

Cue Reactivity and Craving in Behavioral Addictions with Focus on Internet Use Disorder

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Keywords

Cue reactivity · Craving · Internet addiction · Internet use disorder · Internet gaming disorder

Summary

Behavioral addictions are described as repeated, specific behavioral patterns irrespective of negative consequences and loss of control in daily life. The research about substance use disorder describes cue reactivity and craving as key constructs, which are also integrated in several theoretical models of behavioral addictions. This article provides an overview of theoretical assumptions and empirical studies that emphasize the relevance of cue reactivity and craving on the subjective, the peripheral physiological, and the neural level for the development and maintenance of specific behavioral addictions. We focus on specific Internet use disorders and the current empirical evidence about them. Based on the findings presented, recommendations for therapeutic settings are derived which should focus on cue reactivity and craving. The efficacy of these approaches should be addressed systematically in future studies to optimize therapeutic interventions in the treatment of behavioral addictions.

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Schlüsselwörter

Reizreaktivität · Craving · Internetsucht · Internetnutzungsstörungen · Internet-Gaming Disorder

Zusammenfassung

Verhaltenssüchte sind gekennzeichnet durch das wiederholte Ausüben eines spezifischen Verhaltens unter Missachtung negativer Konsequenzen und des erlebten Kontrollverlusts im Alltag. Zentrale Konstrukte sind dabei Reizreaktivität und Craving, die aus der substanzbezogenen Suchtforschung auch durch aktuelle theoretische Modelle auf die Verhaltenssüchte übertragen werden. Dieser Artikel gibt einen Überblick über theoretische und empirische Arbeiten, die konsistent die Relevanz von Reizreaktivität und Craving als Schlüsselkonzepte auf subjektiver, peripherphysiologischer und neuraler Ebene bei der Entwicklung und Aufrechterhaltung spezifischer Verhaltenssüchte unterstreichen. Ein besonderer Schwerpunkt wird hierbei auf spezifische Internetnutzungsstörungen und die bisherigen empirischen Befunde gelegt. Aus den dargestellten Erkenntnissen werden Empfehlungen für therapeutische Konzepte abgeleitet, die vor allem Reizreaktivität und Craving in den Fokus rücken sollten. Die Wirksamkeit dieser Ansätze sollte in zukünftigen Studien systematisch zur Optimierung therapeutischer Interventionen im Rahmen der Behandlung von Verhaltenssüchten überprüft werden.

Introduction

In the last few years, besides the study of mechanisms and factors of substance use disorder, there has been increasing attention given to addiction-like behavior, mainly summarized by the concept of behavioral addictions. Although so far only gambling disorder and quite recently so-called gaming disorder (excessive, uncontrolled playing of computer and Internet games) are represented in classification systems such as the ICD-11 (International Classification of Diseases), other excessive behavior patterns are often called behavioral addictions, even though they have not yet been formally classified. Behavioral addiction is often defined as repeated, uncontrolled performance of a specific behavior, such as gambling, shopping, sexual behavior, and the use of specific Internet applications. Behavioral addictions can occur mostly offline (not on the Internet), but also online (by the use of certain Internet services). Specific behavioral addictions almost exclusively involve the use of digital services, such as the uncontrolled playing of Internet or computer games and excessive communication by digital social media. One main factor of the definition of an addictive behavior is the irresistible desire or craving, in which positive emotional states or short-term rewards are felt as primary, despite the experience of negative consequences [Grant et al., 2010; Kiefer et al., 2013]. The core characteristics of behavioral addictions are the loss of control and the continuation of the behavior despite the experience of negative consequences in everyday life [see also Chamberlain et al., 2016]. Although many researchers recommend classifying pathological behavior as a behavioral addiction, borrowing from the diagnostic criteria for a substance use disorder, the diagnostic manual of the American Psychiatric Association [2013] lacks clear classification and terminology [Griffiths and Szabo, 2014]. Pathological gambling was included as a diagnosis in the section on 'substance-related and addictive disorders' in the Diagnostic and Statistical Manual of Mental Disorders (DSM)-5 [American Psychiatric Association, 2013], while Internet gaming disorder (IGD) was included only as a research diagnosis, noting the need for further research. Nevertheless, the inclusion of 'gaming disorder' as well as the mention of additional 'disorders due to addictive behaviors' in the World Health Organization's (WHO) ICD-11 classification system highlights the clinical relevance of the phenomenon [Mann et al., 2017; World Health Organization, 2018]. Meanwhile, several authors are calling for attention to be paid to further behavioral addictions and for these to be included in future classification systems, such as pathological shopping and the uncontrolled use of Internet pornography [Potenza et al., 2018]. Theoretical considerations as well as empirical studies are already looking at the mechanisms of development and maintenance of pathological behavior, with the focus mainly on pathological gambling [Menchon et al., 2018; Murch and Clark, 2016; Nicholson et al., 2018; Potenza, 2014; Wölfling et al., 2009; Yau and Potenza, 2015]. While the present article discusses key aspects that these mechanisms have in common, its focus is on the pathological use of Internet applications. Our objective is to highlight theoretical works and key features of behavioral addiction, and to examine how these apply to

new, much-discussed forms of behavioral addiction such as the addictive use of the Internet. We propose to use the term Internet use disorder (IUD) and to further specify the applications that are used in an uncontrolled way (online games, online shopping websites, online pornography, and online communication) [Brand et al., 2016b]. Most of the current work on behavioral addictions in general and IUDs in particular concentrates on theories and concepts that originate in research on substance use disorders.

The constructs and mechanisms firmly anchored in substance-related addictions also come to the fore in the specific IUDs, notably assumptions from classical substance-related addiction research, such as cue reactivity and craving. Cue reactivity describes the increased sensitivity to cues that are associated, through classical conditioning mechanisms, with addiction-like behavior. Attentional bias toward addiction-related cues can lead to craving – the desire to perform the behavior or to consume the substance (for a more detailed explanation, see table 1 and the next section) [Carter and Tiffany, 1999; Kiefer et al., 2013; Tiffany and Wray, 2012]. Below we outline the theoretical models as well as the transfer of concepts to the field of behavioral addiction and to IUDs, and examine the empirical findings to date.

Derivation of Theoretical Assumptions from Substance-Related Addiction Research

Substance-related addiction research points to the relevance of classical and operant conditioning to explain mechanisms of the development and maintenance of an addiction. By experiencing the effect of a substance or by repeating a behavior, cues that were originally neutral, such as external and internal stimuli (which might be certain emotional states or feelings of stress) are conditioned with a learned response. Similarly, objects associated with addictive behavior (e.g., the presence of a bottle with an alcoholic drink) are conditioned with the performance of the behavior and the initially pleasurable consequences of that behavior. This can occur both through the effect of the substance itself, and through behavior that is excessively rewarding, and which can also lead to biochemical and neural brain changes. Kiefer et al. [2013] assume that a behavior such as the usage of the Internet and of specific applications to cope with stress increases the probability that in a comparable situation, the same coping strategy of Internet usage will be used.

Core assumptions that explain the developmental process of an addiction, taking into account the mechanisms just described, are explained in the Incentive Sensitization Theory by Robinson and Berridge [1993, 2001, 2008]. It emphasizes the incentive salience of previously neutral cues by their linkage to learned responses, such as the effect of a substance in a certain situation. The stimulus-response schemata assume that the repetition of behavior associated with a reward leads to an increase in attentional bias towards the conditioned, addictive cue ('incentive salience'), which is the result of the progressive, extreme, and persistent hypersensitivity of specific neural systems [Berridge and Robinson, 1995]. It is also asso-

Table 1. Overview of central constructs and their explanations relating to Internet use disorders (IUDs)

Construct	Explanations and connection to Internet-use disorders
Coping style	dealing with stress and everyday burdens; differentiation into functional coping (e.g., use of problem-solving strategies) and dysfunctional coping (e.g., denial of the problem, consumption of alcohol and other substances)
Internet-related cognitive bias	expectations for the use of Internet applications; automatic attention to Internet-related cues; illusions about Internet use
Cue reactivity	physiological, emotional, and cognitive responses to conditioned addiction-related cues (e.g., Internet-related cues)
Craving	desire for consumption of a substance or performance of a behavior (with the preferred application); desire for a reward and for relief; often triggered by cue reactivity
Inhibitory control and executive functions	ability to suppress impulses (e.g., craving); control over the processing of cues and the performance of behaviors
Decision on usage	the decision to use an application (during the process of addiction: the decision to use an application despite knowing about and experiencing negative consequences from doing so)
Gratification and compensation	feelings of being rewarded while using the Internet application; avoidance/suppression of negative feelings

ciated with the processes of ‘wanting’ and ‘liking’ [Berridge et al., 2009; Robinson and Berridge, 1993]. While the hedonic effect of ‘liking’ is usually associated with the desired positive expectation of a state, which occurs especially at the beginning of an addiction, ‘wanting’ describes the desire or urge to perform a behavior repeatedly. Although the two processes cannot be treated separately, they nevertheless act in opposite directions. At the beginning of the process and taking positive or negative reinforcement mechanisms into account, the behavior or an associated cue is related with positive feelings, which leads to repetition of the specific behavior. In operant conditioning, negative reinforcement simultaneously leads to a reduction of negative emotions or to an avoidance of stressful situations. In this process of opposite trajectories, ‘liking’ decreases while ‘wanting’ increases and withdrawal symptoms are avoided as well [Berridge and Robinson, 1995; Berridge et al., 2009; Breiner et al., 1999; Stodt et al., 2015]. In other words, at the beginning of an addiction, the gratification experienced is paramount, while later the aspect of compensation for negative feelings becomes stronger [Brand et al., 2016b].

Closely related to these concepts and also integrated into the theory by Robinson and Berridge [1993, 2003, 2008] are the concepts of cue reactivity and craving, which are used primarily to explain repeated consumption, as well as relapse after successful abstinence. Attentional bias and the implicit perception of ‘wanting’ and ‘liking’ form the basis for experiencing cue reactivity – the increased susceptibility or increased attention to stimuli associated with addiction [Kiefer et al., 2013]. Carter and Tiffany [1999] define this as follows: ‘... addicts [are] vulnerable to drug use when in the presence of stimuli related to previous episodes of use’ (p 327). The cues described are relevant to the individual and can thus induce stronger physiological, emotional, and cognitive responses than less relevant, unconditioned, neutral stimuli [Carter and Tiffany, 1999; Cook et al., 1988]. This is the basis for the experience of craving, which is defined as a strong urge or desire for a substance [Everitt and Robbins, 2005; Tiffany and Wray, 2012].

The inclusion of IGD in DSM-5 also placed a significance focus on the experience of craving, since it was listed as an important diagnostic criterion [Drummond, 2001; Kavanagh and Connor, 2013]. Furthermore, Sinha [2013] emphasizes that craving should be understood as a multi-dimensional construct that increases in the addiction process, and is the result of growing motivation and the ‘wanting’. This is consistent with findings from many functional magnetic resonance imaging (fMRI) studies that stress out the interaction between wanting and craving [Tiffany and Wray, 2012]. Niu et al. [2016] also emphasize that addiction-related cues can cause direct craving because of positive reinforcement mechanisms. Repetitive behavior creates a connection between specific cues and the positive experience evoked by a drug or a reward after a behavior is performed [Drummond, 2001; Niu et al., 2016].

These arguments illustrate the central role of cue reactivity and craving as key mechanisms in both substance use disorder and behavioral addictions. This assumption is not based only on theoretical considerations, as shown by numerous empirical studies of cue reactivity and craving in different patient samples: the addictive, abusive consumption of tobacco and nicotine [e.g., Balter et al., 2015; Goddriaan et al., 2010; Ko et al., 2013b; Shiffman et al., 2013; Smolka et al., 2006; Vollstadt-Klein et al., 2011; Wray et al., 2013; Zhang et al., 2011], alcohol [e.g., Courtney et al., 2014; Vollstadt-Klein et al., 2012; Witteman et al., 2015], cannabis [e.g., Gray et al., 2008, 2011; Henry et al., 2014], cocaine [e.g., Robbins et al., 1999], and heroin [e.g., Fatseas et al., 2011] is associated with increased sensitivity to addiction-related cues and craving for the specific substance.

Transfer of Previous Theoretical Assumptions to Specific IUDs

The quite homogeneous findings and the explicit theoretical integration of the constructs of cue reactivity and craving in substance-related addiction research were an essential foundation for

theoretical models of the development and maintenance of behavioral addictions; they stimulated empirical research on mechanisms of behavioral addiction. Various empirical studies have also shown that people with behavioral addictions experience increased sensitivity to cues associated with the corresponding behavior. A recently published meta-analysis [Starcke et al., 2018] combined and evaluated the findings on cue reactivity reported in numerous studies of people with behavioral addiction. The meta-analysis included studies of people who suffer from gambling disorder, gaming disorder, or buying disorder. The effects on subjective assessments of cue reactivity when a person is confronted with addiction-related cues were considered, as well as the effects of peripheral physiological reactions and effects at the brain level (fMRI). The reactions of patients with one of the above-mentioned behavioral addictions were compared to those of healthy controls; within the combined patient samples, reactions to addiction-related cues were contrasted with those patients' reactions to control cues. Although comparatively few studies ($n = 18$ with 26 data sets) could be included in the analyses, significantly higher subjective, peripheral physiological, and neural responses to addiction-related stimuli were found in the patient samples compared to the control samples. In the combined patient samples, only the comparison of subjective ratings of cue reactivity when confronted with addiction-related cues did not differ significantly from the reactions to control cues. The peripheral physiological and neural reactions, on the other hand, were higher for the patient samples when confronted with addiction-related cues (pictures) than with control cues. On the neural level, both contrasts (patients > control subjects; addiction-related > control pictures in the patients) showed increased activity in the caudate nucleus, the inferior frontal gyrus, and the middle part of the anterior cingulate gyrus (and in the individual comparisons, even further activation such as in the precuneus, when comparing the addiction-related condition with the respective control condition in the patient samples). The results suggest that in individuals with behavioral addictions (such as gambling disorder, Internet and computer gaming disorders, and buying disorder), cue reactivity is demonstrable on the subjective, peripheral physiological, and neural levels. The findings from this meta-analysis are comparable to those that were reported in meta-analyses on cue reactivity in substance use disorder [Carter and Tiffany, 1999; Noori et al., 2016].

It is thus a logical conclusion that cue reactivity and craving should be integrated when we derive mechanisms for the development and maintenance of a specific IUD. Proceeding from Robinson and Berridge's [1993, 2001, 2008] theories of learning psychology and other basic works on addiction research [Drummond, 2001; Tiffany and Wray, 2012], various theoretical framework models for IUDs emphasize the relevance of the constructs of cue reactivity and craving.

Two of these core models that are used to explain specific IUDs are the Cognitive-Behavioral Model of IGD by Dong and Potenza [2014] and the Interaction of Person-Affect-Cognition Execution Model (I-PACE model, short form) by Brand et al. [2016b]. Dong and Potenza's [2014] model assumes the interaction between personality traits and cognitive components, which serves as the basis

for explaining an IGD. The cognitive components comprise motivational drive and thus striving for reward, behavioral control through executive functions, and decision-making behavior. Through the constantly increasing interaction of individual cognitions, the reward leads to continual repetition of the behavior, despite simultaneous negative consequences. Craving also plays a reinforcing role in this cycle as a motivational-emotional state and leads in the long term to pathological use of the specific Internet application. Besides their explanatory approach to the emergence of an IGD, the authors also suggest therapeutic implications and clinical measures to counteract this cycle. The modification of cognitive tendencies to address the heightened incentive sensitization must be noted in particular, in view of the craving experience [Dong and Potenza, 2014].

The theoretical model by Brand et al. [2016b], along with predisposing variables such as personality traits, addresses the relevance of cognitive and affective components to explain the development and maintenance of specific IUDs such as Internet gaming, Internet gambling, Internet pornography use, Internet communication, and the use of Internet shopping sites [Brand et al., 2014; Griffiths, 2012; Kuss and Griffiths, 2011, 2012; Young et al., 1999; Zander et al., 2016]. Executive functions, as well as decision-making behavior that leads to the use of a specific Internet application, also play an important role. The process model begins by explaining the predisposing factors such as social cognitions, personality, biopsychological constitution, psychopathology, and specific motives. These factors affect the subjective perception of a situation, increased attention to specific cues, as well as the urge for emotion regulation. This evokes affective and cognitive responses, including cue reactivity and craving, attention to addiction-related or application-related cues, and the urge to regulate one's mood. Through interaction with other Internet-related cognitive biases, coping style, affective and cognitive responses, and additional impaired executive functions, this may lead to the decision to use a preferred, specific application. Looking at positive as well as negative reinforcement mechanisms, it is assumed that the experience of gratification or compensation increases the likelihood that the same decision will be made in a comparable situation. In the long term, it leads in a reinforcing cycle to subjectively experienced loss of control and the experience of negative consequences [see also Brand et al., 2016b]. A scaled-down version of the I-PACE model is shown in figure 1. The essential constructs that are discussed in the context of behavioral addiction and are central to the I-PACE model are set forth in table 1.

The experience of loss of control is based on the conditioning processes described by Robinson and Berridge [1993, 2001, 2008], and illustrates the similarity of substance-related assumptions to those of behavioral addiction research. In the two models cited here as examples, those of Dong and Potenza [2014] and of Brand et al. [2016b], similar mechanisms are primary, such as executive functions and decision-making behavior, along with the experience of increased sensitivity to addiction-related cues and craving, whose relevance we now examine on the basis of empirical investigations.

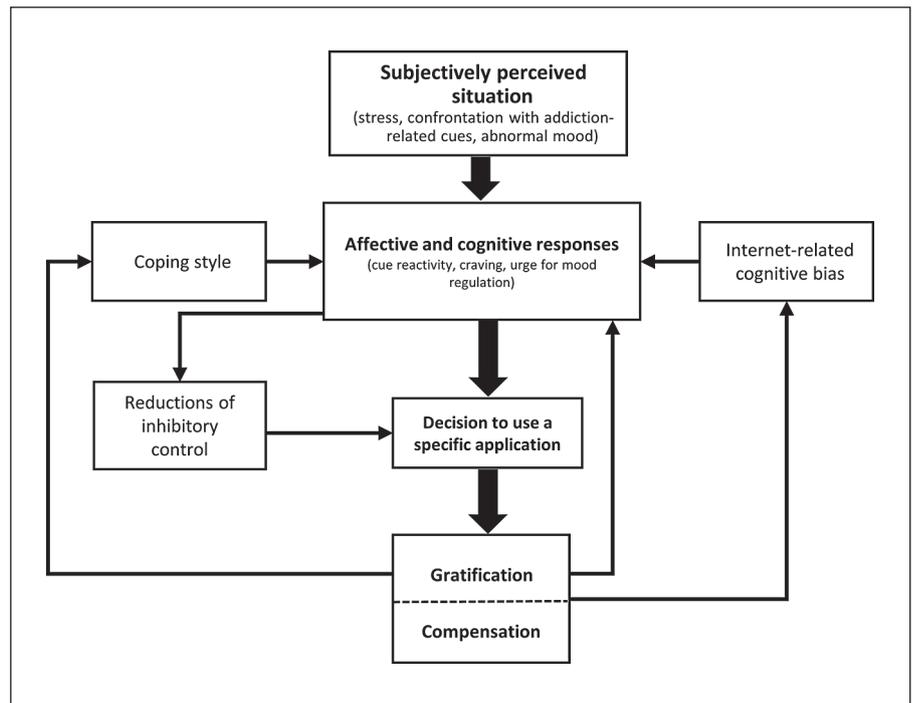


Fig. 1. Simplified, schematic representation of the I-PACE-model by Brand et al. [2016b].

Current State of Research: Cue Reactivity and Craving in Specific IUDs

As already mentioned, different forms of pathological use of the Internet are differentiated in research. These include IGD, Internet gambling disorder, Internet pornography use disorder, Internet shopping disorder, and Internet communication disorder [Brand et al., 2016b]. We now examine to what extent the current state of research illustrates the relevance of the constructs of cue reactivity and craving for specific IUDs.

The importance of these mechanisms in the development and maintenance of pathological Internet use has been demonstrated for IGD [Dong et al., 2017; Han et al., 2012; Ko et al., 2013a; Liu et al., 2016; Sun et al., 2012; Zhang et al., 2016], Internet shopping disorder [Trotske et al., 2015], Internet pornography use disorder [Brand et al., 2011, 2016a; Snagowski et al., 2015], and Internet communication disorder [Wegmann et al., 2018a, 2018b]. It has been shown for all of these specific facets of Internet use that increased craving is associated with confronting of application-specific cues. Thus, the fMRI study by Liu et al. [2016] illustrates cue-induced neural activation in the ventral and dorsolateral striatum in persons with IGD. This activation within the patient group is positively correlated with subjectively perceived craving. The results also emphasize the transition of activations from ventral to dorsolateral processing [Liu et al., 2016]. Ko et al. [2013a] also showed that after confrontation with specific cues, activations in the brain regions that are fundamentally associated with craving reactions are stronger in people with IGD. In addition to the exclusive presentation of visual cues, Dong et al. [2017] studied whether playing online games in itself causes craving in people with a sub-

jective impairment due to Internet gaming. Here, too, there was a stronger increase in craving as a result of gaming, as well as stronger activation in the lateral and prefrontal cortex in people with IGD compared to players without subjective impairments.

The findings on the relationship between cue reactivity and craving in IGD are so far stronger than for other specific IUDs. To our best knowledge, no study has specifically examined the relevance of craving in an Internet gambling disorder. And while for IGD, imaging studies illustrate the comparability between this disorder and substance use disorder, it is mostly behavioral studies that are available for Internet shopping disorder, Internet pornography use disorder, and Internet communication disorder.

Studies based on behavioral data have shown that pornographic imagery leads to a stronger desire for masturbation than neutral pictures, for people who report subjective impairments due to excessive use of Internet pornography [Brand et al., 2011]. Snagowski et al. [2015] also found a significant positive relationship between craving and the tendency for Internet pornography use disorder. The study by Trotske et al. [2015] illustrates that the relevant craving effects of pathological buying – as described in the meta-analysis by Starcke et al. [2018] – can also be detected in individuals with Internet shopping disorder. It was shown that comparison of subjective craving before and after exposure to specific buying cues resulted in a significant increase. Furthermore, the effect of craving on the symptom severity of Internet shopping disorder is mediated by the anticipation of experiencing positive emotions through shopping on the Internet. This is consistent with assumptions of the I-PACE model by Brand et al. [2016b], which illustrates that expectations for the use of specific applications intensify the effect of affective and cognitive components on the specific IUD. The study of

Internet communication disorder by Wegmann et al. [2018a] shows that this mediation effect can also be transferred to other specific IUDs. The addictive use of various online communication applications such as social networks and messenger services, independently of the device selected, whether a PC, tablet, or smartphone, could be summarized as Internet communication disorder. The authors were able to identify a subjectively perceived craving after confrontation with specific cues on the symptom severity of Internet communication disorder. This effect was also mediated by the expectation to avoid negative emotions by using the application [Wegmann et al., 2018a]. A further study emphasizes that craving was not only experienced after the confrontation with specific visual cues, but also with auditory stimuli such as the ringtone of a new message on the smartphone, and that this is associated with a tendency for Internet communication disorder as well [Wegmann et al., 2018b].

Thus, it can be shown that individuals with a specific (Internet) behavioral addiction tend to have stronger craving reactions if confronted with addiction-related cues compared to neutral cues, or to control groups without subjective impairment because of the use of a specific Internet application [Niu et al., 2016]. The examples of empirical studies mentioned here emphasize, consistently with the theoretical assumptions by Dong and Potenza [2014] and Brand et al. [2016b], the relevance of cue reactivity and craving as key concepts in the development and maintenance of a specific behavioral addiction. The knowledge thereby gained is an important factor, which should be kept in mind when deriving therapeutic concepts and treatment options.

Derivation of Therapeutic Approaches for Specific IUDs by Addressing the Constructs of ‘Cue Reactivity’ and ‘Craving’

Theoretical framework models such as the I-PACE model can inspire theory- and hypothesis-driven research on psychological and neurobiological mechanisms that underlie an IUD and other behavioral addictions. If the findings suggest that individual interactions of processes are valid, these conclusions can be used to expand current therapeutic approaches and, for example, to integrate specific intervention approaches. It is not possible to give here an overview of therapeutic approaches to the treatment of behavioral addictions in general or IUDs in particular. We refer to recent works that have appeared internationally and nationally [e.g., King et al., 2017; Winkler et al., 2013; Wölfling et al., 2012; Young, 2013]. Therefore, we focus on implementation of the core constructs of the I-PACE model in cognitive-behavioral interventions.

In order to change reactions to confrontation with addiction-related cues, the development of behavioral or situational analyses according to individualized disorder models is helpful for discovery of disorder-relevant cognitive processes. Where appropriate, these can be supplemented by mindfulness-based approaches, for example to reduce stress in daily life. This can also focus on dysfunctional coping with situations through the behavior and can derive the need for resource-activating measures. The key here is to

convey functional coping options, such as how to deal with stress and conflicts without addiction-related behavior (e.g., playing computer and Internet games). Cognitive restructuring can be used both to change the patient’s perception of addiction-related situations and to modify the Internet-related cognitions. For example, expectations about Internet use can be discussed in therapy – cognitions such as ‘stress can best be reduced by playing online games’ – thereby changing the patient’s expectations about Internet use compared to other behaviors. The alternative actions can become more attractive.

Implicit cognitions, such as automatic approach tendencies in confrontation with situations that contain addiction-related cues, could be addressed by so-called attention training or approach-avoidance training. Situations in which craving is experienced, avoidance behavior is displayed rather than search behavior [Eberl et al., 2013a, 2013b; Wiers et al., 2011].

The relearning of implicit attention control [e.g., Christiansen et al., 2015; Schoenmakers et al., 2010] may also be helpful to strengthen patients’ inhibition control in situations where craving is experienced, so that addictive behaviors are not performed automatically [e.g., Bowley et al., 2013; Houben and Jansen, 2011; Houben et al., 2011]. Although approaches to stimulus-exposure-intervention in the context of addiction have been discussed critically [Marissen et al., 2007; Mellentin et al., 2017; Park et al., 2015], such techniques could be used as a supplement, to help patients better regulate situational craving [Pericot-Valverde et al., 2015].

Conclusion

Cue reactivity and craving are central constructs of addiction research. These have recently been applied to research on behavioral addiction. Current theoretical models are taking up these constructs and illustrating the interaction between cue reactivity and craving as affective-motivational components, and inhibition control and executive functions as cognitive-controlling factors. For various behavioral addictions, including specific IUDs, the processes of cue reactivity and craving have also been demonstrated in previous empirical-experimental work on the subjective, peripheral-physiological, and neural levels. Theoretical models for the development and maintenance of behavioral addictions and the empirical findings derived from these can inspire specific additions to cognitive-behavioral approaches. The efficacy of experimental approaches to reduce or control cue reactivity and craving and the effects of these on addictive behavior should be systematically evaluated in future studies to further optimize therapeutic interventions to treat behavioral addictions.

Disclosure Statement

The authors affirm that there are no potential, material and/or immaterial conflicts of interest.

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