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Dysfunctional decision-making in pathological gambling: Pattern specificity and the role of impulsivity

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ABSTRACT

Dysfunctional decision-making in individuals with pathological gambling (PGs) may result from dominating reward-driven processes, indicated by higher impulsivity. In the current study we examined (1) if PGs show specific decision-making impairments related to dominating reward-driven processes rather than to strategic planning deficits and (2) whether these impairments are related to impulsivity. Nineteen PGs according to DSM-IV and 19 matched control subjects undertook the Cambridge Gambling Task (CGT) to assess decision-making. The delay discounting paradigm (DDP) as well as the UPPS Impulsive Behavior Scale (measuring urgency, premeditation, perseverance and sensation seeking) were administered as multidimensional measures of impulsivity. Results revealed that (1) PGs exhibited higher risk seeking and an immediate reward focus in the CGT and, in contrast, comparable strategic planning to the control group. (2) Decision-making impairments were related to more severe delay discounting and, specifically, to increased urgency and less premeditation. Our findings suggest (1) the necessity to disentangle decision-making components in order to improve etiological models of PGs, and (2) that urgency and premeditation are specifically related to disadvantageous decision-making and should be tackled in intervention strategies focusing on emotion tolerance and control strategies.

1. Introduction

While it is well known, that individuals diagnosed with pathological gambling (PGs) display impaired performance in neuropsychological decision-making tasks (e.g. Petry, 2001b; Cavedini et al., 2002; Brand et al., 2005; Goudriaan et al., 2005; Linnet et al., 2006; Labudda et al., 2007; Forbush et al., 2008; Roca et al., 2008; Lawrence et al., 2009; Kertzman et al., 2011) and heightened impulsivity (Goudriaan et al., 2004; Verdejo-Garcia et al., 2008; van Holst et al., 2010), the relation of both constructs in PGs remains unclear. Findings from previous studies on this issue in non-gambling samples were inconsistent (e.g. Monterosso et al., 2001; Jollant et al., 2005; Zermatten et al., 2005; Suhr and Tsanadis, 2007; Dolan et al., 2008; Franken et al., 2008; Sweitzer et al., 2008; Janis and Nock, 2009; Perales et al., 2009; Xiao et al., 2009; Billieux et al., 2010) which may result from a neglected consideration of the lower-order sub-components, for either or both constructs. Thus, the present study aims to assess the relation of impaired decision-making and impulsivity in PGs taking a multidimensional perspective.

In line with recent models on pathways of addictions (Bechara, 2005; Bühringer et al., 2008; Redish et al., 2008b; Goldstein and Volkow, 2011) and specifically of pathological gambling (Bechara, 2003; Evans and Coventry, 2006; van Holst et al., 2010), we assume an important role of an – either antecedent or resultant – imbalance of (more automatic) motivational and valuation brain networks and (more reflective) cognitive control networks. According to these models, the motivational and valuation systems in PGs may overestimate the value of immediate short-term rewards. This would explain, on the one hand, the heightened impulsivity found in PGs, because the tendency towards immediate rewards while disregarding negative consequences is frequently considered a central aspect of impulsivity (Moeller et al., 2001; Bechara, 2005; Verdejo-Garcia et al., 2008). On the other hand, this imbalance may result in disadvantageous gambling-related decisions, as dominating reward-driven processes were found to be strongly related to impaired decision-making (Krawczyk, 2002; Fellows, 2004; Yechiam et al., 2005; Dunn et al., 2006; Rangel et al., 2008). Due to the lack of a consensus model of decision-making, a broad variety of tasks has been used to measure the construct (Fellows, 2004). However, a fractionating of lower-order decision-making components may be an advantageous approach to gain a deeper understanding of the

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complexity of underlying processing mechanisms (see e.g. Busemeyer and Stout, 2002; Krawczyk, 2002; Clark et al., 2004; Brand et al., 2005; Fellows and Farah, 2005; Yechiam et al., 2005; Diekhof et al., 2008). Following this approach, it can be expected that PGs will show specific impairments in decision-making sub-components associated with reward and valuation. These decision-components have often been related to processes in the ventromedial regions of the prefrontal cortex (PFC) (e.g. Brand et al., 2006; Lawrence et al., 2008; Clark, 2010). Indeed, PGs display functional changes in these brain areas in tasks of reward processing and decision-making (Potenza et al., 2003; Reuter et al., 2005; Potenza, 2008; Clark, 2010). In contrast, decision-making components like reasoning or strategic planning – often related to processes in the dorsolateral PFC – may be unchanged in PGs (Lawrence et al., 2009; Clark, 2010). A neuropsychological task which differentiates between different components of decision-making behavior is the Cambridge Gambling Task (CGT) (Rogers et al., 1999). The CGT assesses parameters related to risk seeking (e.g. 'risk taking'), an immediate reward focus (e.g. 'delay aversion') or strategic planning (e.g. 'percentage of rational choices'). First studies using the CGT in gamblers and PGs revealed disorder-specific deficits in risk seeking rather than in strategic planning (Lawrence et al., 2008; Grant et al., 2011). Crucially, both studies did not explicitly report on other parameters related to reward-driven processes like delay aversion or chasing behavior within a task (i.e. betting larger sums of money or taking greater risks with an intention to recover prior losses immediately) (O'Connor and Dickerson, 2003; Linnet et al., 2006).

According to our present hypothesis, the impaired reward- and valuation-related components of decision-making are positively related to impulsivity, in contrast to the strategic components of decision-making (Lawrence et al., 2008). To our best knowledge, to date, there are no studies on the relation of impaired decision-making components and impulsivity in PGs. Studies on this relation in non-gambling samples have mainly been conducted without considering the aforementioned multidimensional nature of decision-making and of impulsivity itself (e.g. Reynolds et al., 2006; Verdejo-Garcia et al., 2008; Broos et al., 2012). Especially, the behaviorally assessed impulsivity dimension delay discounting (Bechara, 2003; Franken et al., 2008) as well as self-reported dimensions concerning the tendency to act rashly in an emotional context (urgency) and the lack of forethought (Whiteside and Lynam, 2001) may be relevant mechanisms underlying impaired decision-making (Enticott and Ogloff, 2006). Hitherto, studies with non-gambling samples assessing the relation of delay discounting and decision-making yielded inconsistent results (Monterosso et al., 2001; Janis and Nock, 2009), whereas studies on urgency and premeditation underpin our hypothesis (Zermatten et al., 2005; Billieux et al., 2010).

In summary, we expected a specific pattern of impaired decision-making components in PGs which is related to an imbalance of reward- and valuation-related and reflection-related brain networks, as indicated by increased risk seeking and an immediate reward focus. Further, we hypothesized that impulsivity is an important indicator of this imbalance. Thus, we expect that the impaired decision-making components are specifically related to the impulsivity dimensions delay discounting, urgency and premeditation. As impaired decision-making is important in the development (e.g. starting to gamble regularly), maintenance (e.g. chasing behavior) and cessation (as well as relapse) of pathological gambling, it is of central importance to understand its components and underlying mechanisms. If a dominating reward- and valuation-system, indicated by an elevated impulsivity, turns out to be the core mechanism rather than problems in reasoning or strategic planning, this would be an important result for the adaptation of etiological models as well as therapeutic strategies.

2. Methods

2.1. Design

We used a cross-sectional design with matched-pairs to compare a pathological gambling group (PGG) and a paired control group (CG). In detail, we matched for each member of PGG a corresponding member of the control group. The matching was realized according to age (± 2 years), gender and smoking status (daily smoking or not), because these variables were found to be associated with different decision-making and impulsivity measures (Mitchell, 2004; Reynolds et al., 2007; Fields et al., 2009). All individuals in the CG were related to a unique corresponding individual in the PGG and, thus, the samples were dependent. The matched-pairs design has the advantage to obtain improved estimates of group differences by keeping possible confounders constant and, consequently, to achieve greater statistical power and economy (e.g. Mitchell and Jolley, 2012).

A power analysis was performed previously with Stata 11.2 (StataCorp., 2011) based on an analysis of variance design with paired measures and two-sided dependent t-test comparisons. A sample size of 19 in each group was needed for detecting medium-to-large effects of the CGT performance differences ($d=0.7$) found in earlier studies (Lawrence et al., 2009), with $\alpha=0.05$ and $\beta=0.80$. The study was approved by the local Ethics Committee at the TU Dresden, Germany.

2.2. Screening

Participants of the PGG and the CG were recruited in 2009 in Dresden (Germany) by newspaper, internet advertisements and postings on community boards. Included in the PGG were subjects who fulfilled diagnostic criteria for pathological gambling according to DSM-IV-TR (American Psychiatric Association, 2000) in the last 12 months. Excluded were subjects who fulfilled any of the following criteria assessed in a telephone interview: (1) age under 18, (2) psychotropic medication in the last 3 months, (3) current treatment for mental disorders, (4) disorders which might influence cognition or motor performance (e.g. attention deficit hyperactivity disorder) and (5) mother tongue other than German. Additionally, all volunteers were personally screened for comorbidity with the Munich Composite International Diagnostic Interview (DIA-X/M-CIDI) (Wittchen and Pfister, 1997; Wittchen et al., 1998). Exclusion criteria regarding comorbidity were (6) current (last 3 months) other mental disorders (i.e. somatoform disorders, anxiety disorders, affective disorders, eating disorders, substance use disorders, obsessive compulsive disorders, psychotic disorders) with the exception of nicotine dependence, because we included smokers in both groups.

2.3. Final sample

Out of 93 screened subjects, the final sample resulted in 19 participants for each group. Reasons for exclusion in the PGG were: no pathological gambling diagnosis ($n=19$), history of ADHD or medication ($n=2$) and current mental disorders ($n=5$). In the CG we excluded those interested persons who did not match to one of the PGG in terms of age, gender or smoking status according to our paired sample design ($n=24$). Further exclusion criteria in the CG were history of ADHD or medication ($n=2$) and current mental disorders ($n=2$). The final sample included only male participants due to small number of females fulfilling DSM-IV criteria for pathological gambling ($n=1$). Demographic and clinical data of the final sample are shown in Table 1. We found no significant differences in age and years of education between groups. The mean number of fulfilled DSM-IV criteria for pathological gambling in the PGG was 7.16. Thirteen of the 19 matched pairs showed the same income class. There was a non-significantly higher rate of alcohol consumption in the PGG ($t(18)=1.74$, $p=0.10$). Regarding mental disorders there were no significant differences in number of lifetime mental disorders. Current (last 3 months) nicotine dependence did also not significantly differ between the groups: 26% ($n=5$) of the PGG and 42% ($n=8$) of the CG were diagnosed having a current nicotine dependence.

2.4. Measurements

2.4.1. Cambridge Gambling Task (CGT)

We used the CGT provided by the Cambridge Neuropsychological Test Automated Battery (CANTAB, Cambridge Cognition Ltd., Cambridge, United Kingdom) to assess decision-making. Ten blue and red boxes were presented in a varying ratio (9:1, 8:2, 7:3 and 6:4). Participants had to decide whether a yellow token is hidden under a red or a blue box, staking a proportion of points on this choice being correct. The available proportion of points to be staked were 5%, 25%, 50%, 75% or 95% of the current points given in ascending (5–95%) or descending (95–5%) order. Ascending and descending conditions were randomized and balanced within and matched between groups.

As dependent variable we used eight decision-making parameters according to the hypothesized sub-components. *Risk seeking* behavior was operationalized with the following three parameter: (1) 'Overall proportion bet' as the mean proportion