



Stressful life events and problematic Internet use by adolescent females and males: A mediated moderation model [☆]

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ABSTRACT

In a sample of 660 adolescents (*M* age = 14.14 years; 55% females), this study examined a mediated moderation model in which temperamental effortful control and sensation seeking moderated the relationship between stressful life events and problematic Internet use (PIU), and this moderating effect was mediated by maladaptive cognitions. Findings revealed that effortful control buffered the risk of stressful life events for females' PIU, and this effect was mediated through maladaptive cognitions. The risk-buffering effect of effortful control for males' PIU was not significant, although it buffered the risk of maladaptive cognitions for PIU. The risk-enhancing effect of sensation seeking was not significant in both female and male adolescents. In addition, males scored higher on risks but lower on protective factors of PIU than females, which explain the gender difference in PIU. The authors discuss the theoretical and practical implications of these findings.

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1. Introduction

The Internet is an integral tool for information, communication, and entertainment among adolescents (Tsitsika et al., 2009). Appropriate Internet use can be beneficial to adolescents' development, however, problematic Internet use (PIU) may be detrimental to adolescents' development (Greenfield & Yan, 2006). Problematic Internet use can be defined as "use of the Internet that creates psychological, social, school and/or work difficulties in a person's life" (Beard & Wolf, 2001). A number of empirical studies focusing on the problems caused by excessive Internet use have shown that PIU are associated with a variety of negative developmental outcomes of children and adolescents such as depression, social isolation and especially time-disruption (Chou, Condron, & Belland, 2005; Guan & Subrahmanyam, 2009; Shaw & Black, 2008). Despite the large number of empirical studies on PIU, recent reviews noted that current understanding of why adolescents differ in their PIU, for the most part, is still limited (Guan & Subrahmanyam, 2009; Willoughby, 2008). The problem is particularly urgent because demonstrating the determinants of PIU is the first step for effective prevention and intervention.

In this study, we propose that both environmental (i.e., stressful life events) and personal (i.e., gender, temperament, and maladaptive cognitions about Internet use) factors need to be taken into consideration simultaneously in order to fully understand the determinants of adolescents' PIU. Specifically, we used survey data based on 660 adolescents to empirically test a mediated moderation model in which the relationship between stressful life events and PIU varied with adolescents' temperament, and adolescents' maladaptive cognitions about Internet use mediated this moderating effect. We also explored the sources of gender difference in PIU implied in this mediated moderation model. Following are the relevant theoretical and empirical works that have led us to this postulated model.

1.1. Stressful life events and PIU

Due to the significant biological, psychological, and social changes during adolescence, individuals have to face many challenges from family, school, and peer settings. These environmental stresses might pave the way for their problematic use of Internet. Until recently, very few studies have focused on the role of stressful life events in adolescents' PIU (Leung, 2007; Li & Lei, 2005). Preliminary research evidence suggested that cumulative life stresses significantly increased the risk for PIU (Lei & Wu, 2007; Leung, 2007; Li, Wang, & Wang, 2009; Yen, Yen, Chen, Chen, & Ko, 2007). For instance, Li et al. (2009) analyzed the association of stressful life events and coping styles with generalized PIU among college students. They found that stressful life events positively

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predicted generalized PIU, with effect being largely mediated by avoidant coping style (e.g., self-blame, fantasy, withdrawal or rationalization). In a study of 717 adolescents aged 8–18 years, Leung (2007) found that stressful life events were significantly associated with adolescents' use of the Internet for mood management (such as entertainment and information seeking) and social compensation (such as recognition gaining and relationship maintenance) motives. The findings of these studies supported the premise proposed by affect-dependant stimulus arrangement theory which posited that "individuals consume media entertainment purposively in efforts to manage moods" (Zillmann, 1988).

Although stressful life events have been found to account for large proportions of variance in adolescents' PIU, they do not lead to the same extent of PIU for all adolescents. The impact of stressful life events may be contingent upon many factors, among which adolescents' own characteristics may serve as important protective/vulnerable factors. The present study fills this gap by incorporating adolescents' temperament (effortful control and sensation seeking), which may be an important individual characteristic that determines how adolescents respond to heightened stressful life events, into the examination of the effects of stressful life events on adolescents' PIU.

1.2. Temperament and PIU

Although many studies focused on the association between environment factors and PIU, there is evidence suggesting that adolescents' temperament also plays an important role in the development of PIU. Temperament is defined as individual differences in reactivity and self-regulation that are genetically influenced, biologically based, and shaped by socialization and contextual experiences (Rothbart & Bates, 2006). According to Nigg (2006), temperament is closely related to developmental psychopathology. On one hand, it may interact with other factors to produce problem behavior (see Section 1.3); on the other hand, it may predispose individuals to problem behavior via a series of mediating mechanisms (see Section 1.4).

One dimension of temperament known as effortful control may be particularly relevant to the development of PIU. Effortful control is a core aspect of self-regulation and refers to "the efficiency of executive attention, including the ability to inhibit a dominant response and/or to activate a subdominant response, to plan, and to detect errors" (Rothbart & Bates, 2006, p. 129). Adolescents with higher levels of effortful control can better focus and shift their attention (attentional focusing), suppress inappropriate responses (inhibitory control), and perform an action when there is a strong tendency to avoid it (activation control). There is extensive evidence supporting the beneficial role of effortful control in children's maladaptive behavior (Eisenberg et al., 2001, 2005; Eisenberg, Hofer, & Vaughan, 2007; Valiente, Lemery-Chalfant, Swanson, & Reiser, 2008). Given that PIU is one aspect of maladaptive behavior, it is reasonable to assume that PIU may also have a relationship with effortful control. To date, there have been very few studies done to explore the role of effortful control in the development of PIU. However, there is evidence that indicators of self-regulation that are similar to effortful control are associated with PIU or online gaming (Kim, Namkoong, Ku, & Kim, 2008; LaRose & Eastin, 2004; LaRose, Lin, & Eastin, 2003; Liu & Peng, 2009; Seay & Kraut, 2007). In these studies, self-regulation was usually defined as the ability of an individual to manage his or her own behavior through observation, evaluation, and consequence (Bandura, 1991). Therefore, adolescents with higher levels of temperamental effortful control may be less likely to overuse the Internet.

Another dimension of temperament known as sensation seeking may also play an important role in the development of PIU. Sensation seeking refers to the tendency to seek out novel, varied,

and highly stimulating experiences, and the willingness to take risks in order to attain them (Zuckerman, 1979). A large body of evidence has supported the role of sensation seeking in a wide range of behaviors, from risk driving and extreme sports to substance use, unsafe sex, hazardous vocations, and crime and other antisocial behaviors (Zuckerman, 2007). Many researchers are interested in the relationship between sensation seeking and PIU. Although there have been some inconsistencies in the literature, most of the existing studies supported a positive relationship between sensation seeking and PIU (e.g., Ko et al., 2006; Ko, Yen, Yen, Lin, & Yang, 2007; Lin & Tsai, 2002; Mei et al., 2008; Shi, Zhou, Ge, Qin, & Zhang, 2005; Yang & Zhou, 2005). However, in some of these studies, measures of sensation seeking (e.g., sensation seeking scale, SSS; Zuckerman, Eysenck, & Eysenck, 1978) were not clearly differentiated from measures of a similar but different concept, impulsivity, which refers to a lack of self-control or deficiencies in response inhibition and often leads to hasty, unplanned behavior (Steinberg et al., 2008). This distinction is important, because not all sensation seeking is done impulsively, and not all impulsivity leads to stimulating or even rewarding experiences. To address this limitation, the current study used a measure adapted by Steinberg et al. (2008) which appropriately assesses sensation seeking rather than impulsivity.

1.3. Temperament as a moderator

Researchers have increasingly realized that (problem) behavior is the product of the interplay between an individual and its environment (Belsky, 2005; Belsky, Bakermans-Kranenburg, & van IJzendoorn, 2007; Boyce & Ellis, 2005; Wachs & Plomin, 1991), that is, individuals respond differentially to the environment according to their own characteristics. However, few researchers have adopted an organism \times environment interaction ($O \times E$) approach to examine the occurrence of adolescents' PIU. In the current study, we argue that the association between stressful life events and PIU may be contingent upon many factors, among which adolescents' temperament (i.e., effortful control and sensation seeking) may serve as important protective/vulnerable factors.

Stressful life events often involve threat and provoke negative emotions through different mechanisms such as biological, psychological, and social processes (Grant et al., 2003). Effortful control provides adolescents with resources that are necessary for them to cope with these negative emotions aroused by stressful life events (Rueda & Rothbart, 2009; Valiente, Lemery-Chalfant, & Swanson, 2009). Adolescents high in effortful control are able to voluntarily regulate their emotional state by deploying their attention, can suppress initial reactive tendencies so as to conform to situational demands successfully (Dishion & Connell, 2006; Rothbart & Putnam, 2002), and anticipate the negative outcomes caused by excessive Internet use, thus restrain their impulses from getting involved in PIU. By contrast, when coping with stressful life events, adolescents high in sensation seeking are prone to actively seeking out new stimuli and are more sensitive to the cues of reward rather than the cues of punishment, therefore they are more likely to use and be gratified with the Internet. In other words, effortful control is a risk-buffering factor that may mitigate the potential negative association between stressful life events and PIU, whereas sensation seeking is a risk-enhancing factor that may exacerbate the negative association between stressful life events and PIU. Consequently, we propose the following:

Hypothesis 1a: Effortful control moderates the relationship between stressful life events and PIU, such that this relationship is positive when levels of effortful control are low but much weaker when levels of effortful control are high.

Hypothesis 1b: Sensation seeking moderates the relationship between stressful life events and PIU, such that this relationship

is positive when levels of sensation seeking are low but much stronger when levels of sensation seeking are high.

1.4. Maladaptive cognitions as mediators

Although the interactions between stressful life events and temperament may plausibly explain the differences of individuals' involvement in PIU, the question remains *how* adolescents' temperament factors may influence the relations between stressful life events and PIU or, in other words, what process is responsible for the moderation effect. Unfortunately, earlier studies on the effects of stressful life events and temperament have typically investigated direct relationships between the independent variables (i.e., stressful life events and temperament) and dependent variables (i.e., PIU) without exploring the processes that may underlie these relationships. In the present study, we propose a mediated moderation model to examine potential underlying mechanisms of the stressful life events \times temperament interactions predicting PIU. In a mediated moderation model, a moderating effect can be explained, at least in part, by a mediator variable. More precisely, it is hypothesized that maladaptive cognitions mediate the moderating effect of temperament on the relationship between stressful life events and PIU (see Fig. 1).

In the present study, maladaptive cognitions about the Internet are defined as one's beliefs or outcome expectancy about Internet use that favor online activities rather than similar offline activities. They are characterized by unrealistic thoughts and/or over-emphasizing the function of the Internet, such as perceptions that one may be better treated or one may better cope with stress online than offline or in real life. This definition is based on several similar concepts, such as distorted thoughts about the self and the world (Davis, 2001), preference for online social interaction (Caplan, 2003), and expectations about outcome of media exposure (LaRose & Eastin, 2004). The role of cognitions in PIU was acknowledged in the cognitive-behavioral model of PIU proposed by Davis (2001), which emphasized the individual's cognitions as the sufficient cause of abnormal behavior. Consistent with this view, several investigators have reported that adolescents high in maladaptive cognitions were also high in PIU or game playing (Caplan, 2003; LaRose & Eastin, 2004; Liu & Peng, 2009).

Although to our knowledge having not yet been tested, it is reasonable to hypothesize that maladaptive cognitions mediate the moderating effect of temperament on the relationship between stressful life events and PIU. To prove this, two aspects of evidence are needed (Muller, Judd, & Yzerbyt, 2005). First, maladaptive cognitions are associated with PIU. This condition has been met because, as mentioned earlier, adolescents with PIU have been found to be high in maladaptive cognitions (Caplan, 2003; LaRose & Eastin, 2004; Liu & Peng, 2009). Second, the relationship between stressful life events and maladaptive cognitions is moderated by

temperament. Compared with adolescents who are low in effortful control, those who high in effortful control are more likely to use adaptive forms of coping (e.g., problem solving, emotional regulation, positive thinking, and cognitive restructuring) when facing the challenge of stressful life events (Carver & Connor-Smith, 2010; Lengua & Long, 2002; Rueda & Rothbart, 2009), therefore they do not need to overly rely on the Internet to manage the negative emotions caused by stressful life events. In other words, in the presence of stressful life events, adolescents with high effortful control are less likely to develop maladaptive cognitions about the Internet-attaching too much importance to the social compensation and stress management functions of the Internet. In contrast, compared with adolescents with low sensation seeking, those with high sensation seeking are more likely to actively seek out new stimuli and are more sensitive to the cues of reward rather than that of punishment; thus they are more likely to be gratified with the Internet and attach more importance to the social compensation and stress management functions of the Internet. Therefore, the relationship between stressful life events and maladaptive cognitions may be moderated by temperament. Based on these analyses, it might be assumed that maladaptive cognitions mediate the moderating effect of temperament on the relationship between stressful life events and PIU.

Hypothesis 2a: Maladaptive cognitions mediate the moderating effect of effortful control on the relationship between stressful life events and PIU.

Hypothesis 2b: Maladaptive cognitions mediate the moderating effect of sensation seeking on the relationship between stressful life events and PIU.

In addition, we anticipate the moderating effect of temperament to be mainly manifested in its moderating effect on the relationship between stressful life events and maladaptive cognitions, rather than the relationship between maladaptive cognitions and PIU, according to Davis's (2001) proposition that maladaptive cognitions are sufficient causes of PIU.

1.5. Gender difference in the antecedents of PIU

A large body of evidence supported the gender difference in PIU-males are more likely to be involved in PIU than females (for reviews, see Chou et al., 2005; Shaw & Black, 2008). Then, an important and interesting question is why this gender difference might exist? As discussed above, the development of PIU can be explained by a mediated moderation model which includes independent variable (i.e., stressful life events), moderator variables (i.e., effortful control and sensation seeking), mediator variable (i.e., maladaptive cognitions), and outcome variable (i.e., PIU). The gender difference in PIU may theoretically come from two sources. On one hand, males may score higher on the risk factors of PIU than females, whereas females may score higher on the protective fac-

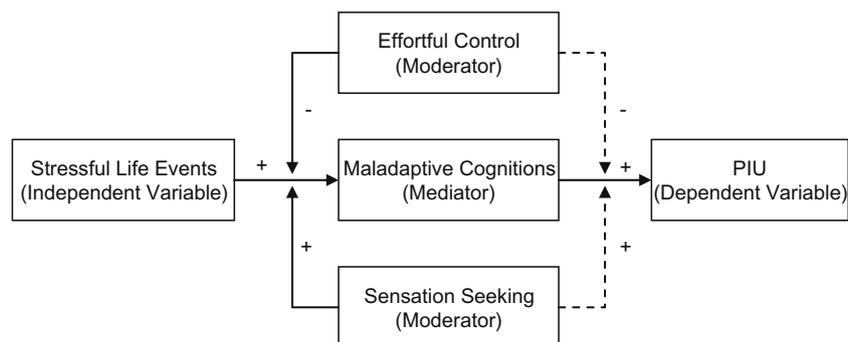


Fig. 1. Overview of the hypothesized mediated moderation model. Note. PIU, problematic Internet use.

tors for PIU than males. On the other hand, the strength of the associations that enhance PIU may be more potent for males than for females, whereas the strength of the associations that weaken PIU may be more potent for females than for males. However, given the lack of evidence in these two aspects at present, the hypothesis about the sources of gender difference in PIU is exploratory rather than confirmatory.

2. Method

2.1. Sample

Participants were 660 junior high school students from Grades 7 and 8 in Guangzhou area, southern China, all of whom came from middle-income families and schools. The mean age of these adolescents were 14.14 years ($SD = 0.86$, range = 12–17); 55% of them were females; 70.8% of their fathers and 85.6% of their mothers received less than high school education; 16.8% of their fathers and 41.2% of their mothers did not have a full time job during the past year.

2.2. Measures

2.2.1. Stressful life events scale

The stressful life events adolescents experienced during the past year were assessed with a 16-item questionnaire. The items in this questionnaire were adapted from adolescent self-rating life events checklist (Liu, Liu, Yang, & Zhao, 1997) to represent several stress domains: family, school, interpersonal, and individual. The items were “conflict or fighting against friends/classmates”, “misunderstood/blamed by others”, “falling behind in study”, “burdened with heavy load of study”, “family financial problems”, “serious family conflicts”, “major personal illness/injury”, “serious or chronic illness/injury of a relative”, “death of a parent”, “death of a close family member or friend”, “parents’ divorce”, “father or mother went out to work”, “sentiment or long separation between parents”, “being punished in school”, “transferring to a new school/suspended from the school”, “suffering a serious natural disaster”. For each of the 16 items, adolescents reported whether each event had occurred during the past year, if yes, they then indicated how stressful each event was for them, using a 6 point scale ranging from 0 = *did not occur* to 5 = *occurred and extremely stressful*. The mean was taken, with higher scores representing greater stressful life events they had experienced during the past year. The Cronbach’s α coefficient for the present sample was .76.

2.2.2. Effortful control and sensation seeking

Adolescents’ effortful control was assessed with early adolescent temperament questionnaire-revised short form (Ellis & Rothbart, 2001, April), a revision of that developed by Capaldi and Rothbart (1992). The revised questionnaire has 65 items and assesses 10 aspects of temperament related to self-regulation in adolescents. Given the focus of the present study, we selected 16 items pertaining to activation control, attention, and inhibitory control to measure effortful control. We used the Chinese version translated by Lay and Hsu and made slight adaptation in a pilot study. For each of the 16 items, adolescents rated how true each statement is for themselves on a 6-point scale ranging from 1 = *almost always untrue of you* to 6 = *almost always true of you*. The mean was taken, with higher scores representing higher levels of effortful control. The Cronbach’s α coefficient for the present sample was .76.

Adolescents’ sensation seeking was assessed by a subset of six items from sensation seeking scale (SSS; Zuckerman et al., 1978) as used by Steinberg et al. (2008), which clearly index thrill or nov-

elty seeking rather than impulsivity. These items were forward- and back-translated by Chinese speakers who were fluent in both Chinese and English. Slight changes were made to the items that could not be applied to typical Chinese cultures. For each of the 6 items, adolescents rated how true each statement is for themselves on a 6-point scale ranging from 1 = *almost always untrue of you* to 6 = *almost always true of you*. The mean was taken, with higher scores representing higher levels of sensation seeking. The Cronbach’s α coefficient for the present sample was .69.

2.2.3. Maladaptive cognitions

In this study, maladaptive cognitions are defined as unrealistic or all-or-nothing thinking associated with Internet use. This construct was measured by ten items which were adapted from previous measures in accordance with this definition and a small-scale open-ended questionnaire survey. These items captured two aspects of maladaptive cognitions: social convenience and stress coping. The former reflected adolescents’ overemphasis on the social compensation function of the Internet, for example, “friends online are more trustable than those offline” “friends online are much friendlier than those offline”. The latter reflected adolescents’ overemphasis on the stress management function of the Internet, for example, “people can escape from the stress in daily life when they are online” “when you are online, you do not have to worry about the difficult school work”. For each of the 10 items, adolescents indicated how true each statement is for themselves on a 6-point scale ranging from 1 = *not at all true* to 6 = *very true*. The mean of each aspect was taken, with higher scores representing stronger emphasis on social convenience and stress coping respectively. Given that the two aspects were highly correlated with each other ($r = .62$, $p < .001$), and the reliability of the 10 items ($\alpha = .88$) were higher than each of the two subscales ($\alpha = .83$ for social convenience, and $\alpha = .82$ for stress coping), we combined them by calculating the mean of the ten items without considering the unique effect of the two aspects.

2.2.4. PIU

Adolescents’ PIU was assessed with ten items adapted from Young’s (1998) questionnaire. For each of the 10 items, adolescents indicated how true each statement is for themselves on a 6-point scale ranging from 1 = *not at all true* to 6 = *very true*. The mean was taken, with higher scores representing higher levels of PIU. The Cronbach’s α coefficient for the present sample was .72.

2.3. Procedures

The assessment was conducted in classrooms after informed consents were obtained from the schools and the participants. The data collectors were trained post-graduates. They explained to all participants the requirements of questionnaires using standard instructions and emphasized the authenticity, independence and integrity of all answers. They also explained the confidentiality about all information collected. If participants had any questions during the assessment, they could raise their hands and ask the trained data collectors. The questionnaires were taken back right after they were finished. Participants were given approximately 20 min to complete the questionnaires.

3. Results

3.1. Descriptive analyses

Means and standard deviations of the major variables are presented in Table 1, for females and males separately. All variables, except for stressful life events and sensation seeking, showed sig-

Table 1

Means and standard deviations of stressful life events, temperament, maladaptive cognitions, and PIU.

Variables	Females (n = 364)		Males (n = 296)		F test
	M	SD	M	SD	
1. Stressful life events	1.01	0.74	1.03	0.82	0.03
2. Effortful control	4.16	0.66	4.01	0.71	7.73**
3. Sensation seeking	2.88	1.00	3.02	1.10	2.77
4. Maladaptive cognitions	2.60	1.01	2.97	1.11	19.31***
5. PIU	2.33	1.01	2.93	1.09	54.31***

Note. PIU = problematic Internet use.

** $p < .01$.

*** $p < .001$.

Table 2

Correlations between stressful life events, temperament, maladaptive cognitions, and PIU, for females and males.

Variables	1	2	3	4	5
1. Stressful life events	–	–.21***	.11*	.25***	.22***
2. Effortful control	–.14*	–	–.15**	–.38***	–.43***
3. Sensation seeking	.09	–.31***	–	.28***	.24***
4. Maladaptive cognitions	.21***	–.35***	.39***	–	.61***
5. PIU	.24***	–.51***	.34***	.64***	–

Note. Females' correlations appear above the diagonal and males' correlations below the diagonal. PIU = problematic Internet use.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

nificant gender differences. Compared with females, males had lower scores on effortful control, higher scores on maladaptive cognitions, and higher scores on PIU.

Table 2 contains the correlations between the variables involved in the present study, with above the diagonal for females and below the diagonal for males. Stressful life events and temperament variables were associated slightly to moderately with one another and with maladaptive cognitions and PIU. Maladaptive cognitions were associated moderately with PIU. There were some significant gender differences in the correlations, with the association between effortful control and sensation seeking (z difference = 2.05) stronger for males than for females ($p < .05$).

3.2. Testing for mediated moderation

As noted, the first and the second hypothesis, taken together, form a mediated moderation model. Mediated moderation occurs when a moderating effect is mediated by another variable (Mackinnon & Fairchild, 2009). We tested this model by multiple linear regression analyses, using the analytic procedures recommended by Muller et al. (2005).¹ The specification of these models can be seen in Tables 3 and 4, for females and males separately. In Equation 1, we estimated the moderation effect of two temperament dimensions (i.e., effortful control and sensation seeking) on the relationship between the independent variable (i.e., stressful life events) and the outcome variable (i.e., PIU).² In Equation 2, we estimated

¹ Structural equation model (SEM), which takes into account measurement error, can also be used to test the mediated moderation model. However, given that there exists no straightforward solution for estimating SEM models with latent variable interactions, complex model should be estimated with a large sample, and most of the measures used in this study showed acceptable reliability, we choose multiple regressions to estimate this model.

² Some scholars have theorized that different temperamental characteristics might interact with each other in predicting adolescents' adjustment, where one temperament trait might exacerbate or protect against risk consequences of another temperament trait (Rothbart & Bates, 2006), so we include effortful control by sensation seeking interaction term in the regression equations.

the moderation effect of two temperament dimensions on the relationship between the independent variable and the mediator (i.e., maladaptive cognitions). In Equation 3, we allowed both the mediator's (partial) effect on the outcome variable and the residual effect of the independent variable on the outcome variable to be moderated by the two temperament dimensions. In each equation, adolescents' age was included as a control variable. Following Frazier, Tix, and Barron (2004), all the predictors were centralized. Multicollinearity was not a problem according to the variance inflation factors.

For the present study, mediated moderation is indicated if the equation estimation results meet four criteria: (a) Equation 1 shows a significant association of the stressful life events \times temperament interaction with PIU, (b) Equation 2 shows a significant association of the stressful life events \times temperament interaction with maladaptive cognitions, (c) Equation 3 shows a significant association of maladaptive cognitions with PIU, and (d) the regression coefficient for the stressful life events \times temperament interaction estimated in Equation 3 is reduced in magnitude (or rendered non-significant) in comparison with the same coefficient estimated in Equation 1 (Muller et al., 2005).

3.2.1. Adolescent females

Table 3 presents the regression models for adolescent females. Presented here are the unstandardized coefficients (b) and their associated t statistics. Consistent with the results of correlation analysis, Equation 1 showed that stressful life events adolescent females experienced during the past year were positively associated with their PIU. Adolescent females' effortful control was negatively associated with PIU, whereas sensation seeking was positively associated with PIU. Equation 1 also found evidence for the predicted interaction between stressful life events and effortful control on outcome variable, PIU. To facilitate the interpretation of this interaction effect, Fig. 2 presents the predicted PIU as a function of stressful life events and effortful control. Simple slope test (Dearing & Hamilton, 2006) showed that the relationship between stressful life events and PIU was positive when levels of effortful control were low, $b = .31$, $t = 3.27$, $p < .01$, but non-significant when levels of effortful control were high, $b = -.01$, $t = -.07$, $p = .95$. However, the interaction between effortful control and sensation seeking, the interaction between stressful life events and sensation seeking, and the interaction between stressful life events, effortful control, and sensation seeking were non-significant.

Equation 2 reveals a significant association between stressful life events and maladaptive cognitions. Adolescent females' effortful control was negatively associated with maladaptive cognitions, whereas sensation seeking was positively associated with maladaptive cognitions. Equation 2 also found evidence for the interaction between stressful life events and effortful control. Fig. 3 presents the predicted maladaptive cognitions as a function of stressful life events and effortful control. Simple slope test showed that the relationship between stressful life events and maladaptive cognitions was significantly positive when levels of effortful control were low, $b = .33$, $t = 3.54$, $p < .001$, but non-significant when levels of effortful control were high, $b = .04$, $t = .44$, $p = .66$. However, the interaction between effortful control and sensation seeking, the interaction between stressful life events and sensation seeking, and the interaction between stressful life events, effortful control, and sensation seeking were non-significant.

Finally, the last equation in Table 3 showed that when maladaptive cognitions were included in the equation, the size of the interaction effect between stressful life events and effortful control previously discussed was significantly reduced and the interaction term became non-significant, indicating that maladaptive cognitions fully accounted for the moderating effect found between stressful life events and effortful control. In addition, the effect of sensation seeking previously discussed was also significantly

Table 3
Least squares regression results for mediated moderation model in females sample.

Predictors	Equation 1 (criterion PIU)		Equation 2 (criterion MC)		Equation 3 (criterion PIU)	
	<i>b</i>	<i>t</i>	<i>b</i>	<i>t</i>	<i>b</i>	<i>t</i>
Age	-.01	-.21	.09	1.60	-.06	-1.12
Stressful life events (SLE)	.15	2.27*	.19	2.85**	.06	1.03
Effortful control (EC)	-.56	-7.61***	-.44	-6.01***	-.34	-5.03***
Sensation seeking (SS)	.17	3.35***	.19	3.82***	.09	1.92
EC × SS	.00	.02	-.10	-1.50	.05	.76
SLE × EC	-.24	-2.23*	-.22	-2.06*	-.14	-1.42
SLE × SS	.03	.50	.00	.02	.02	.27
SLE × EC × SS	-.05	-.51	-.19	-1.87	.01	.14
Maladaptive cognitions (MC)					.51	10.84***
MC × EC					.01	.11
MC × SS					.06	1.21
MC × EC × SS					.08	1.32
<i>R</i> ²	.24		.25		.43	
<i>F</i>	13.93***		14.83***		22.39***	

Note. PIU = problematic Internet use.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

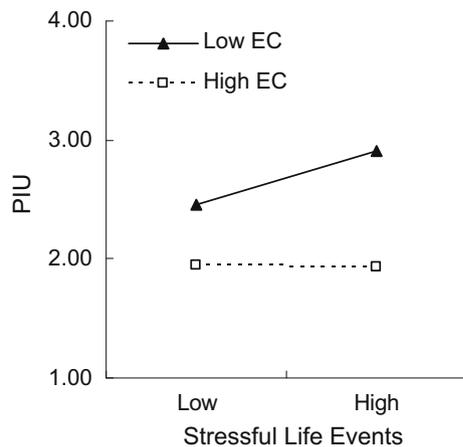


Fig. 2. Effortful control as a moderator of the relationship between stressful life events and females' PIU. Note. PIU, problematic Internet use; EC, effortful control.

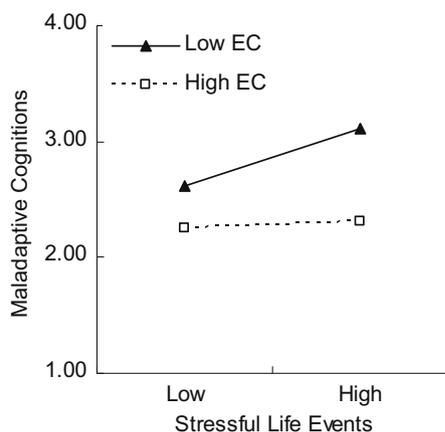


Fig. 3. Effortful control as a moderator of the relationship between stressful life events and females' maladaptive cognitions. Note. EC, effortful control.

reduced and became non-significant in Equation 3, thus indicating that maladaptive cognitions fully mediated the relationship between sensation seeking and PIU.

3.2.2. Adolescent males

Table 4 presents the regression models for adolescent males. Consistent with the results of correlation analysis, Equation 1 showed that stressful life events adolescent males experienced during the past year were positively associated with their PIU. Adolescent males' effortful control was negatively associated with PIU, whereas sensation seeking was positively associated with PIU. However, none of the predicted interactions reached the significance level at $p < .05$.

The results from Equation 2 showed that stressful life events adolescent males experienced during the past year were positively associated with maladaptive cognitions. Adolescent males' effortful control was negatively associated with maladaptive cognitions, whereas sensation seeking was positively associated with maladaptive cognitions. However, none of the predicted interactions reached the significance level at $p < .05$.

Finally, the last equation in Table 4 showed that when maladaptive cognitions were included in the equation, the effects of stressful life events and sensation seeking previously discussed were significantly reduced and became non-significant, indicating that maladaptive cognitions fully accounted for the relationship between stressful life events and PIU, and the relationship between sensation seeking and PIU. In addition, the size of the effect for effortful control previously discussed was also reduced but remained significant in Equation 3, thus indicating that maladaptive cognitions partially mediated the relationship between effortful control and PIU. Contrary to our hypothesis, we found a significant interaction between maladaptive cognitions and effortful control. This interaction meant that maladaptive cognitions significantly predicted PIU in adolescent males, but this effect was buffered by effortful control. That is, the risk effect of maladaptive cognitions for adolescent males high in effortful control, $b = .37$, $t = 5.52$, $p < .001$, was smaller than that for those with low levels of effortful control, $b = .57$, $t = 8.31$, $p < .001$ (see Fig. 4).

3.3. Gender difference in the antecedents of PIU

According to the hypothesis of the present study, gender difference in PIU may come from two sources. In line with our hypothesis, we found that males scored higher on the risk factors of PIU (i.e., maladaptive cognitions) than females, whereas females scored higher on the protective factors of PIU (i.e., effortful control) than males (see Table 1). However, we did not find that the strength of the associations that enhance or weaken PIU were different for

Table 4
Least squares regression results for mediated moderation model in males sample.

Predictors	Equation 1 (criterion PIU)		Equation 2 (criterion MC)		Equation 3 (criterion PIU)	
	<i>b</i>	<i>t</i>	<i>b</i>	<i>t</i>	<i>b</i>	<i>t</i>
Age	.10	1.65	.11	1.61	.06	1.11
Stressful life events (SLE)	.21	2.92**	.25	3.17**	.09	1.43
Effortful control (EC)	-.62	-7.63***	-.36	-4.06***	-.43	-5.95***
Sensation seeking (SS)	.17	3.30**	.31	5.61***	.02	.35
EC × SS	-.03	-.42	-.01	-.17	.02	.39
SLE × EC	-.03	-.33	-.02	-.21	-.01	-.06
SLE × SS	.07	.92	-.01	-.11	.09	1.33
SLE × EC × SS	-.01	-.15	.18	1.77	-.12	-1.54
Maladaptive cognitions (MC)					.47	9.49***
MC × EC					-.14	-2.11*
MC × SS					-.02	-.53
MC × EC × SS					-.01	-.25
R ²	.33		.25		.53	
F	17.60***		11.78***		26.20***	

Note. PIU = problematic Internet use.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

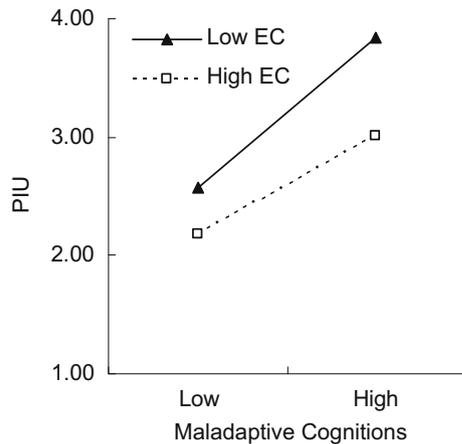


Fig. 4. Effortful control as a moderator of the relationship between maladaptive cognitions and males' PIU. Note. PIU, problematic Internet use; EC, effortful control.

females and males. One exception is that the association between the three-way interaction (i.e., stressful life events × effortful control × sensation seeking) and maladaptive cognitions were negative for females but positive for males, $Z = -2.57$, $p < .05$ (for detailed discussion of the method for comparing the equality of parameter estimates, see Brame, Paternoster, Mazerolle, & Piquero, 1998). Since neither of the regression coefficients ($b = -.19$, $t = -1.87$ for females, and $b = .18$, $t = 1.77$ for males) were significant at the significance level of .05, nor we have priori reason to support this difference, we do not attempt to make a further discussion about this result.

4. Discussion

Although stressful life events accounted for large proportions of variance in adolescents' PIU, greater stressful life events might not lead to the same increasing of PIU for all adolescents. In this study, we adopted an organism × environment (O × E) interaction approach to examine the occurrence of PIU in adolescent females and males. We tested a mediated moderation model, in which temperament moderated the relationship between stressful life events and PIU, and this moderating effect was mediated by maladaptive cognitions about Internet use; we also examined the sources of gender difference in PIU implied in this model.

First, the findings of the present study confirm the results from earlier studies that have found a positive relationship between stressful life events and PIU in adolescents. Our study also expands on the existing literature by examining whether adolescents' temperament (i.e., effortful control and sensation seeking) would moderate the relationship between stressful life events and PIU. Specifically, whether effortful control was a risk-buffering factor and whether sensation seeking was a risk-enhancing factor for adolescents' PIU. Consistent with our hypothesis, we found that adolescent females' effortful control moderated the relationship between stressful life events and PIU, such that this relationship is positive when levels of effortful control were low but non-significant when levels of effortful control were high. We can thus conclude that adolescent females who experienced stressful life events during the past year are indeed prone to getting involved in PIU, but also that this PIU is dynamic and is dependent upon their temperamental effortful control. This finding supports the view that self-regulation is a promising index or source of adolescent resilience—relatively positive adaptation in the face of heightened risk for maladaptation (Luthar, 2006). However, in contrast to our expectation, we did not find the moderating effect of sensation seeking on the relationship between stressful life events and PIU. Thus, our data suggests that stressful life events is a risk factor for PIU whose strength does not depend on the level of sensation seeking and, similarly, that high sensation seeking is a risk factor for PIU whose strength is not moderated by the presence or absence of stressful life events. This result should also be interpreted with caution given that the sample size of this study is relatively small that might decrease the statistical power to detect interaction effects.

The second goal of the present study was to understand the potential mechanisms of the moderating effect of temperament on the relationship between stressful life events and PIU. As mentioned above, adolescent females respond differently to the same stressful life events, depending on their levels of effortful control. Then, why are adolescent females high in effortful control less likely to get involved in PIU when they experience stressful life events? By including maladaptive cognitions as a mediator of the moderating effect, we found that in the face of stressful life events, adolescent females with high levels of effortful control are less likely to develop maladaptive cognitions about Internet use, thereby inhibiting their propensity for PIU. This is probably because adolescent females high in effortful control can flexibly shift their attention from negative stimuli and can use more positive coping

styles such as problem-solving when they face the challenge of stressful life events, thus they are less likely to overemphasize the social compensation and stress management function of the Internet.

Third, in line with prior studies (for reviews, see Chou et al., 2005; Shaw & Black, 2008), the present study demonstrates that males are more likely to develop PIU than females. More importantly, this study provides insight into the sources of gender difference in PIU. As expected, we found that males scored lower on the protective factors of PIU (i.e., effortful control) but higher on the risk factors of PIU (i.e., maladaptive cognitions) than females. Gender difference in effortful control is in agreement with a recent meta-analysis conducted by Else-Quest, Hyde, Goldsmith, and Van Hulle (2006), in which they found that girls displayed a stronger ability to manage and regulate their attention and to inhibit their impulses. Gender difference in maladaptive cognitions is likely because the content on the Internet (such as games) can better serve the needs of males than females. However, we did not find any meaningful gender difference in strength of the associations that enhance or weaken PIU in the present study. Given that the issue of gender in regard to the question of Internet use is an important one (Chou et al., 2005), more studies that incorporate other personal and environmental factors into the study of gender difference in PIU are particularly warranted.

Surprisingly, we found an interesting and important interaction effect between maladaptive cognitions and effortful control for adolescent males' PIU. This finding suggests that, as an important asset, effortful control can still protect adolescent males from PIU even if they develop maladaptive cognitions about Internet use. This is a little contrary to Davis' (2001) cognitive-behavioral model of PIU which proposed that maladaptive cognitions were proximal sufficient cause for the development of PIU. Although maladaptive cognitions are the main etiological factor for PIU, individuals high on them might not necessarily develop PIU, depending on their effortful control. In fact, some researchers have argued that no single cause (such as maladaptive cognitions in this study) may be either necessary or sufficient and the effect of a risk factor will depend on its timing and relation to other risk factors (Greenberg, 2006). Therefore, we can keep a positive perspective toward the relative plasticity of individuals who are high on maladaptive cognitions.

The present study should be interpreted in light of certain limitations. First, the correlational nature of the data precludes ascertaining direction of effects, although the direction of effects we advance is consistent with previous theoretical and empirical work. Future research should adopt a longitudinal design and begin to explore potential reciprocal influences among the constructs. In addition, all measures in the present study were based on adolescents' self-report. Future research should use multiple informants (e.g. adolescents, parents, teachers, and peers) and multiple methods (e.g. survey, interview, and observation) simultaneously to collect data, thereby measuring these constructs more comprehensively.

The findings of this study extend our current knowledge and have important implications for our etiological models of adolescents' PIU, as well as for prevention efforts aimed at diminishing the negative impact of stressful life events. Although previous studies have increasingly focused on the contribution of stressful life events to the development of adolescents' PIU, few studies have investigated when and how this risk effect exists. This study adds to existing research by demonstrating that effortful control buffered the risks of stressful life events for adolescents' PIU, and maladaptive cognitions mediated this risk-buffering effect. This view is consistent with the first and second major contribution of this work. In this initial attempt to examine the sources of gender difference of PIU, the findings suggest that adolescent males scored

higher on risks but lower on protective factors of PIU. The findings of the present study highlight the importance of using a person and environment interaction approach to understand, prevent, and intervene in the development of adolescents' PIU. First, unlike previous research in this area, our results imply that enhancing self-regulation or identifying self-regulation deficiencies in adolescents exposed to stressful life events should be the focus of preventive interventions aimed at mitigating the impact of stressful life events on adolescents' PIU. Additionally, our results imply that treatments aimed at changing maladaptive cognitions such as cognitive behavioral therapy may also be promising for reducing the development of PIU.

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