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FULL-LENGTH REPORT



Mindfulness buffers the influence of stress on cue-induced craving for Internet among Chinese colleges with problematic Internet use

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ABSTRACT

Background and aims: Stress is a common experience among college students with problematic Internet use, and it may exacerbate their cue-induced Internet craving. This study aimed to examine the influence of stress on cue-induced craving for the Internet among subjects with problematic Internet use and the buffering effect of mindfulness. *Methods:* Sixty-eight college students with problematic Internet use were assigned to groups with a 2 (stress vs. no-stress) × 2 (high vs. low mindfulness) between-subject design. *Results:* It was deduced that stress could significantly enhance cue-induced craving for the Internet, and mindfulness could buffer this effect. Specifically, the effect of stress on cue-induced craving for the Internet was weaker among subjects with high mindfulness as compared to subjects with low mindfulness. *Discussion and Conclusions:* These findings contribute to understanding of the factors influencing problematic Internet use and how such factors interact. It also provides recommendations on how to prevent the progression of problematic Internet use and suggests possible interventions.

KEYWORDS

cue-induced craving, stress, mindfulness, problematic internet use

INTRODUCTION

Problematic Internet use (PIU; also known as “Internet addiction” or “pathological Internet use”) (Kojima, Shinohara, Akiyama, Yokomichi, & Yamagata, 2021) is an increasingly prevalent behavioral problem. It refers to the inability of individuals to control their use of the Internet, thereby leading to panic in its absence and detrimental effects on their lives (Vadher et al., 2019; You et al., 2021). PIU was found to be linked to a high risk for physical and psychological problems, such as suicidal ideation and self-harm (Kuang et al., 2020) and other mental disorders (e.g., substance use disorders and mood disorders) (Chamberlain, Ioannidis, & Grant, 2018; Sevelko et al., 2018).

The Interaction of Person–Affect–Cognition–Execution (I-PACE) model provides a theoretical framework explaining the processes underlying the development and maintenance of Internet-use disorder. The model suggests that cravings induced by addiction-related cues are the key mechanism for the maintenance of PIU (Brand et al., 2016, 2019). Researchers have demonstrated that individuals with internet gaming disorder reported a high craving of internet gaming, following game-related cues (Ma et al., 2019). These cue-induced cravings were also observed in those with substance addiction (Giasson-Gariépy, Potvin, Ghabrash,

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Bruneau, & Jutras-Aswad, 2017). On the brain level, brain regions related to cue-induced craving (e.g., precuneus and right anterior cingulate) are activated in individuals with internet gaming addiction. These activations also exist in individuals with substance addiction (Ko et al., 2009, 2013).

Based on these evidences, cravings are not only limited to substance addiction but also may be a key factor uncovering the mechanism underlying PIU. Cravings are the subjective perception of a motivational state characterized by an uncontrollable urge to participate in addictive behavior (Sayette, Shiffman, Tiffany, Niaura, & Shadel, 2015; Tiffany & Conklin, 2000). However, there has been few research examining the predisposing factors and moderating variables involved in cravings for the Internet (Brand et al., 2016, 2019). According to the I-PACE model, the present study aimed to examine factors (e.g., stress) influencing cue-induced craving among subjects with PIU. The study also analyzed whether personality traits (e.g., mindfulness) would moderate the effect of stress on cue-induced craving among subjects with PIU, with the goal of providing scientific support for the I-PACE model and contributing to the development of interventions preventing relapse among former college students with PIU.

Simultaneously, I-PACE posits that the combination of internal (i.e., personality) and external factors (i.e., stress) contributes to the development of addiction (Brand et al., 2016, 2019). Stress is an important external factor in the development of cravings and the provocation of relapse in addictive behaviors (Fox, Bergquist, Hong, & Sinha, 2007; Glynn et al., 2018; Michalowski & Erblich, 2014; Ruisoto & Contador, 2019; Tartter & Ray, 2012). Specifically, adopting Internet as a tool for coping with stressful life events and negative emotions is considered the most likely initiating factor in the development of PIU (Canale et al., 2019; Hou et al., 2019). This can be explained by the affective processing model of negative reinforcement (Baker, Piper, McCarthy, Majeskie, & Fiore, 2004; Snelleman, Schoenmakers, & van de Mheen, 2014). In this model, stressors cause or increase negative affect, which, in turn, influences unconscious cognitive processes and motivates the learned avoidance behavior of engaging with the addictive substance or behavior to relieve negative affect. Repetition of this process conditions an association between the addiction stimuli and relief from distress, thereby leading to cravings for the stimuli. Empirical research has demonstrated that stress contributes to cravings for addictive stimuli, such as alcohol and nicotine than stimuli per se (Netter & Hennig, 2017; Tartter & Ray, 2012). Cravings can be triggered by addiction-related stimuli, and PIU is no exception. Internet-related stimuli significantly increase craving for the Internet among subjects with PIU (Niu et al., 2016). Thus, it was hypothesized that stress would exacerbate cue-induced cravings among subjects with PIU.

In addition, the I-PACE model also postulates that personality trait (e.g., trait mindfulness) is an important factor in the development of addictive behavior (Brand et al., 2016, 2019). Though mindfulness could be a trait or state, state mindfulness is a short-term experience that fluctuates in the

engagement of mindfulness processes using mindfulness skills (Eisenlohr-Moul, Peters, Pond, & DeWall, 2016), whereas, trait mindfulness is a relatively stable capacity that represents non-judgmental, accepting, and self-empathetic awareness of the present-moment experience (i.e., physical sensations, thoughts, and emotions) (Brown & Ryan, 2003; Calvete, Gámez-Guadix, & Cortazar, 2017). Trait mindfulness is more widely accepted as compared to state mindfulness, and is used in studies owing to its stability and valid measurement. A mindfulness re-perceiving model argues that shifting individuals' perceptions toward mindfulness enables them to free themselves of the control exerted by problematic emotions and habitual reactive patterns (Shapiro, Carlson, Astin, & Freedman, 2006). Empirical research supports the negative association between trait mindfulness and craving (Garland, 2014; Hsiao et al., 2019).

It is possible that the association between stress and cue-induced craving could be moderated by trait mindfulness. The craving induced by stress (Netter & Hennig, 2017) may be attenuated in individuals with high levels of trait mindfulness. Individuals with high levels of trait mindfulness have more metacognitive awareness (Garland, Gaylord, & Park, 2009), and this facilitates more functional coping strategies (Li, Howard, Garland, McGovern, & Lazar, 2017) to deal with stress. Trait mindfulness also enhances self-regulation (Calvete et al., 2017; Sancho et al., 2018) and disengages the attention of addicts from substance-related stimuli (Garland, 2014), both of which would decrease cravings in substance use disorders (Garland et al., 2014; Li et al., 2017; Hochster, Block-Lerner, Marks, & Erblich, 2018; Tapper, 2018). Thus, it was hypothesized that trait mindfulness would moderate the influence of stress on cue-induced cravings. Specifically, those with high mindfulness will cope better with stress and show low levels of cue-induced cravings.

METHODS

Participants

A total of 68 subjects with PIU from two public universities in central China were recruited for this study (43 men and 25 women, $M_{\text{age}} = 19.57 \pm 1.33$ years old). The inclusion criteria were (1) a score of ≥ 3.15 on the Adolescent Pathological Internet Use Scale (APIUS) (Lei & Yang, 2007) and (2) more than five affirmative answers to Young's brief diagnostic questionnaire (Young, 1998). Participants were asked not to use the Internet for two hours before the experiment and were compensated with 20 RMB (approximately \$3) for completing the experiment.

Measures

The public speaking paradigm (Cremers et al., 2015) was adopted to induce stress in study participants. Participants were instructed to deliver a three minutes self-introduction speech on camera for a job application. They were informed that their performances would be video-taped and judged by



experts (Cremers et al., 2015). All participants were asked to prepare for three minutes and participate in the experiment immediately after the preparation. This procedure was performed to guarantee the validity of the stress experience throughout the experiment. Moreover, on one item “How intense is your stress right now?” participants were asked to rate their stress level with seven-point scale from 1 (no-stress) to 7 (intense stress).

Trait mindfulness was assessed using the Mindful Attention Awareness Scale (MAAS) (Brown & Ryan, 2003). A representative item is as follows: “I could be experiencing some emotion and not be conscious of it until sometime later.” Participants rated 15 items on a six-point scale from 1 (almost always) to 6 (almost never), with high scores indicating high levels of mindfulness. The robust psychometric properties of the Chinese version of the MAAS have been demonstrated in prior studies among college students (Deng et al., 2012). The internal consistency of the Chinese MAAS in the present study was good ($\alpha = 0.84$). Using grouping methods from previous research (Patterson & McDonald, 2015) and allowing for balance between groups, the participants were divided into high and low mindfulness groups by a median split of their scores on the MAAS. In the present study, the scores for the high mindfulness group were also significantly higher than those of the low mindfulness group: $M_{\text{high}} \text{ mindfulness} = 4.33 \pm 0.72$, $M_{\text{low}} \text{ mindfulness} = 3.21 \pm 0.82$; $t = 4.57$, $P < 0.01$, which indicates the validity of mindfulness grouping experimental manipulation.

PIU was assessed using the Adolescent Pathological Internet Use Scale (APIUS) (Lei & Yang, 2007). This consists of 38 items and measures six dimensions (i.e., salience, mood alteration, social comfort, tolerance, compulsive Internet use/withdrawal symptoms, and negative outcomes). A representative item is as follows: “I forget nearly everything else when I am online.” Participants rated all items on a five-point scale from 1 (totally disagree) to 5 (totally agree). A score of ≥ 3.15 on the APIUS is indicative of PIU. The internal consistency of the APIUS in the present study was good ($\alpha = 0.91$ for the whole scale; α between 0.80 and 0.89 for all dimensions).

The cue-reactivity paradigm was adopted to induce and evaluate participants’ cravings for the Internet (Carter & Tiffany, 2001; Niu et al., 2016). In the cue-reactivity experiment, initially, instructions were given to ensure participants understood the task; then, a fixation point “+” was presented for 500 ms. Subsequently, a series of six internet-related words were presented (using E-Prime 2.0 software) randomly for 3,000 ms each, with each word reappearing four times. The stimuli were 12 internet-related words. These were Taobao (淘宝), group buying (团购), e-bank (网银), online game (网游), level up (升级), game equipment (装备), WeChat (微信), Tencent (腾讯), Weibo (微博), download (下载), links (链接), and websites (网页). These were standardized items that have been used in a previous study (Niu et al., 2016) to induce Internet cravings in Internet addicts. Participants were asked to assess their craving for the Internet (post-cue exposure) with a seven-point scale from 1 (no craving) to 7 (intense craving) after

being exposed to this set of stimuli in an experimental trial. Self-reported cravings (pre-cue exposure) were also assessed with one item “How intense is your craving for the Internet right now?” with a seven-point scale ranging from 1 (no craving) to 7 (intense craving). The difference between self-reported cravings before and after cue exposure indicated the level of cue-induced craving for the Internet.

Procedure

All participants were initially instructed to perform a five minutes relaxation exercise. After the relaxation exercise, two items were used to assess their pre-stress levels and pre-exposure craving for the Internet. Then, participants were then randomly assigned to the stress or the non-stress condition. Participants in the stress condition were asked to undergo the cue-reactivity paradigm to measure post-exposure craving immediately after three minutes of speech preparation. Participants in the non-stress condition were asked to undergo the cue-reactivity paradigm to measure post-exposure craving after a three minutes preparation. Following the experiment, participants were asked to reevaluate their level of post-stress, and the participants in the stress group gave a three minutes public speech as required after stress was reassessed. Finally, all participants were again instructed to perform a five minutes relaxation exercise to eliminate any negative effects from the stress induction.

Statistical analyses

Statistical analyses were conducted with SPSS 22.0. First, descriptive statistics were employed to calculate means, standard deviations for all variables. Then, t tests for independent samples were used to analyze group differences (e.g., stress or non-stress). After that, an ANOVA was used to examine the main effect of stress or mindfulness on cue-induced craving, and the interaction effect of stress and mindfulness on cue-induced craving. Finally, a further simple effect analysis was performed to investigate the effect of stress on cue-induced cravings on individuals with high and low mindfulness.

Ethics

The study procedures were approved by the Ethics Committee of Institutional Review Board. Prior to the study, all participants gave written informed consent.

RESULTS

As presented in Table 1, no significant difference was observed for the APIUS, mindfulness, pre-stress, and pre-exposure craving between the stress and non-stress groups, thereby ensuring the homogeneity of the two groups and successful randomization. However, significant differences were observed for post-stress and post-craving between the two conditions, demonstrating the validity of the

Table 1. Descriptive analysis of all variables and *T*-test for between the two conditions

	Overall (<i>n</i> = 68) <i>M</i> (<i>SD</i>)	Stress (<i>n</i> = 34) <i>M</i> (<i>SD</i>)	No-stress (<i>n</i> = 34) <i>M</i> (<i>SD</i>)	<i>t</i>
APIUS	3.98 (0.31)	3.94 (0.28)	3.99 (0.40)	0.61
Mindfulness	3.78 (0.76)	3.83 (0.74)	3.75 (0.81)	0.88
Pre-stress	3.88 (1.12)	3.84 (1.06)	3.90 (1.17)	0.65
Post-stress	4.52 (1.34)	5.21 (1.13)	3.88 (1.52)	3.25*
Pre-craving	2.84 (1.22)	2.81 (1.26)	2.89 (1.17)	0.91
Post-craving	5.49 (0.58)	5.99 (0.42)	5.05 (0.73)	3.79*

Note. **P* < 0.05, ***P* < 0.01, ****P* < 0.001.

experimental manipulation. The public speaking paradigm, in particular, was successful in inducing stress, and internet-related cues were also successful in inducing craving for the internet.

The results revealed significant main effects for both stress ($F_{(1, 66)} = 13.35, P < 0.01, \text{partial } \eta^2_p = 0.39$) and mindfulness conditions ($F_{(1, 66)} = 8.79, P < 0.05, \text{partial } \eta^2_p = 0.21$), indicating that the cue-induced craving for the Internet was significantly higher for those in the stress condition than those in the non-stress condition, and the cue-induced craving for the Internet was significantly lower in the high mindfulness condition than in the low mindfulness condition (see Fig. 1). Additionally, a significant interaction ($F_{(1, 66)} = 6.27, P < 0.05, \text{partial } \eta^2_p = 0.18$) was found. As shown in Fig. 1, although the effect of stress on cue-induced craving for the Internet was significant in both the high ($F_{(1, 66)} = 3.16, P < 0.05$) and low mindfulness ($F_{(1, 66)} = 6.92, P < 0.01$) groups, this effect was attenuated among individuals with PIU with higher mindfulness (see Fig. 1). This indicates that mindfulness can significantly buffer the effect of stress on cue-induced craving for the Internet in PIU.

DISCUSSION

Previous research has revealed that internet-related stimuli could induce craving for the Internet among individuals with

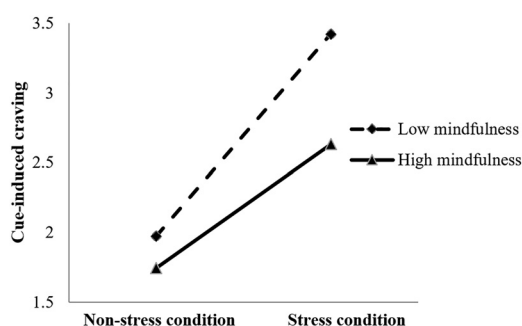


Fig. 1. The buffering effect of mindfulness on the effect of stress on cue-induced craving for the Internet

Note. There were only 65 participants in the mindfulness group analysis, as three participants had median scores and were not included in the analysis.

PIU (Niu et al., 2016; Zhang et al., 2016). Based on these findings, the present study demonstrated that stress could significantly enhance cue-induced cravings for the Internet among individuals with PIU. That is, the cue-induced craving for the Internet is more pronounced under stress. According to the positive reinforcement theory of craving, individuals gradually establish a close association between addiction-related stimuli and the positive feelings accompanying the addictive behavior, thereby leading the stimuli to reinforce cravings (Drummond, 2001; Drummond, Litten, Lowman, & Hunt, 2000). Regarding stress, research indicates that stress can trigger the motivation and reward system underlying addictive behaviors and make people more sensitive to addiction-related stimuli (Volkow & Morales, 2015; Johnston, Linden, & van den Bree, 2016). Coping with or escaping from stress is believed to be the primary motivation for PIU (Jun & Choi, 2015). Hence, individuals with PIU are likely to exaggerate the positive valence of internet-related stimuli and the satisfaction attained from Internet use in stressful situations (Michalowski & Erblich, 2014; Glynn et al., 2018). Therefore, stress can enhance cue-induced craving for the Internet among subjects with PIU.

This study also demonstrated that mindfulness can help mitigate the effect of stress on cue-induced cravings, with this association being more noteworthy among participants with low mindfulness. Mindfulness, in particular, could attenuate the effect of stress on cue-induced cravings among participants with PIU. Individuals who have high mindfulness have more objective awareness of their state and experience, thereby making them accept stress and negative emotional experiences, and adopt more positive and adaptive strategies to cope with stress (Akin & Akin, 2015; Kalapiran, Koo, Kirubakaran, & Hancock, 2015). All such coping mechanisms could relieve the perceived stress (Daubenmier, Hayden, Chang, & Epel, 2014; Khoury, Sharma, Rush, & Fournier, 2015) and attenuate the deleterious effects of stress (Khoury et al., 2015; Song & Park, 2019) on craving for the Internet among subjects with PIU. Simultaneously, individuals with high mindfulness will observe and act with awareness, thereby increasing self-regulation and reducing compulsion and loss of control (Calvete et al., 2017). This may also help reduce cravings for PIU, even when individuals are under a lot of stress. Thus, mindfulness may attenuate the enhanced cue-induced cravings for the Internet in stressful situations.

IMPLICATIONS AND LIMITATIONS

Previous studies have found trait mindfulness to be negatively associated with PIU and to buffer the influence of risky environmental factors (such as stress) on PIU (Liu et al., 2018; Song & Park, 2019). The present study expanded on this by examining the effects of trait mindfulness on cue-induced craving for the Internet among individuals with PIU. Cue-induced craving is one of the most important mechanisms underlying the maintenance of substance addiction (Ko et al., 2013). The present study supports

previous research that has demonstrated a similar mechanism at work in Internet-use disorders. The study findings also provide practical guidance for prevention of, and intervention with, PIU. PIU interventions should be conducted in a stress-free situation, and mindfulness should be incorporated to reduce the cravings for the Internet induced by external factors.

Some limitations of the present study should be considered. First, the first-choice applications and control for other aspects of participants' Internet use (e.g., frequency or duration) were not collected. Future research should consider first-choice applications and usage motivations when investigating specific subtypes in the context of Internet-use disorders. Second, the sample size was relatively small, and this may limit the generalizability of the study's findings. Future research should recruit more participants to replicate the present study results and examine the relationship between stress, mindfulness, and craving in Internet-use disorders. Finally, the classification of PIU use was based on questionnaires, which are susceptible to recall bias. In the future, more objective, standardized diagnostic criteria should be used.

CONCLUSIONS

The present study revealed that stress can enhance cue-induced craving for the Internet among individuals with PIU and mindfulness can buffer the deleterious effect of stress on cue-induced craving for the Internet. Mindfulness is a positive trait that should be developed to promote healthy growth and prevent Internet addiction. In summary, this study provides a theoretical basis for the development of mindfulness-based intervention programs addressing Internet addiction.

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Authors' contribution: Xiao-jun Sun, Chang-ying Duan: Conceptualization, Formal analysis, Writing - Original Draft; Yuan Tian, Ya-mei Zhang: Writing - Review and Editing; Geng-feng Niu: Supervision.

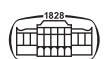
Conflict of interest: The authors declare that they have no conflicts of interest.

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