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# To gamble or not to gamble: At risk for craving and relapse – learned motivated attention in pathological gambling

Klaus Wölfling[a,*], Chantal P. Mörsen[b], Eva Duven[a], Ulrike Albrecht[b], Sabine M. Grüsser[a], Herta Flor[c]

[a] Outpatient Clinic for Gaming Addictions, Department of Psychosomatic Medicine and Psychotherapy, University Medical Center Mainz, Germany
[b] Department of Psychiatry, Charité -Universitätsmedizin Berlin, Campus Mitte, Germany
[c] Department of Clinical and Cognitive Neuroscience, Central Institute of Mental Health University of Heidelberg, Germany

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ABSTRACT

In recent research similarities between pathological gambling and drug addiction have been identified, suggesting excessive gambling to constitute an addiction. So far, we have insufficient knowledge concerning the psychophysiological mechanisms underlying this kind of non-substance-related addiction. The objective of the study was to investigate emotional processing of gambling-relevant and -irrelevant stimuli in pathological gamblers and non-gambling controls using an EEG cue-reactivity paradigm. Whereas gambling-irrelevant stimuli were processed similarly in non-gambling controls (HC) and pathological gamblers (PG), PG showed significantly stronger gambling-relevant stimulus-induced psychophysiological cue-reactivity (larger gambling stimulus-induced late positive potential, LPP, higher arousal and more positively toned valence ratings as well as higher stimulus-induced craving for gambling cues compared to HC – but not the expectable increase of general craving over time and after stimulus presentation). Our findings suggest enhanced cue-reactivity in pathological gamblers indicative of learned motivated attention that may induce subjective craving and relapse.



## 1. Introduction

Gambling is a popular leisure activity, 60–90% of the adult population have gambled at least once in their lifetime. On the one hand gambling is an enjoyable popular activity, but on the other hand excessive, pathological gambling is known to lead to health, financial and social problems. The current prevalence of pathological gambling in the general population ranges from 1% to 2% in the United States of America (Shaffer et al., 1997; Welte et al., 2008), in different parts of Canada (Ladouceur, 1996; Ladouceur, 2004), and in Europe (e.g. Bühringer et al., 2007; Bondolfi et al., 2008). The addictive nature of gambling as a behavioral addiction (Holden, 2001, 2010; Frascella et al., 2010) has often been discussed, but incompletely investigated. Besides descriptions of pathological gambling as an obsessive-compulsive disorder it has been posited that pathological gambling meets internationally established criteria of addiction (Blanco et al., 2001; Potenza, 2002; Rosenthal, 2003; Shaffer and Kidman, 2003).

According to the model of incentive sensitization by Robinson and Berridge (2003) altered processing found in both substance and behavioral addictions may develop through a sensitization of the brain towards rewarding effects of the drug/behavior. After regular use of the substance/behavior the brain attributes incentive salience to it and to related (or contextual) cues. This leads to an irresistible "wanting" of the drug, also called craving while concurrently the "liking" of the drug/behavior in addicted individuals is diminished. The incentive sensitization which develops throughout the course of addiction is displayed both in psychomotor activation (arousal, attention, and approach) and also in sensitized motivation.

It has been suggested that due to their biological meaning emotionally arousing stimuli activate basic motivational systems in the brain that can be subdivided into an aversive and an appetitive system (Lang, 1995; Lang et al., 1997). According to this view emotions can be thought to be action dispositions, capturing attention and preparing the organism for avoidance- or approach-related behavior. This 'motivated attention' refers to a natural state of selective attention (Lang et al., 1997). In addiction formerly neutral cues become associated with the drug/behavior through regular use and are then likely to become increasingly salient and are thought to grab the attention of the dependent individual more easily (O'Brien et al., 1992; Robbins and Everitt, 2002; Robinson and Berridge, 1993; Berridge and Robinson, 2009). The sensitization is suggested to be related to an alteration of the "brain reward system" in which dopamine release is activated when addiction-associated cues are present even without the necessity of consumption/display of excessive behavior (Everitt and Robbins, 2005). Baler and Volkow (2006) stated that the high rewarding nature of addictive behavior

* Corresponding author. Tel.: +49 6131 176147; fax: +49 6131 176439.
*E-mail address:* woelfling@uni-mainz.de (K. Wölfling).

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may lead to an enhanced consolidation of the association between reward and addiction-related cues in the memory of addicted persons. To investigate the nature of addictive behavior it is therefore necessary to examine underlying learning processes, which have the potential to elicit automatic motivational addictive behavioral patterns.

Craving can be described as the subjective urge to consume a drug or to behave a certain way. The urge to gamble has already been measured psychometrically after exposing pathological gamblers to virtual and real gambling environments (e.g. a casino: Kushner et al., 2007, 2008). Grüsser et al. (2005) investigated cue-induced craving in pathological gamblers by using four visual analogue scales after presenting four different categories of cues (gambling-relevant, gambling-irrelevant (neutral, positive, negative). They found that pathological gamblers perceived gambling-relevant cues as more emotionally arousing, pleasant, and dominant than the control group and that the gambling-relevant cues elicited craving, even after year-long abstinence.

In electroencephalographic (EEG) recordings selective attention is reflected in an enhancement of the late positive potential (LPP), evoked by emotionally arousing pictures (e.g. Hamm et al., 2003; Schupp et al., 2004a,b; Hajcak et al., 2006, 2007; Hajcak and Nieuwenhuis, 2006). It is assumed that this enhancement reflects the intrinsic significance of emotional stimuli during stimulus representation in working memory (Schupp et al., 2006). Psychophysiological approaches in the research of addiction have shown that cortical as well as peripheral responses of addicts differentiate reliably between drug-associated and neutral stimuli. The late positive potential (LPP) of the event-related potential (ERP) of the electroencephalogram (EEG) has also been shown to be enhanced in response to the specific drugs of abuse in all groups compared to healthy controls. This was shown in substance-related addictions such as opiate addiction (Franken et al., 2003), cocaine addiction (Franken et al., 2004), and cannabis addiction (Wölfling et al., 2008). ERP-data in reaction to visual stimulus material (pictures from the International Affective Picture System (IAPS; Lang and Bradley, 2005) and addiction-related pictures) were recorded to investigate the specific cue-reactivity. A similar paradigm employing words instead of visual material was conducted by Herrmann, Herrmann et al. (2000) with patients suffering from alcohol dependence.

Based on research on motivated attention, it is assumed that the processing of stimuli of high arousal elicits a larger LPP than less affectively intense neutral material such as pictures and that the late positivity seems to be modulated by intrinsic motivational relevance (Schupp et al., 2004a,b). Hence, emotion is thought to facilitate subsequent processing of information by directing attention towards a stimulus, constituting a bias to preferentially attend to the stimulus (Ferrari et al., 2008). In studies on cue-reactivity an in-depth emotional processing of drug-related cues comparable to the processing of high arousing emotional stimuli was suggested and supported by the findings of an increased LPP in reaction to addiction-related, positive and negative cues (Franken et al., 2003, 2004; Wölfling et al., 2008; Herrmann et al., 2000). Field et al. (2009) investigated the relationship between attentional biases and craving employing meta-analytic methodology. Their findings suggest a rather weak relationship between the two concepts, even though direct measurement of attentional biases (eye-movement and measurement of the LPP) showed a closer relationship to subjective craving than indirect measurements.

Only a few studies have focused on the underlying psychophysiological mechanisms of the development and maintenance of gambling in pathological gamblers (Campbell-Meiklejohn et al., 2008; Crockford et al., 2005; Potenza et al., 2003a,b; Reuter et al., 2005). In accordance to findings in substance addiction, a reduction in the sensitivity of the brain reward system and hyperactivity towards addiction-associated stimuli was demonstrated in pathological gamblers. Based on prior findings in the research of motivated attention it can be hypothesized that gambling stimuli attain motivational relevance, which is reflected in an enhanced late positivity in the ERP. However, no study up to now known to the authors has investigated the electrophysiological correlates of addiction-related cue-reactivity in gamblers.

Therefore the aim of the present study was to investigate the processing of gambling-relevant stimuli and–irrelevant (neutral, negative and positive) stimuli using an EEG cue-reactivity paradigm in gamblers, while additionally assessing verbal reports of craving for gambling. According to Potenza et al. (2003a,b) we used standardized positive, neutral, and negative visual stimulus material and compared the responses to gambling-related stimuli in pathological gamblers and matched controls. Based on prior research we hypothesized an increase in self-reported craving after presentation of gambling stimuli, as well as a significant shift of attention towards gambling stimuli in pathological gamblers compared to controls. Hence, an interaction between gambling behavior and emotional and arousing features of the presented stimuli, as shown by higher subjective ratings for pleasantness and arousal and an enhanced LPP for gambling stimuli in pathological gamblers was hypothesized.

## 2. Methods

### 2.1.1. Participants

Fifteen active pathological gamblers (age in years $M = 34.93$; SD = 9.77; 12 males and 3 females) and 15 healthy control persons (age in years $M = 34.27$; SD = 5.34; 13 males and 2 females) participated in the study. The mean years of education were 13.20 (SD = 3.29; range, 8–17) for the control group and 12.27 years (SD = 3.24; range, 8–17) for pathological gamblers. Group differences for age ($t$ (28) = −.23; $p$ = .82), sex ($\chi^2$ (1, $N$ = 30) = .42, $p$ = .52) and education ($t$ (28) = .78; $p$ = .44) did not reach statistical significance. Mean age at the beginning of excessive gambling in active gamblers was 25.27 years (SD = 9.43, range 16–34 years) and the mean duration of pathological gambling was 10.07 years (SD = 12.03, range 2–19 years). The favoured kind of gambling was slot machine gambling (93.3%), followed by roulette (66.7%), card games (Black Jack, Poker, 20.0%), sports betting (20%) and lottery (13.1%). Also 26.7% indicated excessive gambling on the stock exchange in their lifespan (multiple answers allowed). Participants were recruited in a slot machine casino and by newspaper announcements. Active pathological gamblers had to meet the criteria of pathological gambling of the South Oaks Gambling Screen (SOGS; Lesieur and Blume, 1987) and the criteria of the Diagnostic and Statistical Manual of Mental Disorders-IV Trial Revision (DSM-IV-TR; Saß et al., 2003). Pathological gambling was indicated by scores of five and higher on the SOGS and scores of five or more fulfilled criteria of DSM-IV-TR. None of the participants met the criteria for addiction to a psychotropic substance except for tobacco smoking. Eleven persons in the control group and twelve pathological gamblers reported smoking tobacco regularly in the last six months before the day of investigation ($\chi^2$ (1, $N$ = 30) = .34, $p$ = .56). Healthy controls reported to smoke 16.20 (SD = 14.02; range, 0–50) and pathological gamblers 15.10 (SD = 9.28; range, 0–25) cigarettes on average per day with no significant difference ($t$ (28) = .21; $p$ = .84) for mean amount of daily smoked cigarettes in the past six months.

To exclude the influential effects varying mood states on cue-reactivity (e.g. Grüsser et al. (2007)) current mood state of all participants was assessed prior to the electrophysiological recording session using visual analogue scales (VAS). Pathological gamblers ($M = 1.73$; SD = 2.31) showed slightly increased sad mood compared to healthy controls ($M = .67$; SD = .89) but the group difference was not significant ($t$ (28) = −1.67; $p$ = .11). The study was approved by the Ethics Committee of Charité – University Medicine and conducted in accordance with the Declaration of Helsinki.

### 2.1.2. Psychological and psychophysiological assessment

After informed consent was given, subjects participated in a comprehensive psychological examination with respect to their gambling behavior and the assessment of demographic and clinical data using the 'Questionnaire of Differentiated Assessment of Addiction' (QDDA, Grüsser et al. (2004)).

General (non-stimulus-induced) craving was assessed before and after visual cue-exposure (pre, post 1) as well as after the EEG-recordings (post 2) using visual analogue scales (VAS, 0–100 mm, ranging from not at all to very strong; Grüsser et al., 2000). Craving was operationalized by four single craving factors including baseline-, reward- and relief-craving and intention to gamble (Grüsser et al., 2000; Tiffany et al., 2000; Tiffany and Drobes, 1991). In the present investigation craving for gambling was measured by the mean value of these four single craving factors.