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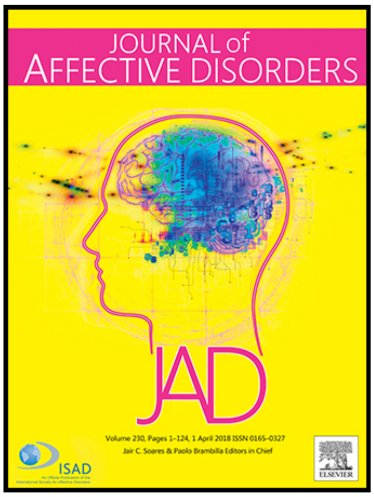

Disordered gambling and attentional bias: The mediating role of risk-taking

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PII: S0165-0327(19)32961-1
DOI: https://doi.org/10.1016/j.jad.2020.03.144
Reference: JAD 11824

To appear in: *Journal of Affective Disorders*

Received date: 24 October 2019
Revised date: 14 February 2020
Accepted date: 29 March 2020

Please cite this article as: Maria Ciccarelli , Mark D. Griffiths , Marina Cosenza , Giovanna Nigro , Francesca D'Olimpio , Disordered gambling and attentional bias: The mediating role of risk-taking, *Journal of Affective Disorders* (2020), doi: https://doi.org/10.1016/j.jad.2020.03.144

Disordered gambling and attentional bias: The mediating role of risk-taking

1. Introduction

Attentional bias refers to the preferential deployment of attentional resources towards stimuli that individuals are addicted to. A wealth of research has demonstrated that attentional biases are related to the maintenance, as well as to the risk of relapse, in different substance addiction disorders (see Field and Cox, 2008 for a review). Several theoretical positions have been proposed concerning the development of attentional bias. According to Tiffany (1990), attentional biases occur below the threshold of awareness and develop when, after being repeatedly exposed to substance use, individuals become more responsive to addiction-related stimuli. Robinson and Berridge's (2008) model gave importance to the reward system. They asserted that frequent substance intake induces neuroadaptations that lead the addiction-related stimuli to acquire salience and become "wanted", producing attentional bias. Additionally, the "theory of current concern" (Cox et al., 2006) posits that individuals' goals and motivations affect cognitive processes. This implies that substance-related goals increase the reactivity toward addiction-related stimuli and produce attentional biases.

Attentional biases also occur in behavioral addictions such as gambling disorder. Utilizing different samples and procedures, a substantial body of empirical literature has demonstrated that disordered gamblers exhibited enhanced attentional processing towards gambling cues than non-disordered gamblers. For instance, they show more pronounced Stroop effect towards gambling than neutral words (Molde et al., 2010), take longer to react to non-relevant stimuli during a gambling session (Diskin and Hodgin, 1999), commit more errors when performing an inhibition task in gambling-related trials (van Holst et al., 2012), show poor accuracy in identifying rotations of target images when preceded by gambling distractors (Hudson et al., 2017), and have automatic action tendencies towards gambling cues (Boffo et al., 2018). Furthermore, there is growing empirical evidence that biased attention toward gambling stimuli among gamblers reflects both initial engagement (Brevers et al., 2011a; Ciccarelli et al., 2016a) and maintenance of attention (Ciccarelli et al., 2019a; McGrath et al., 2018). A recent study (Ciccarelli et al., 2016b) has also showed that the relationship between gambling and attentional bias changes according to gambling level: while disordered gamblers exhibited an automatic facilitation in detecting gambling stimuli, abstinent disordered gamblers undergoing treatment showed a strategic avoidance bias in the maintenance of attention. These results have been interpreted as being consistent with the notion that attentional biases are important not only in the maintenance but also in the extinction of gambling behavior.

However, to date, the empirical base has been limited in investigating the association between attentional bias and gambling severity. There is arguably a surprising lack of research investigating how the different components of attentional bias correlate with specific aspects of gambling behavior. Consequently, the primary aim of the present study was to examine attentional bias and risk-taking among adult gamblers, as well as examine the relationship between attentional bias and risk-taking. Compared to non-disordered gamblers, it was expected that disordered gamblers would give more preferential attention to gambling images and to be more likely to engage in risk-taking behavior. In addition, the study also investigated the relationship between attentional bias and risk proneness in order to clarify if attentional bias mediated the relationship between risk-taking and gambling severity, or, alternatively, if risk-taking was the mediator of the impact of attentional bias on gambling severity.

2. Methods

2.1. Participants and procedure

The sample was recruited from Italian gambling venues comprising 70 male gamblers aged 30-63 years (M_{age} = 44.36; SD = 10.40). The Ethics Committee of the Department of Psychology of the University of Campania "Luigi Vanvitelli" approved the study. Before data collection, participants signed a consent form about the aims of the study, right to withdraw at any time, and aggregate analysis of data. Administration took place in a quiet room of gambling venues, where participants performed, in a counterbalanced order, two computerized tasks – modified version of Posner Task (Posner, 1980) and Balloon Analogue Risk Task (BART; Lejuez et al., 2002) – and completed the South Oaks Gambling Screen (SOGS; Lesieur and Blume, 1987; Italian-translation, Cosenza et al., 2014). Participation in the study was voluntary. After data collection, participants were debriefed.

2.2. Measures

The *South Oaks Gambling Screen* assesses the frequency and the severity of gambling involvement via 20 self-report items with dichotomous (yes/no) answers, based on the DSM-III criteria for pathological gambling (American Psychiatric Association, 1980). The scores vary from 0-20. Scores from 0-2 indicate no problem gambling, scores of 3-4 indicate problem gambling, and scores of 5 or above indicates (probable) pathological gambling.

The *Modified version of Posner Task* is a computerized version of a detecting attentional biases task. It was administered on a PC using the experimental software SuperLab 4.0 and the operating system Windows 8. The experimental stimuli comprised 40 color pictures, 20 gambling-related and 20 neutral, matched for color and shape. Gambling pictures represented different types of gambling, such as lottery tickets, cards, and slot machines, whereas neutral pictures represented objects similar for size, color, and shape, such as paintings, watches, and petrol pumps. Each image measured 350x350 mm and was presented on a personal computer that had a 15.6″ monitor on a grey background. The task comprised 160 trials. For each trial, participants are presented a fixation point ("+") (ITI; 1cm in height) for 1000ms, followed by a gambling or neutral image in the left or right side of the screen. At stimulus offset

(100 or 500ms), a blue probe (target) appeared in the same position of the picture (valid trial) or on the opposite side (invalid trial) for 1500ms. The participants' task was to identify the location of the target as quickly and accurately as possible. According to Posner (1980), 80% of the trials should be valid (128 trials; 64 gambling, 64 neutral) and 20% of the trials should be invalid (32 trials;16 gambling, 16 neutral). Each image appears four times, as a valid and invalid trial, for 100 and 500ms. The stimuli presentation time was manipulated to investigate different attentional components (e.g., Bradley et al., 2004; Field and Cox, 2008). More specifically, the initial orienting of attention (facilitation and/or avoidance) with a stimulus onset asynchrony (SOA) was from 50 to 200ms, and the maintenance or disengagement of attention with a SOA of 500ms (Field and Cox, 2008). Both accuracy and response times (RTs) were the variables of interest.

The *Balloon Analogue Risk Task* is a computerized task that assesses risk-taking. The animated presentation shows 30 balloons, one at time, and a participant is required to inflate the balloon by clicking a button on the screen. Each click inflates the balloon and accrues 5 cents in a temporary bank, so the more the participant inflates the balloon, the more money accrues. After an unpredictable number of balloon pumps, the balloon may burst causing the loss of the money accrued in the temporary bank. At any time, participants can decide to stop inflating and to click on the button labelled "Collect $$$", transferring money from the temporary bank to the permanent bank, where the money can no longer be lost. The mean average number of pumps on un-popped balloons is used as measure of risk-taking. High scores indicate high risk-taking (Lejuez et al., 2002).

3. Data preparation

After removing outliers (RTs<150 and >1000), only RTs of correct trials were taken into account. By subtracting RTs for gambling-related stimuli from neutral stimuli in valid trials, facilitation bias scores were obtained. Positive scores indicate enhanced attention toward gambling cues, whereas negative scores indicate attention away from gambling cues. By subtracting RTs for neutral stimuli from gambling-related stimuli in invalid trials, disengagement bias scores were obtained. Positive scores indicate attentional holding by gambling cues, whereas negative scores indicate faster shifted attention from gambling cues. Scores of zero indicate no attentional bias.

4. Results

Based on SOGS scores, a gambling scale based on the DSM-III (APA, 1980) pathological gambling criteria, participants were classed as non-problem gamblers (N = 42), problem gamblers (N = 10), or pathological gamblers (N = 18). Since problem and pathological gamblers did not differ on attentional biases and risk-taking, they were merged into a single group of 'problem gamblers', in line with a study by Ciccarelli et al. (2019b). According to DSM-5 recommendations, hereafter the terms "non-disordered gamblers" (NDGs) and "disordered gamblers" (DGs) are used. The majority of the sample participated in multiple forms of gambling (81%) and reported preference for sport betting (43%), lottery playing (30%), and slot machine gambling (17%).

No significant differences in age (NDGs = 46.19; DGs = 41.61; $F_{1,68} = 3.37$; $p = .07$; $\eta^2_p = .05$) or years of education (NDGs = 11.02; DGs = 11.07; $F_{1,68} = .004$; $p = .95$; $\eta^2_p = .001$) were found between the two groups. Zero-order correlations showed positive associations of facilitation bias at 100ms with both SOGS scores (r =.31; p <.01) and BART scores (r =.26; p <.05). To examine if disordered gamblers differ from non-disordered gamblers on attentional bias, a mixed ANOVA was performed on facilitation scores at 100 and 500ms (Time) with SOGS groups as between variable. The analysis yielded Time ($F_{1,68} = 11.46$; $p = .001$; $\eta^2_p = .14$) and Time x Group ($F_{1,68} = 8.01$; $p < .01$; $\eta^2_p = .10$) effects, whereas the effect of Group was not significant ($F_{1,68} = 0.58$; $p = .45$; $\eta^2_p = .01$). Specifically, disordered gamblers showed a facilitation bias at 100 ms (DGs = 18.78) as compared to non-disordered counterparts (NDGs = 1.47) (Bonferroni correction; p =.01). The same analysis performed on disengagement bias at 100 and 500ms revealed no effects of Time ($F_{1,68} = 0.05$; $p = .82$; $\eta^2_p = .001$), Group ($F_{1,68} = 0.66$; $p = .42$; $\eta^2_p = .01$), or Time x Group ($F_{1,68} = 2.72$; $p = .10$; $\eta^2_p = .04$).

In addition, single-sample *t*-tests were performed on each attentional bias for both groups to evaluate whether bias scores differed significantly from zero. Analyses showed neither facilitation bias (100ms: $t_{41} = 0.42$, $p = .67$; 500ms: $t_{41} = -0.25$, $p = .81$) nor disengagement bias (100ms: $t_{41} = -0.99$, $p = .33$; 500ms: $t_{41} = 1.15$, $p = .26$) in the non-disordered gambler group. A facilitation bias at 100ms ($t_{27} = 4.01$, $p < .001$), but not at 500ms ($t_{27} = -1.16$, $p = .26$), and no disengagement bias (100ms: $t_{27} = 1.29$, $p = .21$; 500ms: $t_{27} = 0.19$, $p = .85$) were observed in the disordered gambler group.

To examine risk-taking differences between groups, a univariate analysis of variance on BART scores using SOGS group (non-disordered gamblers vs. disordered gamblers) as between variable was performed. Results indicated that BART scores differed between groups ($F_{1,68} = 7.29$; $p < .01$; $\eta^2_p = .10$), with disordered gamblers (*M* = 33.00; *SD* = 19.08) that pumped more balloons than non-disordered gamblers (*M* = 21.10; *SD* = 17.38).

To identify the predictors of gambling severity, a linear regression analysis was conducted on SOGS scores using age, years of education, attentional bias (facilitation and disengagement, both at 100 and 500ms), and BART scores. Collinearity diagnostics indicated that multicollinearity was not a concern (tolerance ranging from 0.90 to 1.00, VIF ranging from 1.00 to 1.16; according to Ryan, 1997). Results of the final model indicated that young age, facilitation bias at 100ms, and risk-taking significantly predicted gambling severity ($R^2_{adj} = .15$; $F_{3,66} = 4.93$; $p < .01$).

Considering linear regression analysis results and the associations among the examined variables, path analysis was conducted to analyze associational relationships among variables contributing to gambling severity. More specifically, analysis was performed to ascertain if automatic facilitated attention for gambling cues was on the path from risk-taking to gambling severity, or alternatively, if risk-taking mediated the impact that facilitation biases had on gambling severity. Two different models were compared: the first model (Model-1) assumed that risk-taking predicted gambling severity not only directly but also indirectly via attentional bias, whereas the second model (Model-2) assumed that facilitated attention for gambling stimuli predicted gambling severity not only directly but also indirectly via risk-taking proneness. The path analysis showed that the second model (see Table 1) was a better fit to the data (see Figure 1).

TABLE 1 AND FIGURE 1 ABOUT HERE

5. Discussion

The aim of the present study was to assess both attentional bias and risk-taking behavior in gambling and to examine, for the first time, the relationship between these two constructs among male adult gamblers. Compared to non-disordered gamblers, disordered gamblers showed higher scores on facilitation bias at 100ms, indicating that they detected gambling-related stimuli faster than neutral stimuli. This finding concurs with previous studies which observed attentional bias in the initial orientation of attention among disordered gamblers (e.g., Brevers et al., 2011a, 2011b; Field and Cox, 2008; Molde et al., 2010). Furthermore, consistent with past research, disordered gamblers were found to pump balloons in the BART significantly more times than non-disordered gamblers. This result indicates that disordered gamblers engage in generalized risk-taking behavior significantly more than non-disordered gambling counterparts (for similar results, see Ciccarelli, Malinconico, et al., 2016; Cosenza et al., 2017).

In line with hypotheses, the evidence demonstrates that, alongside young age, attentional biases for gambling stimuli, namely a facilitated attention to gambling at short stimulus durations, predict gambling severity not only directly, but also indirectly, via risk-taking. In light of incentive-sensitization theory (Robinson and Berridge, 2008), it can be argued that gambling stimuli grab attention and increase desire for gambling activities, fostering risk-taking behavior that is the quintessence of gambling, i.e., “risk losing something of value (generally, money) in the hope of gaining something of greater financial value” (Cosenza et al., 2017, p. 384). In addiction, age was found to directly predict disordered gambling. Even if the present sample is a middle-aged group, this finding agrees with Welte et al. (2011) results that have underlined that, though frequent and disordered gambling increases in adolescence, it peaks in adulthood (at age 31-40) and decline with age (over 70 years).

Taken together, these preliminary novel findings have an important clinical implication because they suggest that attentional biases are a vulnerability factor for the maintenance of gambling disorder. Moreover, the present results provide some insight about the relationship between attentional bias and risk-taking, indicating that facilitated attention for gambling stimuli may lead to greater proneness to take monetary risks. In turn, risk-taking promotes the perseveration in gambling. It is likely that considering attentional bias as worthy target for therapeutic interventions would help in overriding problematic risk-taking proneness that facilitates the development of disordered gambling.

6. Limitations

The absence of a measure of gambling-related craving precluded the possibility to test whether both risk-taking and attentional bias were associated with the subjective experience of urge. Moreover, the modest sample size (although adequate for experimental data collection) and the absence of female gamblers limit the generalizability of the present results. The present study did not include a group of non-gamblers and is highly recommended for future studies (Field and Cox, 2008). Furthermore, it should be noted that although no participant smoked cigarettes or drank alcohol during the experiment they may have consumed these substances beforehand (and this was not asked about). Future experiments should ensure participants are not under the influence of possible intoxicants that could influence the findings. Finally, the present findings should be interpreted cautiously, taking into account the correlational nature of the data that prevent causal inferences from being drawn. The hypothesis that enhanced attention to gambling cues promotes risk-taking needs to be experimentally investigated in future studies.

7. Conclusions

To the best of the authors' knowledge, the present study is the first to examine the interplay between risk-taking, attentional bias, and gambling severity. Findings regarding risk-taking as mediator between facilitation bias and gambling severity are compatible with the idea that automatic early detection of gambling stimuli in the environment is one explanation for greater riskiness among gamblers. Future research is needed to further elucidate the specific processes underlying attentional bias and gambling-related behaviors.

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