



Cue-induced craving for Internet among Internet addicts



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HIGHLIGHTS

- The cue-reactivity paradigm was used to examine cue-induced craving for the Internet among Internet addicts and non-addicts.
- Internet-related words were used as stimuli to induce craving for the Internet.
- Internet-related words aroused all participants' cue-induced craving, with Internet addicts reporting more intense craving.

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ABSTRACT

Intense craving is a core feature of addictive disorder, and cue-induced craving is believed to be a key factor in the maintenance and relapse of addictive behaviors. With the rapid development of the Internet, Internet addiction has become a widespread behavioral problem accompanied by many negative effects. This study used the cue-reactivity paradigm to examine cue-induced craving for the Internet among Internet addicts and non-addicts. Participants were exposed to Internet-related words, and asked to report their craving for the Internet. Results indicated that Internet-related words aroused cue-induced craving for the Internet among both Internet addicts and non-addicts; however, the craving was more intense among Internet addicts. These results suggest that craving may not be a unipolar, all or none state found only in addicts, but may also be present among non-addicts. They indicate that Internet-related words may be able to induce craving for the Internet, and that Internet addiction and other addictions may share similar underlying mechanisms. This finding has important implications for designing interventions for Internet addiction.

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1. Introduction

With the exponential growth of information technology in the last two decades, the Internet has become an integral part of our daily lives. The number of global Internet users has reached almost 2.5 billion (Spada, 2014), and at the end of 2014, the number of Internet users in China alone was 649 million (almost half of the country's total population) (CNNIC, 2014). Although the Internet offers many benefits, it is

becoming apparent that it also comes with some costs, notably that of Internet addiction. Internet addiction, also known as problematic Internet use, Internet dependence, or pathological Internet use, is characterized by compulsive Internet use and preoccupation with and loss of control over this use that interferes with an individuals' daily functioning (Caplan, 2002; Davis, 2001; Van den Eijnden, Meerkerk, Vermulst, Spijkerman, & Engles, 2008; Young & Abreu, 2011).

Internet addiction has now been recognized to be a common behavioral problem worldwide because of its negative effects (Kalaitzaki & Birtchnell, 2014; Spada, 2014; Wang et al., 2013). It not only causes social and psychological problems, but also leads to significant impairments in physical health (Aboujaoude, 2010; Young, 1998). Prior studies have examined the variables that predict Internet addiction, such as individual factors (e.g., personality and self-control) and environmental factors (e.g., parent-child relationships and peer relationships) (Lam, 2014; Liu et al., 2015; Yang, Lu, Wang, & Zhao, 2014), but little attention has been paid to the mechanisms by which Internet

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addiction may be maintained. A better understanding of these underlying mechanisms is required to develop effective interventions.

In previous studies on addiction, craving has received considerable attention. It refers to a strong and prevalent desire or motivational state wherein an individual cannot restrain the impulse to experience or act out an addictive behavior repeatedly (Shiffman, 2000; Skinner & Aubin, 2010; Tiffany & Wray, 2012). Research on tobacco, alcohol, drug, and gambling addiction has shown that craving may serve to maintain and exacerbate addictive behaviors, and often even induces relapse (Skinner & Aubin, 2010; Tiffany & Wray, 2012; Welberg, 2013). Addiction-related cues can significantly arouse addicts' craving, and cue-induced craving is thought to be a key factor in the maintenance and relapse of addictive behaviors (Ashrafioun & Rosenberg, 2012; Sinha & Li, 2007). To explain why craving may be induced by addiction-related cues, positive reinforcement theory holds that addiction-related cues are positively reinforcing because of the repetitive nature of addiction-related behaviors. It suggests that addiction is a process whereby individuals gradually establish a close association between addiction-related cues and the positive affect and feelings that accompany addictive behaviors (Drummond, 2001).

The cue-reactivity paradigm is one of the most reliable and ecologically valid paradigms to induce and evaluate craving, and has been widely used to induce and evaluate craving for substances, food, and gambling (Carter & Tiffany, 2001; Ko, Liu, Yen, Chen, et al., 2013). In the classic version, participants are briefly exposed to cues (neutral or addiction-related), and self-reported cravings are assessed immediately after cue exposure. Typically, pre-exposure and post-exposure cravings are compared to measure the craving induced by the cues (Salgado-García, Cooper, & Taylor, 2013; Yokum & Stice, 2013). Given the importance of cue-induced craving in addiction, some researchers have investigated cue-induced craving in Internet addiction using the cue-reactivity paradigm. For example, using gaming pictures, Ko, Liu, et al. (2009), Ko, Yen, et al. (2009), and Ko, Liu, Yen, Yen, et al. (2013) investigated the brain areas associated with cue-induced craving for online games in online gaming addicts, and found activation in the right orbitofrontal cortex, bilateral anterior cingulate, medial frontal cortex and right DLPFC; interestingly, these areas have also been implicated in substance abuse cravings. It should be noted that research on online gaming addicts has used game-related pictures as stimuli. Compared to words, pictures are more ubiquitous, and may arouse greater cognitive and emotional processing (Kensinger & Schacter, 2006).

According to the incentive-sensitization model of addiction, which accounts for the incentive salience of addiction-related cues as well as addicts' sensitivity to these cues, long-term addictive behavior could change the sensitivity of related neuro systems, in particular those involved in the process of incentive motivation and reward. As a result, addicts may gradually form neural sensitization, and become highly sensitive to related cues (Robinson & Berridge, 2001). Although this model was initially proposed to explain substance addiction, it has since been applied to behavioral addictions, such as gambling and Internet addiction (Ko, Liu, Yen, Chen, et al., 2013; Rømer, Fjorback, Møller, & Lou, 2014). Researches have found that related word stimuli can significantly induce addicts' psychological and behavioral reactions including craving and attentional biases to related stimuli (Field & Cox, 2008; Field, Munafò, & Franken, 2009; Sayette et al., 2000). Internet addicts have also been found to show attentional bias to Internet-related word stimuli (Holst et al., 2012; Metcalf & Pammer, 2011). For instance, using a modified Stroop task, Metcalf and Pammer (2011) found that online game addicts had significantly longer reaction times to game-words compared with neutral words, whereas non-game players showed no such bias.

Based on these findings, the goal of this study was to use the cue-reactivity paradigm to investigate the effect of Internet-related words on cue-induced craving for the Internet. The results of the study should shed light on the psychological mechanisms underlying Internet addiction, as well as any differences and similarities with other addiction

disorders. Building upon the literature reviewed above, and the incentive-sensitization model we hypothesized that: Internet-related words would arouse cue-induced craving for the Internet, and that cue-induced craving would be more intense among Internet addicts than non-addicts.

2. Method

2.1. Participants

A total of 40 Internet users were recruited from undergraduate courses, and they were selected and categorized into two groups (Internet addicts and non-addicts) based on their scores on the Adolescent Pathological Internet Use Scale (APIUS) (Lei & Yang, 2007) and Young's brief diagnostic questionnaire (YDQ) (Young, 1998). The APIUS has been found to be reliable and valid among Chinese adolescents and university students, with high internal consistency ($\alpha = 0.95$ for the whole scale; α between 0.81 and 0.91 for all subscales) (Lei & Yang, 2007; Liu et al., 2015). The APIUS has 38 items, which assess the behavioral, emotional and maladaptive cognition symptoms of Internet addiction (e.g., salience, mood alteration, compulsive internet use/withdrawal symptoms, and negative outcomes); each item is rated from 1 to 5, and each participant's mean score was computed. Individuals with a mean score higher than 3.15 were included in the Internet addict group, whereas those with a mean score below 3 were considered to be average, non-addicted Internet users. For an additional source of information about their extent of Internet use, Young's brief diagnostic questionnaire (YDQ) (Young, 1998) was also used; respondents who answered "yes" to five or more of the criteria (e.g., do you feel the need to use the Internet with increasing amounts of time in order to achieve satisfaction?) were considered to be Internet addicts. A meta-analysis previously indicated that the criterion-related validity for the YDQ was 0.72, and coefficient alpha was 0.87 (Kuang, Cao, & Dai, 2011). The criteria for inclusion in the Internet-addict group was that participants had to receive an APIUS average score higher than 3.15, and had to provide at least five affirmative answers on the YDQ. In contrast, Internet users who did not satisfy the above criteria for the two screening tools were included in the non-addict control group. Respondents were excluded from the study if they reported (1) current or past substance abuse, (2) a history of hospitalization for mental illness, and (3) were less than 18 years old.

The mean score on the APIUS for Internet addicts ($M = 3.97 \pm 0.27$, ranging from 3.42 to 4.68) was significantly higher than that of the non-addicts ($M = 2.05 \pm 0.32$, ranging from 1.17 to 2.54; $t_{(38)} = 19.94$, $p < 0.001$); similarly the mean score on the YDQ was also significantly higher for the Internet addicts ($M = 6.95 \pm 0.41$, ranging from 6 to 8) than for the non-addicts ($M = 2.74 \pm 0.43$, ranging from 1 to 4; $t_{(38)} = 14.96$, $p < 0.001$). Participants' age ranged from 18 to 23 years, and there was no statistically significant difference ($t_{(38)} = 0.08$, $p > 0.05$) between Internet addicts ($M = 19.72 \pm 1.29$) and non-addicts ($M = 19.81 \pm 1.27$) with regards to age. All participants were given written informed consent according to guidelines for the protection of research volunteers of Central China Normal University's Institutional Review Board. Participants were also asked not to use the Internet 2 h prior to their participation in the experiment. At the completion of the experiment, 20 RMB (about 3 US dollars) was given to participants for their participation.

2.2. Stimuli

The stimuli were twelve Internet-related words, which were identified through open-ended questionnaires from 178 undergraduate students. Twelve words were selected according to their frequency. Subsequently, 15 different undergraduate students (including five Internet addicts) used a 7-point Likert response format to evaluate the words on their perceived relevance to Internet; the average score was

6.17 ± 0.54 . These twelve words were then used in the experiment, and examples include Taobao (淘宝), WeChat (微信) and online-game (网游).

2.3. Assessment

Self-reported craving was assessed two times (pre-cue exposure and post-cue exposure) through a brief, 0 (no craving)–10 (intense craving), instrument (“How intense do you feel a craving for the Internet right now?”). Designed specifically to make rapid assessments of craving during the experiment, it has been used widely in relevant studies (Ashrafioun & Rosenberg, 2012; Sayette et al., 2000). A brief instrument (1 “not at all” to 7 “very much”) was also used to assess participants’ relaxation state before the formal experiment.

2.4. Design and procedure

The study employed a mixed 2×2 design with the cue-reactivity paradigm, with addiction status (Internet addicts vs. non-addicts) as the between-subjects factor, and pre-cue exposure vs. post-cue exposure as the within subjects-factor. To ensure that participants would not be affected by their former state and behaviors, they were asked to do five-minute relaxation exercises, and their current relaxation and craving (pre-exposure craving) for the Internet was assessed. Then, participants were shown a series of six words (each word was presented for 3000 ms and appeared four times throughout the experiment) randomly through the E-prime 2.0. Participants were exposed to each series of words for 18 s and were given 45 s to respond to the craving assessment before the next series of words appeared automatically. The average score of the four values yielded the post-exposure craving.

2.5. Data analysis

In order to assess the craving induced by the Internet-related word stimuli, an experimental craving value (cue-induced craving) was computed for each participant by subtracting the pre-exposure value from the post-exposure value. A mixed 2×2 ANOVA were used to analyze craving in Internet addicts and non-addicts.

3. Results

No significant difference was observed in the relaxation between Internet addicts ($M = 5.22 \pm 1.35$) and non-addicts ($M = 5.19 \pm 1.08$; $t_{(38)} = 0.32$, $p > 0.05$). A mixed 2×2 ANOVA (between-subjects factor: Internet addicts vs. non-addicts; within-subjects factor: pre-cue exposure vs. post-cue exposure) showed a significant main effect for exposure ($F_{(1,38)} = 7.99$, $p < 0.01$, partial $\eta_p^2 = 0.14$) as well as a significant main effect for Internet addict status ($F_{(1,38)} = 14.67$, $p < 0.001$, partial $\eta_p^2 = 0.23$), indicating that post-exposure craving was significantly higher than pre-exposure craving, and the craving reported by Internet addicts was also significantly higher than that of non-addicts (see Table 1). The results also yielded a significant interaction ($F_{(1,38)} = 111.60$, $p < 0.001$, partial $\eta_p^2 = 0.58$). Then a post-hoc test was performed using Bonferroni method, and the results showed that the differences between pre-exposure craving and post-exposure craving were significant among both Internet addicts ($p < 0.001$) and non-addicts

($p < 0.01$); the difference between Internet addicts and non-addicts was not statistically significant in the pre-exposure craving ($p > 0.20$), but was significant in the post-exposure craving ($p < 0.001$). This further indicated that, though Internet-related words aroused cue-induced Internet craving among both Internet addicts and non-addicts, the increase in Internet addicts’ craving was more intense. Table 1 and Fig. 1 showed the mean pre- and post-exposure craving, as well as the cue-induced craving reported by Internet addicts and non-addicts.

4. Discussion

First, no significant difference was observed in the relaxation and pre-exposure craving for the Internet between Internet addicts and non-addicts. To a certain extent, this demonstrates that the steps we took were effective that the two groups were similar with regard to prior state and behaviors.

Secondly, the results showed that Internet-related word stimuli can significantly arouse cue-induced craving for the Internet among both Internet addicts and non-addicts. This result is consistent with those of previous studies on tobacco and alcohol addiction (Salgado-García et al., 2013; Sinha & Li, 2007), which have found that non-addicts also report a craving state. Furthermore, researchers have found that even exposure to food-related cues can induce intense cravings for food among individuals who have recently eaten (Yokum & Stice, 2013). These results suggest that craving may not be a unipolar, all or none state found only among addicts, it may also be present among non-addicts (Franken, 2003). At the same time, the results also reveal that Internet addicts’ craving was more intense than non-addicts, which is also consistent with research on tobacco, alcohol, and gambling addiction (Ashrafioun & Rosenberg, 2012; Salgado-García et al., 2013; Sinha & Li, 2007).

As the Internet is playing a more and more important role in our daily life, and is used for a variety of motivations (e.g., getting information, social interaction, escaping from real life and accessing to social compensation) (Amiel & Sargent, 2004; Vas & Gombor, 2009), individuals can get satisfaction from Internet use (Courtois, Mechant, Marez, & Verleye, 2009). Thus, the Internet may be closely associated with positive experiences and memories, which could account for our finding that Internet-related cues aroused craving for the Internet among both Internet-addicts and non-addicts. In addition, Schwabe, Dickinson, and Wolf (2011) further pointed out that addiction is a process from goal-directed control (instrumental) behaviors to habitual control behaviors, and consequently, addictive behaviors became more and more habitual and can be aroused by addiction-related stimulus. Positive reinforcement theory also holds that addiction is a process of reinforcement formation and maintenance, and individuals gradually establish a close association between addiction-related cues and the positive affect and feelings that accompany addictive behaviors (Drummond, 2001). Thus addicts may perceive the addictive behaviors to be particularly salient, and the memories and expectations of addiction could be strongly aroused when exposed to related cues. As a result even though exposure to Internet-related stimuli might have aroused all Internet users’ craving for the Internet, Internet addicts’ craving may have been more intense.

Finally, this research showed that Internet-related stimuli could significantly arouse Internet addicts’ cue-induced craving for the Internet, which further verifies the incentive-sensitization model, which posits that addicts gradually become extremely sensitive to related stimuli

Table 1
Craving for the Internet during exposure to Internet-related words.

	Pre-exposure craving	Post-exposure craving	Cue-induced craving ^a
Internet addicts	3.82 ± 1.83	7.36 ± 1.77	3.54 ± 1.89
Non-addicts	3.61 ± 2.01	5.13 ± 2.69	1.72 ± 2.34

^a Post-exposure craving level – pre-exposure craving level.

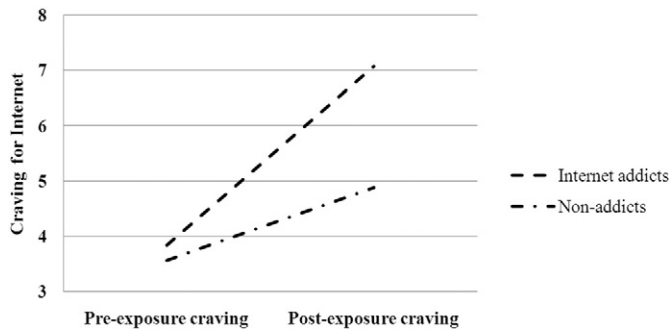


Fig. 1. Mean craving for the Internet among Internet addicts and non-addicts.

because of changes in related parts of the nervous system. The results are also similar to the findings of addiction to substances (e.g., Wöfling, Flor, & Grüsser, 2008) or pathological gambling (e.g., Miedl, Büchel, & Peters, 2014), and further indicates that Internet addiction may share similar underlying mechanisms with these addiction disorders (Ko, Liu, Yen, Chen, et al., 2013; Shaw & Black, 2008), a possibility that should be examined in future research.

Some limitations of the present study should be mentioned. First, self-report of cravings was used without physiological measures of cue-reactivity. Though self-report of cravings is appropriate, and sensitive to craving changes after cue-exposure, future studies should measure physiological indices (e.g., heart rate, skin conductance and EEG-signals) (Ashrafioun & Rosenberg, 2012; Ko, Liu, Yen, Chen, et al., 2013; Wöfling et al., 2008) to enhance the reliability and validity of the measures. Second, both APIUS and YDQ were used as screening tools, but they are all self-report scales which may be susceptible to memory loss and other biases. Thus, more objective diagnostic criteria should be used in future research. In addition, Internet addiction can be divided into generalized Internet addiction and specific Internet addiction, which includes different subtypes such as online game addiction and online relationship addiction (Young, 1998; Davis, 2001). However, the present study only investigated generalized Internet addiction with general Internet-related stimuli. It is possible that cues related to specialized uses such as online communication or games might not lead to craving among non-addicts as was found in this study. Finally, a methodological limitation is that we did not control for other aspects of participants' Internet use such as their daily time use or kinds of use (e.g., work, gaming, and socializing).

Craving is a core feature of addictive disorders, and it does maintain and exacerbate addictive behaviors. Our findings provide a theoretical basis and practical guidance for the prevention and intervention of Internet addiction under the perspective of craving. As Internet-related stimuli can arouse Internet-addicts' intense craving for the Internet, keeping addicts completely isolated from related stimuli for a period is absolutely necessary, especially in the early periods of intervention. Kober, Kross, Mischel, Hart, and Ochsner (2010) found that cravings could be reduced by focusing on the long-term consequences associated with addictive behaviors. Similarly, such cognitive control strategies also could be used to intervene with Internet addicts' craving. The study also suggests that more attention should be paid to craving for the Internet, which could deepen our understanding of the underlying addiction mechanism of Internet addiction, as well as its similarities and differences with other addictions.

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Contributors

Geng-Feng Niu, Xiao-Jun Sun and Zongkui Zhou generated the idea for the study and designed the experiment. Geng-Feng Niu, Fan-Chang Kong, and Xiao-Jun Sun conducted all the experiments and statistical analyses. Geng-Feng Niu, Xiao-Jun Sun and Kaveri Subrahmanyam wrote the full manuscript. Yuan Tian contributed the English Writing, methods and discussion. Geng-Feng Niu, Xiao-Jun Sun, and Kaveri Subrahmanyam participated in the manuscript preparation. All authors contributed to and approved the final manuscript.

Conflict of interest

All authors declare they have no conflicts of interest.

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