

RESEARCH ARTICLE

The Relationship between Recent Stressful Life Events, Personality Traits, Perceived Family Functioning and Internet Addiction among College Students

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Abstract

Internet addiction (IA) is an emerging social and mental health issue among youths. Analysis of risk factors, as well as their interactions, is crucial for understanding the development of IA. This study investigated the relationship between recent stressful life events, personality traits, perceived family functioning and IA in 892 college students. Subjects were classified into categories (non-addicted, mild IA or severe IA) using the Chen Internet Addiction Scale. Stressful life events, personality traits and family functioning were assessed using the Adolescent Self-Rating Life Events Checklist, the Eysenck Personality Questionnaire, and the Family Adaptability and Cohesion Scale, respectively. The results indicated that compared with non-addicted subjects, subjects with severe IA (9.98%) had lower family functioning, lower extraversion, higher neuroticism and psychoticism, and more stressful life events, and subjects with mild IA (11.21%) had higher neuroticism and more health and adaptation problems. Neuroticism and health and adaptation problems were potential predictors of IA. An interaction effect between psychoticism and total life stress on IA was also found. These findings highlight the role of personality traits and life stress and their interactions in college students' IA. Further research should explore the mechanisms underlying the interaction effect of psychoticism with life stress on IA. Copyright © 2013 John Wiley & Sons, Ltd.

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Keywords

Internet addiction; life events; family functioning; personality trait; college students

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Introduction

Internet addiction (IA) is a newly emerging social and mental health issue among youths that has attracted much attention around the world, especially in certain Asian countries, including China and South Korea (Ko, Yen, Yen, Chen and Chen, 2012). According to the 2009 National Report on Internet Addiction of Chinese Youths conducted by the China Youth Association for Network Development (China Youth Association for Network Development, 2010), 14.1% of the young people in China aged 13–29 years (i.e. at least 24 million youths) were potentially addicted to the Internet. Among them, more than half were college or high school students. Addictive Internet use by students may cause poor academic performance, continued conflicts with parents, interpersonal problems, and psychological and somatic symptoms (Anderson, 2001; Tsai & Lin, 2001). IA, also termed

'pathological/problematic Internet use', is defined as an individual's inability to control use of the Internet, eventually leading to psychological, social, school and/or work problems in one's life (Davis, 2001; Young, 1998). Although IA is considered a serious clinical disorder (Beard & Wolf, 2001; Davis, 2001; Shapira et al., 2003; Young, 1998), it has not been registered in the Diagnostic and Statistical Manual of Mental Disorders (DSM), primarily because of the absence of a universal definition and diagnostic criteria. However, there has been extensive discussion about whether IA should be included in the forthcoming version of the DSM (i.e. DSM-V) (Block, 2008; Holden, 2010) as a category of 'behavioural addiction' along with pathological gambling (Grant, Potenza, Weinstein & Gorelick, 2010). Thus, analysis of the risk factors for IA is of interest and improves our collective understanding of the development of this problem among youths.

In comparison with most segments of society, college students are more vulnerable to IA because of the psychological and developmental characteristics of late adolescence/young adulthood, easy access to the Internet and the expectation of Internet use (Kandell, 1998). Because of rapid psychological, biological and societal changes, college students face many challenges from school, peers and family. External stress, including stressful life events, might pave the way for their problematic use of the Internet (Li, Zhang, Li, Zhen & Wang, 2010). Many studies have suggested that cumulative life stress notably increases the risk for IA in high school adolescents (e.g. Lam, Peng, Mai & Jing, 2009; Leung, 2007; Li et al., 2010; Yen, Yen, Chen, Chen & Ko, 2007), and a few studies have confirmed the role of life stress in IA among college students (Li, Wang, & Wang, 2009; Velezmore, Lacefield & Roberti, 2010). Preliminary evidence showed that stressful life events positively predicted IA (Li, Jiaqi and Li, 2009) and perceived stress predicted Internet abuse for sexual purposes in college students (Velezmore et al., 2010). Although these results suggest that stressful life events are crucial to the development of IA, stressful life events do not lead to the same degree of IA for all youths, probably because of individual differences in responses to life stress. For example, an avoidant coping style and maladaptive cognitions could mediate the relationship between stressful life events and IA (Li et al., 2009; Li et al., 2010). It appears that the effect of stressful life events on IA may be contingent upon individual factors, including personality traits, which may serve as key protective or risk factors (Li et al., 2010). Thus, in this study, we further examined the interaction effects of stressful life events with personality traits in the development of IA among college students.

Much empirical evidence has indicated that personality plays an important role in IA. More neurotic personality characteristics were found in university freshmen with IA (Tsai et al., 2009), and neuroticism was positively correlated with IA among students (Montag, Jurkiewicz & Reuter, 2010). Higher novelty seeking, higher harm avoidance and lower reward dependence were associated with higher likelihood of IA (Ko et al., 2006; Ko et al., 2010), and fun seeking was a shared contributing factor for IA and harmful alcohol use among college students (Yen, Ko, Yen, Chen & Chen, 2009). In Eysenck's model, higher psychoticism and neuroticism and lower extraversion are closely associated with addictive behaviours (Eysenck, 1997; Feldman & Eysenck, 1986). Recently, high neuroticism, high psychoticism and low lie scores were identified as one pattern associated with 'high addiction scores' for substance abuse (Kirkcaldy, Siefen, Surall & Bischoff, 2004) and IA (Fisoun, Floros, Siomos, Geroukalis & Navridis, 2012). The theory of addiction highlights personality vulnerabilities that interact with stress in the development of addiction (Jacobs, 1986). Stressful life events

often involve threats and negative emotions to which individuals respond differently according to their own characteristics (Grant et al., 2003). For instance, the influences of neuroticism, extraversion and openness on stress responses and outcomes are notably different (Schneider, Rench, Lyons & Riffle, 2012). Thus, the interaction between personality traits and life stress could be crucial in the development of IA among youths.

In addition to personality, family plays an important role in individuals' ability to deal with life stress. Family provides the main spiritual and material support system for college students, at least in Eastern cultures such as China's. Aspects of family functioning, including emotional bonding between family members and the ability to change in response to situational and developmental stress in the family system, are related to IA in college and high school students (Huang et al., 2009; Huang et al., 2010; Ko, Yen, Lin & Yang, 2007; Yen et al., 2007). Study results have shown that lower family functioning was a predictor for IA (Ko et al., 2007), whereas a warm family atmosphere was a protective factor against IA among college students (Huang et al., 2009). Therefore, family functioning may also be important in the development of college students' IA. However, whether family functioning interacts with stressful life events to influence IA has been under-investigated, and thus, family functioning was considered in this study.

Considering the above issues, the purposes of this study were (1) to further confirm the relationship between stressful life events, personality traits, family functioning and IA, and (2) to test the possible interaction effects of stressful life events with personality traits and family functioning on IA in college students. We hypothesized that analogous to the pathways model of pathological gambling that emphasizes the cumulative effect of these factors in the pathogenesis of the disorder (Blaszczynski & Nower, 2002), stressful life events, personality traits and family functioning might be closely related to IA. Specifically, the interactions between personality traits, family functioning and stressful life events were expected to play a role in the development of IA. In addition, understanding the chain between adaptive Internet use and pathological Internet use is vital for understanding the pathogenesis of IA. To better reflect the taxonomy of Internet users, IA has been assessed as a non-dichotomous categorical variable (Durkee et al., 2012). In this study, we also employed a non-dichotomous classification of IA (no IA, mild IA or severe IA), instead of a dichotomous classification (no IA or IA) and aimed to test the effects of stressful life events, personality traits and family functioning, as well as their interactions, on IA in a multinomial model.

Methods

Participants

A total of 1065 students from nine universities were selected using cross-sectional sampling in five provinces

of China. Firstly, we randomly selected one province from each of five geographic regions (West, East, South, North and Central) in mainland China. Jiangsu, Shanghai, Shandong, Fujian and Gansu provinces were included. A list of universities from each provincial capital city was then created. Two universities from each city (except in Gansu, where one university was selected because the total number of universities is notably fewer than in the other cities) were randomly selected. The survey was conducted in the nine universities by well-trained psychology teachers and graduate students. In each university, different classes across the four grades were selected from one randomly chosen department. The students in these classes were invited to participate in the study. Among the 1065 respondents, 173 participants were excluded because of missing items on the scales [e.g. the Chen Internet Addiction Scale (CIAS)] or missing demographic information (e.g. gender or age). The total sample used in the data analysis included 892 students, of which 407 (45.6%) were male, with an average age of 20.5 ± 1.2 years. All had used the Internet within the past 6 months and were classified as having no IA, mild IA or severe IA according to the score on the CIAS (Chen, Weng, Su, Wu & Yang, 2003; Ko, Yen, Chen, Chen & Yen, 2005). All participants gave written informed consent and were compensated with a gift. The study was approved by the Institutional Review Board at the Institute of Psychology, Chinese Academy of Sciences.

Measures

Chen Internet Addiction Scale

The CIAS consists of 26 items that assess symptoms of compulsive use, withdrawal, tolerance, interpersonal and health problems, and time management problems on a 4-point scale from 1 ('extremely untrue for me') to 4 ('extremely true with me'). Some of the items are 'I can't resist the impulse to use the Internet', 'I find that there is a marked increase in the duration of Internet use for me', 'I feel sad after several days without Internet activity' and 'My social and recreational activities have been reduced because of Internet use'. The total score ranges from 26 to 104 on the CIAS, with higher scores indicating more severe IA. Studies have suggested that using a 57/58 cut-off point for mild IA and a 63/64 cut-off point for severe IA among college students offers good diagnostic accuracy (Ko et al., 2005; Ko et al., 2009). The Cronbach's α of the CIAS was 0.95 in this study.

Family Adaptability and Cohesion Scale

The Family Adaptability and Cohesion Scale is a self-rating scale with 30 items that assess perceived family functioning, including family adaptability and family cohesion, using a 5-point response scale from 1 ('not at all true') to 5 ('always true') (Olson et al., 1982). Family adaptability refers to the ability of a family

system to change in response to situational and developmental stress, and family cohesion refers to the degree to which family members are connected or separated from others in the family (i.e. the emotional bonding between family members) (Rodick, Henggeler & Hanson, 1986). Higher scores on the scale represent greater perceived family functioning. Family adaptability and family cohesion are analysed independently as two subscales. In this study, the Cronbach's α values for the family adaptability and family cohesion subscales were 0.81 and 0.78, respectively.

Eysenck Personality Questionnaire

The Eysenck Personality Questionnaire (EPQ) is a well-known instrument assessing three dimensions of individual personality: neuroticism, extraversion and psychoticism. Neuroticism is also called emotionality, characterized by high levels of negative emotions, such as depression and anxiety. Extraversion is characterized by talkativeness, a positive affect and the need for external stimulation. Psychoticism is characterized by non-conformity, hostility, anger and impulsiveness, and it is associated with high levels of aggression and high risk for a psychotic episode. There is also a lie factor in the EPQ, originally included to provide an assessment of reliability, but the lie factor may also represent social immaturity. We used the Eysenck Personality Questionnaire—Revised short form (EPQR-S) (Eysenck & Eysenck, 1992), which contains 48 items with yes/no response options. The Cronbach's α values for the subscales were 0.78 (neuroticism), 0.66 (extraversion), 0.75 (psychoticism) and 0.69 (lie) in this study.

Adolescent Self-Rating Life Events Checklist

The Adolescent Self-Rating Life Events Checklist was used to assess individuals' subjective suffering from stressful life events experienced during the past 12 months. The scale includes 26 life events and a 6-point response scale ranging from 0 ('did not occur') to 5 ('occurred and was extremely stressful') (Liu, Liu, Yang & Zhao, 1997). Five types of stressful life events are included in the scale: interpersonal problems (e.g. felt misunderstood by companions, was humiliated in public or experienced discrimination by others), school-related problems (e.g. failed an exam, had a heavy workload or had conflicts with teachers), parental problems (e.g. death of a parent, or parents' separation or divorce), punishment and loss (e.g. suffered a loss by theft or violated laws), and health and adaptation problems (e.g. severe illness or separation from family members). Higher total scores on the scale represent a greater number of stressful life events experienced in the past year. The Cronbach's α of the scale was 0.92 in this study.

Questionnaire for demographic variables

An additional questionnaire was used to collect demographic information (gender, age, grade, university

and province) and information related to Internet usage (number of hours online per day) and activities conducted online (playing games or not).

Statistical analysis

The data were analysed with the Statistical Package for the Social Sciences for Windows, Version 15.0 (SPSS Inc., Chicago, IL, USA). Group differences in categorical data were analysed with chi-square tests. Psychological variables were compared between the groups using a multivariate analysis of variance model with gender, age, grade, university and province as covariates. Post-hoc tests included Fisher's least significant differences protected *t*-test, with Bonferroni correction for multiple comparisons. The relationship between psychological variables and the CIAS score was tested using partial correlations, controlling for gender, age, grade, university and province. Predictive effects of stressful life events, personality traits and family functioning on IA were tested using multiple linear regression analyses with the total CIAS score as the dependent variable and gender, age, grade as covariates. According to the variance inflation factor, multicollinearity was not a problem for any variables except for university and province (variance inflation factor > 20), which were thus excluded from the regression models. In order to confirm the results with a dimensional approach, logistic regression analyses were used to test the effects of stressful life events, personality traits and family functioning, as well as the interactions of stressful life events \times personality traits (neuroticism, extraversion, psychoticism and lie) and stressful life events \times family functioning (family adaptability and family cohesion)

on mild IA and severe IA, controlling for gender, age and grade. The threshold for statistical significance was set at $p < 0.05$, two-tailed.

Results

Demographic characteristics

According to the CIAS scores, 89 students (9.98%) had severe IA and 100 students (11.21%) had mild IA. As presented in Table I, no group differences were observed for gender or grade, but the group with severe IA was slightly older than the non-addicted group ($p < 0.05$). The proportion of students who spent more than 5 h online per day was obviously higher in the group with severe IA ($\chi^2 = 95.287$, $p < 0.001$), and the proportion of game players was lower in the non-addicted group ($\chi^2 = 12.412$, $p = 0.002$).

Differences in psychological variables between the severe Internet addiction, mild Internet addiction and non-addicted groups

The multivariate analysis of variance model revealed that there was a significant group difference in family functioning, both in family adaptability [$F_{(2, 886)} = 11.370$, $p < 0.001$, $\eta_p^2 = 0.025$] and in family cohesion [$F_{(2, 886)} = 7.858$, $p < 0.001$, $\eta_p^2 = 0.017$]. Post-hoc tests showed that the group with severe IA had lower family adaptability and family cohesion than the non-addicted group ($ps < 0.001$). There were also significant group differences in neuroticism [$F_{(2, 886)} = 22.005$, $p < 0.001$, $\eta_p^2 = 0.047$], psychoticism [$F_{(2, 886)} = 8.050$, $p < 0.001$, $\eta_p^2 = 0.018$] and extraversion [$F_{(2, 886)} = 11.00$, $p < 0.001$, $\eta_p^2 = 0.024$], but there was no significant group difference

Table I. Demographic characteristics of the sample

Variables	Non-addicted ($n = 703$)	Mild IA ($n = 100$)	Severe IA ($n = 89$)	F/χ^2
Age, years ($M \pm SD$)	20.44 \pm 1.18	20.63 \pm 1.31	20.74 \pm 1.16	3.379*
Gender, n (%)				4.572
Male	308 (43.8)	51 (51.0)	48 (53.9)	
Female	395 (56.2)	49 (49.0)	41 (46.1)	
Grade, n (%)				7.329
First year in college	232 (33.0)	21 (21.0)	26 (29.2)	
Second year in college	208 (29.6)	32 (32.0)	24 (27.0)	
Third year in college	180 (25.6)	33 (33.0)	26 (29.2)	
Fourth year in college	83 (11.8)	14 (14.0)	13 (14.6)	
Hours online/day, n (%)				95.287**
<1	316 (45.0)	18 (18.0)	14 (15.7)	
1–3	275 (39.1)	47 (47.0)	35 (39.3)	
3–5	95 (13.5)	31 (31.0)	25 (28.1)	
>5	17 (2.4)	4 (4.0)	15 (16.9)	
Game player, n (%)				12.412**
Yes	481 (68.4)	81 (81.0)	73 (82.0)	
No	222 (31.6)	19 (19.0)	16 (18.0)	
CIAS score ($M \pm SD$)	40.8 \pm 10.0	60.3 \pm 1.8	68.9 \pm 5.3	515.2**

IA: Internet addiction; CIAS: Chen Internet Addiction Scale.

* $p < 0.05$, ** $p < 0.01$.

in lie ($p=0.081$). Post-hoc tests showed that subjects with severe IA had higher neuroticism and psychoticism and lower extraversion, and subjects with mild IA had higher neuroticism than non-addicted subjects ($ps < 0.001$). Regarding life stress, there was a significant group difference in the total number of stressful life events [$F_{(2, 886)} = 11.842, p < 0.001, \eta_p^2 = 0.026$] as well as in the five domains of punishment and loss, interpersonal problems, school-related problems, parental problems, and health and adaptation problems. Compared with the non-addicted subjects, the subjects with severe IA scored higher on total life stress and on the five domains ($ps < 0.01$), and the subjects with mild IA scored higher on health and adaptation problems ($p < 0.05$). See Table II.

Partial correlations and linear regression analysis of risk factors

The partial correlations showed that total stressful life events were positively correlated with CIAS score ($r = 0.201, p < 0.001$). Family adaptability and family cohesion were negatively correlated with CIAS score ($r = -0.203$ and $r = -0.220$, respectively, $ps < 0.001$). Neuroticism and psychoticism were positively correlated with CIAS score, whereas extraversion and lie were negatively correlated with CIAS score ($r = 0.289, r = 0.140, r = -0.155$ and $r = -0.126$, respectively, $ps < 0.001$). The multiple linear regression analysis, controlling for age, gender and grade, revealed that neuroticism and health and adaptation problems were significant predictors of IA ($\beta = 0.176, p < 0.01$ and $\beta = 0.099, p < 0.05$, respectively, adjusted $R^2 = 0.132$ for the model). See Appendix Tables S1 and S2 for details.

Logistic regression outcomes

We used two binary regression models, one model for non-addicted versus mild IA and the other for non-addicted versus severe IA, to test the predictive effects of total life stress, family functioning and personality traits, as well as the interactions of total life stress with personality traits and family functioning, on predicting mild IA and severe IA. A 2-step design was used: age, gender and grade were entered in step 1 as control variables, and the other variables were entered in step 2. The results are presented in Table III. The data revealed that in the non-addicted versus mild IA model (Nagelkerke $R^2 = 0.182$), neuroticism significantly predicted mild IA [odds ratio (OR) = 1.230, $p < 0.01$, 95% confidence interval (CI) = 1.053, 1.435], and there was an interaction effect of total life stress \times psychoticism on mild IA (OR = 1.008, $p < 0.05$, 95% CI = 1.001, 1.015). In the non-addicted versus severe IA model (Nagelkerke $R^2 = 0.205$), neuroticism was also a predictor for severe IA (OR = 1.367, $p < 0.01$, 95% CI = 1.121, 1.668), and there was an interaction effect of total life stress \times psychoticism on severe IA (OR = 1.007, $p < 0.05$, 95% CI = 1.000, 1.015). Taken together, these data indicate that high neuroticism is an important factor that independently increases the risk of IA, and psychoticism may interact with life stress to influence IA. High-level psychoticism exacerbates the risk of IA, and low-level psychoticism mitigates the risk of IA when life stress is high (see Appendix Figure S1 for a clear view of the effect of psychoticism \times life stress on IA).

Discussion

The present study examined the relationship between recent stressful life events, personality traits, family

Table II. Psychological variables for the non-addicted, mild IA and severe IA groups

Variables	Non-addicted			<i>F</i>	Post-hoc test ($p < 0.05$)
	(<i>n</i> = 703)	Mild IA (<i>n</i> = 100)	Severe IA (<i>n</i> = 89)		
FACES II (<i>M</i> \pm <i>SD</i>)					
Family adaptability	47.7 \pm 8.5	46.5 \pm 8.0	43.7 \pm 8.1	7.858***	Non-addicted > severe IA
Family cohesion	56.6 \pm 9.9	54.3 \pm 9.7	51.4 \pm 8.9	11.370***	Non-addicted > severe IA
EPQR-S (<i>M</i> \pm <i>SD</i>)					
Neuroticism	5.1 \pm 3.1	6.0 \pm 3.0	7.1 \pm 2.9	22.005***	Non-addicted < mild IA < severe IA
Extraversion	8.2 \pm 2.8	8.1 \pm 2.6	6.7 \pm 2.5	11.00***	Non-addicted = mild IA > severe IA
Psychoticism	2.7 \pm 1.6	3.1 \pm 1.9	3.5 \pm 1.8	8.050***	Non-addicted < severe IA
Lie	5.2 \pm 2.5	4.7 \pm 2.3	4.8 \pm 2.3	2.525	—
ASLEC (<i>M</i> \pm <i>SD</i>)					
Total score	33.8 \pm 19.3	36.1 \pm 18.1	44.3 \pm 19.1	11.842***	Non-addicted = mild IA < severe IA
Punishment and loss	6.6 \pm 7.3	7.5 \pm 6.9	10.0 \pm 7.9	8.476***	Non-addicted < severe IA
Interpersonal problems	8.1 \pm 4.6	8.3 \pm 4.3	10.0 \pm 5.1	7.001**	Non-addicted = mild IA < severe IA
School-related problems	7.4 \pm 3.9	7.7 \pm 3.4	8.4 \pm 3.7	3.772*	Non-addicted < severe IA
Parental problems	5.6 \pm 4.7	5.7 \pm 5.1	7.4 \pm 4.8	4.770**	Non-addicted = mild IA < severe IA
Health and adaptation problems	6.2 \pm 3.3	6.9 \pm 3.3	8.5 \pm 3.4	18.723***	Non-addicted < mild IA < severe IA

IA: Internet addiction; FACES II: Family Adaptability and Cohesion Scale; EPQR-S: Eysenck Personality Questionnaire—Revised short form; ASLEC: Adolescent Self-Rating Life Events Checklist.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table III. Logistic regression analyses controlling for age, gender and grade

Models	Mild IA [†]			Severe IA [‡]		
	<i>B</i>	Wald χ^2	OR (95% CI)	<i>B</i>	Wald χ^2	OR (95% CI)
Age	-0.015	0.014	0.985 (0.766–1.267)	0.238	2.84	1.268 (0.962–1.672)
Male	0.524	4.983*	1.688 (1.066–2.673)	0.308	1.39	1.361 (0.815–2.273)
First year	-1.03	4.384*	0.357 (0.136–0.936)	-0.337	0.420	0.714 (0.257–1.980)
Second year	-0.338	0.721	0.713 (0.327–1.566)	-0.268	0.363	0.765 (0.321–1.827)
Third year	-0.061	0.028	0.941 (0.464–1.908)	-0.154	0.146	0.857 (0.388–1.894)
Total stressful life events (TS)	-0.027	0.338	0.974 (0.89–1.065)	0.002	0.003	1.002 (0.914–1.10)
Family adaptability	0.051	1.24	1.053 (0.962–1.152)	-0.037	0.477	0.963 (0.867–1.071)
Family cohesion	-0.073	3.43	0.929 (0.86–1.004)	0.002	0.002	1.002 (0.913–1.099)
Neuroticism	0.207	6.84**	1.23 (1.053–1.435)	0.313	9.541**	1.367 (1.121–1.668)
Extraversion	0.101	1.246	1.106 (0.927–1.32)	-0.154	2.144	0.857 (0.697–1.054)
Psychoticism	-0.198	1.812	0.82 (0.614–1.095)	-0.115	0.419	0.891 (0.628–1.264)
Lie	-0.055	0.306	0.947 (0.78–1.149)	-0.064	0.278	0.938 (0.739–1.191)
TS × Family adaptability	-0.001	0.681	0.999 (0.997–1.001)	0.000	0.182	1 (0.998–1.003)
TS × Family cohesion	0.001	1.774	1.001 (0.999–1.003)	0.000	0.164	1 (0.998–1.002)
TS × Neuroticism	-0.003	2.43	0.997 (0.993–1.001)	-0.004	3.325	0.996 (0.992–1.000)
TS × Extraversion	-0.002	0.603	0.998 (0.994–1.003)	0.001	0.243	1.001 (0.997–1.006)
TS × Psychoticism	0.008	5.119*	1.008 (1.001–1.015)	0.007	3.375*	1.007 (1.00–1.015)
TS × Lie	0.000	0.005	1 (0.995–1.005)	0.002	0.359	1.002 (0.996–1.007)

CI: confidence interval; OR: odds ratio.

[†]Non-addicted versus mild IA model ($N = 803$), Nagelkerke $R^2 = 0.182$.

[‡]Non-addicted versus severe IA model ($N = 792$), Nagelkerke $R^2 = 0.205$.

* $p < 0.05$, ** $p < 0.01$.

functioning and IA among college students. The results indicated that high neuroticism and more health and adaptation problems were the risk factors for IA. More importantly, we found a significant interaction of psychoticism with life stress on IA among college students. In other words, high-level psychoticism exacerbates the risk of IA, and low-level psychoticism acts as a buffer against IA when life stress is high.

Prevalence of Internet addiction among college students

The prevalence of IA among college students has varied in previous studies: 18.3% in England (Niemz, Griffiths & Banyard, 2005), 12.3–15.3% in Taiwan (Lin, Ko and Wu, 2011; Yen et al., 2009) and 34.7% in Greece (Frangos, Frangos & Sotiropoulos, 2011). In our study, the total prevalence of IA was 21.19% (9.98% for severe IA and 11.21% for mild IA). The variations in these results could be due to different methodologies, the taxonomy of IA or the time frame of the research performed (Durkee et al., 2012). Universal diagnostic criteria for IA would be helpful for future studies.

Stressful life events, personality traits, family functioning and Internet addiction

Life stress is an important factor that has an effect on many psychiatric and psychological diseases. In accordance with previous findings (Li et al., 2009; Velezmore et al., 2010), we found that total stressful

life events correlated positively with IA, and more health and adaptation problems potentially predict IA among college students. Previous research also found that life stress is associated with IA, just as it is related to other addictions (Lam et al., 2009). These findings highlighted the harmful role of cumulative life stress in the development of IA among young students. One possible explanation may be that when confronted with excessive life stress, youths are more inclined to increase their Internet use to manage moods, compensate for social interaction and escape from reality (Leung, 2007).

With respect to personality, a positive relationship between neuroticism and IA has been observed among college students (Tsai et al., 2009; Montag et al., 2010). Our results further revealed a predictive effect of neuroticism on both mild IA and severe IA, confirming that high neuroticism is a risk factor for IA among college students. Neuroticism represents emotional instability or capriciousness. Individuals with higher neuroticism react strongly to different types of stimuli (Eysenck & Eysenck, 1992), and they would be more engaged when using the Internet (Hamburger & Ben-Artzi, 2000). Although the predominant view is that introverts are relatively more likely to be problematic Internet users (Beard, 2005; Griffiths, 2000), extraversion was not a significant predictor for IA in this study, similar to previous results (Mottram & Fleming, 2009). High psychoticism has been reported to predict drug

and alcohol usage, and psychoticism was reported as one of the 'addictive' personality constructs that contributes to substance abuse and IA among adolescents (Kirkcaldy et al., 2004; Fisoun et al., 2012). In this study, higher psychoticism was associated with severe IA among college students; however, a predictive effect of psychoticism on IA was not found. Conversely, a significant interaction effect of psychoticism with total life stress was found on both mild IA and severe IA, which will be discussed in the next section. Low lie scores, together with high neuroticism and high psychoticism, were considered to be one 'high addiction' pattern for drug addiction (Kirkcaldy et al., 2004), and this result has been replicated for IA (Fisoun et al., 2012). Lie scores correlated negatively with IA in our study; however, lie scores did not have a predictive effect for IA.

Family functioning was negatively correlated with IA in this study. Inconsistent with previous reports (Ko et al., 2007; Yen et al., 2007), however, we did not find a predictive effect of family functioning on IA, and there was no interaction effect of family functioning with stressful life events. It is assumed that families with high-quality functioning have high levels of parent-child involvement and adapt better in the face of conflicts (Rodick et al., 1986), which would prevent adolescents from engaging in negative and anti-social behaviours (Hawkins, Catalano & Miller, 1992). Further efforts should be made to verify the relationship between family functioning and IA among college students.

Interaction effect of psychoticism with life stress on Internet addiction

In alignment with previous results, stressful life events were positively correlated with IA, and more health and adaptation problems were a significant predictor for IA in our study. However, stressful life events do not lead to the same degree of IA for all youths because there are individual differences in responses to life stress, and individual maladaptive cognitions and an avoidant coping style could mediate the relationship between stressful life events and IA (Li et al., 2009; Li et al., 2010). Thus, the interaction effects of stressful life events with personality traits and family functioning on IA were examined in greater detail. We found that psychoticism interacted significantly with life stress in the development of IA (both mild IA and severe IA), with higher-level psychoticism exacerbating the risk of IA and lower-level psychoticism mitigating the risk of IA under high levels of life stress. Our results suggest that high psychoticism is a trait that increases susceptibility for IA when life stress is high, whereas low psychoticism is a buffer against life stress, protecting young students from IA. One potential explanation for this interesting finding may be that individuals with high psychoticism are less socialized, unresponsive to social norms, and more impulsive

and aggressive (Eysenck & Eysenck, 1992), and they might have fewer reasonable strategies to cope with life stress. When confronted with frustration and life stress, individuals with high psychoticism might tend to approach the Internet for emotional catharsis or to relieve the anxiety triggered by stressful life events. By contrast, individuals with low psychoticism are more agreeable, peaceful, flexible and skilled in coping with life stress; they have more affective and cognitive resources and interpersonal support. In addition, high psychoticism is associated with blunted hypothalamic-pituitary-adrenal axis responses to psychological stress (Oswald et al., 2006), so high psychoticism may affect individual reactions to life stress through a physiological pathway, whereas low psychoticism may not. Nevertheless, more efforts should be taken to understand the pathways through which psychoticism interacts with life stress, and a combination of psychological and physiological approaches may be extremely helpful.

Limitations

Several limitations in this study should be noted. Firstly, the cross-sectional survey design is not able to verify causal relationships between the risk factors and IA among college students. The results should be interpreted carefully. Secondly, this study was conducted in a population of college students in China. It is unclear whether these results can be generalized in other cultures or to other populations. Cross-cultural studies are needed to confirm these findings. Thirdly, the amount of missing data may indicate potential selection bias. A nationally representative sample of college students is urgently needed to achieve more conclusive results.

Conclusion

In this study, we found that high neuroticism and more health and adaptation problems were risk factors for developing IA among college students. A significant interaction of psychoticism with life stress was also observed to affect the risk of IA. High psychoticism exacerbates the risk that college students will develop IA, and low psychoticism acts as a buffer against IA in the presence of life stress. Further studies are needed to explore the cognitions and coping styles that individuals with high psychoticism use to respond to psychological stress to understand the behavioural mechanism underlying the effect of psychoticism \times stress on IA. The biological and neural bases of the interaction of psychoticism with stress must also be understood to solve the puzzle of why susceptible youths are inclined to overusing the Internet.

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Supporting information

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