Z., & Zhou, Z. (2013). School climate and adolescents' suicidal ideation and suicide attempts: the mediating role of self-esteem. *Psychological Development and Education, 29*, 541–551.
Yen, C. F., Ko, C. H., Yen, J. Y., Chang, Y., & Cheng, C. P. (2009). Multi-dimensional discriminative factors for Internet addiction among adolescents regarding gender and age. *Psychiatry and Clinical Neurosciences, 63*, 357–364.
Yen, J., Ko, C., Yen, C., Chen, S., Chung, W., & Chen, C. (2008). Psychiatric symptoms in adolescents with Internet addiction: comparison with substance use. *Psychiatry and Clinical Neurosciences, 62*, 9–16.
Young, K. S. (1996, August). *Internet addiction: The emergence of a new clinical disorder. Paper presented at the 104th Annual Meeting of the American Psychological Association*. Toronto, Ontario: Canada.
Young, K. S. (2007). Cognitive behavior therapy with Internet addicts: treatment outcomes and implications. *CyberPsychology & Behavior, 10*(5), 671–679.
Zhang, J., Chen, C., Liu, F., Deng, L., & Fang, X. (2012). Perceived peers' Internet overuse behavior, attitude on Internet overuse, pressures of Internet using and college students' Internet addiction. *Psychological Development and Education, 28*, 634–640.
Zhou, Y., Lin, F. C., Du, Y. S., Qin, L. D., Zhao, Z. M., Xu, J. R., et al. (2011). Gray matter abnormalities in Internet addiction: a voxel-based morphometry study. *European Journal of Radiology, 79*, 92–95.
Zhou, Q., Main, A., & Wang, Y. (2010). The relations of temperamental effortful control and anger/frustration to Chinese children's academic achievement and social adjustment: a longitudinal study. *Journal of Educational Psychology, 102*, 180–196.
Zuckerman, M. (2007). *Sensation seeking and risky behavior*. Washington, DC: American Psychological Association.