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Introduction

For many individuals, gambling is a popular form of leisure and social entertainment. However, for a small percentage of population it represents a serious disorder (Petry et al., 2005). The severity of gambling involvement varies in a continuum from non-problematic gambling through to pathological gambling. Problem gambling is less severe than pathological gambling, a psychopathological condition that satisfies diagnostic criteria for gambling disorder (DSM-5; American Psychiatric Association, 2013).

Recently, the observation of endophenotypical and phenotypical similarities (Tamminga and Nestler, 2006) between gambling and substance addictions helped determine a change in the diagnostic classification of gambling from impulse control disorder (American Association, 1980) to behavioral addiction (American Psychiatric Association, 2013). Within the cognitive framework of addictions, much research has demonstrated the importance of attentional bias in influencing the course of such addictive disorders. Attentional biases refer to preferential allocations of attention towards stimuli related to the individual's area of concern (Field and Cox, 2008). In the field of addictions, attentional biases comprise attentional allocation to addicted-related stimuli when compared to neutral stimuli and are deemed alongside other factors responsible for the maintenance and relapse in the disorder (Field and Cox, 2008; Rooke et al., 2008). The prolonged engagement in gambling activities increases perception or detection of gambling-related stimuli in the environment, which can trigger relapses through conditioned responses. Attention is a limited source, and directing attention towards gambling stimuli hinders the detection of alternative stimuli (Kastner et al., 1998). Furthermore, once a gambling-related stimulus has been detected, it can be automatically processed, making it difficult to divert attention away from it.

To date, research on attentional bias in gambling has focused on selective attention, "*a cognitive function that facilitates the processing of relevant stimuli and inhibits the processing of less relevant stimuli*" (Franken, 2003; p.3). Several studies on gamblers have reported longer reaction times in detecting gambling-related words when compared to neutral ones (Boyer and Dickerson, 2003; McCusker and Gettings, 1997), and that their attention is gained by gambling sources of information to the point that they are slower to respond to neutral stimuli during a gambling episode (Diskin and Hodgin, 1999).

Despite the heterogeneity of the adopted measures, the psychological literature has consistently demonstrated that gamblers' attention is biased towards gambling information and that this effect is not observable in non-problem gamblers (Boyer and Dickerson, 2003; Brevers et al., 2011a, 2011b; Ciccarelli et al., 2016; Diskin and Hodgins, 1999; McCusker and Gettings, 1997; Molde et al., 2010; Wolfling et al., 2011). Nevertheless, some important aspects need to be addressed (Hønsi et al., 2013). The first issue relates the stage of cognitive processing during which attentional biases occur, on which there is a paucity of research. Research generally distinguishes automatic and strategic stages of information processing. The automatic stage is a type of processing that requires no awareness or control, whereas the strategic stage is a type of processing that requires intent and control (e.g., Moors and de Houwer, 2006). To date, most studies have employed attentional paradigms that alternately investigate initial orienting (Brevers et al., 2011b; Diskin and Hodgins, 1999) or maintenance of attention (Atkins and Sharp, 2003; Boyer and Dickerson, 2003; McCusker and Gettings, 1997; Molde et al., 2010; Vizcaino et al., 2013).

In fact, research concerning attentional bias in gambling has traditionally employed paradigms, such as the Stroop test or attentional blink, requiring a direct response to gambling stimuli, demonstrating a direct and explicit response to a valent (gambling) stimulus. The use of methods such as eye tracking or the Posner task is more suitable for a deeper understanding of the attentional components, even in overt situations. In fact, in this latter case, participants are required to pay attention and respond to a neutral stimulus appearing after a valence/neutral stimulus (probe) in a visuo-spatial task. If the participant's attention is captured by the probe, the response will be more rapid if it appears in the same spatial location of the probe and it will be slower if it appears in the opposite side. This kind of paradigm, like the use of eye tracking, allows investigation of unintentional attentional allocation and the power of a valence stimulus among those with a gambling disorder.

Similarly, there is little clarity about the components of attentional bias involved in gambling. Attentional biases may comprise (i) facilitated attention to relevant stimuli, (ii) difficulty in disengaging attention from relevant stimuli, and/or (iii) attentional avoidance of relevant stimuli. In relation to gambling behavior, facilitation refers to a faster detection of gambling stimuli when compared to non-gambling stimuli. Disengagement refers to a difficulty in shifting attention away from gambling information. Avoidance refers to an allocation of attention in opposition to that of gambling stimuli (Cisler and Koster, 2010).

To date, only two studies have simultaneously addressed both the issues. Brevers et al. (2011a) found that problem gamblers more rapidly detect gambling-related stimuli and need more time in shifting attention from them, demonstrating both a facilitation in reacting to gambling-related stimuli and difficulty disengaging attention away from gambling pictures. The use of Eye Gaze Monitoring allowed the assessment of time course of attentional bias, concluding that both automatic and strategic stages of attention are biased in problem gamblers. In contrast to this, Ciccarelli et al. (2016) study found a facilitation bias in reacting to gambling-related stimuli only in the initial orienting of attention among problem gamblers.

Examining the literature as a whole, there is a lack of research investigating the relationships between attentional bias and other aspects (such as motivations to gamble). Whereas in the field of substance-addictions, an association between craving and attentional bias has been found (Field et al., 2009), there has been only one study examining gambling disorder (i.e., Molde et al., 2010) – in contrast to others (Brevers et al., 2011a; Wölfling et al., 2011) – that has observed a relationship between attentional bias and gambling abstinence.

Another motivation to gamble is to engage in the activity to suppress or escape negative emotional states. Several studies investigating the reasons to gamble have shown that a high percentage of gamblers rely on gambling to both regulate negative emotions (Blaszczynski and McConaghy, 1989; Dickerson et al., 1996; Gupta and Derevensky, 1998; Beaudoin and Cox, 1999) and to ameliorate mood, increasing arousal and experiencing excitement (Griffiths, 1995; Wood and Griffiths, 2007). Negative affect is also associated with a greater likelihood of gambling relapses (Daughters et al., 2005). However, no study has ever investigated the relationship between negative affectivity and attentional bias towards gambling cues.

To further the understanding concerning attentional bias over a continuum from the absence of gambling problems, to gambling problems and abstinence from gambling, the present study was carried out with three aims. Firstly, it assessed attentional biases in non-problem gamblers, problem gamblers, and abstinent pathological gamblers. Secondly, it investigated craving and emotional distress levels across the three groups. Thirdly, it examined the relationship between emotional distress, craving, and attentional biases across the three groups.

It was hypothesized that problem gamblers, compared to non-problem gambling controls, would detect gambling-related images faster than neutral stimuli in the initial orienting of attention, whereas among abstinent gamblers there would be an avoidance bias towards gambling stimuli in the maintenance of attention due to an intention to keep away from gambling. It was also hypothesized that problem gamblers would exhibit a higher level of craving and that abstinent gamblers would exhibit a higher level of emotional distress, compared to others. Finally, it was expected that there would be correlations between negative affectivity, craving, and attentional bias. Providing empirical evidence of a specific psychotherapy program's validity goes beyond the scope of this paper. However, the study also investigated whether abstinence from gambling, regardless of the type of psychotherapy undergone, affects attentional biases, and whether abstinent pathological gamblers have a specific way of directing attention.

Method

Participants

Three groups of Italian male gamblers (N=75 in total) participated in the study, aged 24 to 65 years (M_{age} = 44.47, *SD* = 10.79): non-problem gamblers (NPGs; N=25), problem gamblers recruited at a gambling venue (PGs; N=25), and pathological gamblers with a diagnosis of gambling disorder according to DSM-5 criteria, enrolled in treatment at Department of Addiction of Local Health Trust in Caserta, (PGTs; N=25). They had been in treatment for a variable time period, ranging from 1 to 19 months (*M*= 6.96 months, *SD*= 5.63). Problem and non-problem gamblers were discriminated using South Oaks Gambling Screen scores: the former had SOGS scores equal to or greater than 3, whereas the latter had SOGS scores equal to or less than 2 (for details, see Table 1). The three groups did not differ significantly in age (NPGs= 45.60 years, PGs= 42.56 years; PGTs= 45.24 years; $F(2,72)$= 0.59, p= .56) or years of education (NPGs= 11.16 years, PGs= 10.84 years, PGTs= 11.68 years; $F(2,72)$= 0.57, p= .57). The sample comprised male-only participants for two reasons. First, to ensure the homogeneity of the sample, and secondly, because men are reported in literature as being more likely to engage in gambling behavior and have gambling problems compared to women (DSM-5; American Psychiatric Association, 2013).

INSERT TABLE 1 ABOUT HERE

Measures

Modified version of Posner Task (PT; Posner, 1980). This computerized version of the PT was used with SuperLab 4.0 experimental software. A total of 40 gambling-related pictures and 40 neutral pictures were chosen from non-copyrighted images found on the internet. Of these, 20 gambling-related images and 20 neutral images were selected on the basis of 20 independent judges' evaluation (10 males; M_{age}= 26 years; SD= 3.8) assessing the gambling relevance, pleasure, and arousal of each image (on a 9-point Likert scale from *not at all* to *very much*). The gambling images that received the highest scores on gambling relevance (mean gambling relevance= 7.26) were chosen as gambling images. To match gambling with neutral images, further internet searches for neutral pictures were conducted. The non-gambling images that received lower scores on gambling relevance (mean gambling relevance= 0.65) were chosen as neutral images. Gambling and neutral images were no different on pleasure (gambling= 2.26; neutral= 2.66) and arousal (gambling= 2.55; neutral= 2.78). Gambling pictures depicted different types of gambling, such as slot machines, scratchcards, and lottery tickets, whereas neutral stimuli depicted objects similar for size, shape and colour (Field et al., 2009; Franken, 2003), such as petrol pumps, paintings, and watches. All the images had the same size (350 x 350 pixel) and were presented on a grey background on a 15.6" computer monitor.

The PT comprised 160 trials for a total duration of approximately seven minutes. Each trial began with the presentation of a fixation point ("+") (ITI; 1 cm in height) in the middle of the screen, between two rectangles (4.8 cm high × 6.5 cm wide). The fixation cross appeared for 1000 ms and was followed by a cue (gambling or neutral) to the left or right side of the screen (with the same size as the rectangles) for a fixed period of 100 ms or 500 ms. When the cue disappeared, a dot (target), consisting of a blue circle, appeared in the left or right of the screen, in the same (valid trial) or in the opposite position (invalid trial) of the previous cue, and remained on the screen for 1500 ms (see Figure 1). After responding, the next trial started immediately. Following the procedure used by Posner (1980), 80% of the trials were valid (128 trials, 64 gambling and 64 neutral), and 20% of the trials were invalid (32 trials, 16 gambling and 16 neutral).

INSERT FIGURE 1 ABOUT HERE

Each image was presented both for 100 ms and 500 ms. The manipulation of the cue presentation time allows the assessment of two different attentional components (e.g., Bradley et al., 2004; Field and Cox, 2008): the initial orienting of attention (facilitation and/or avoidance) (100 ms), and the maintenance or disengagement of attention (500 ms) (Field and Cox, 2008; Field et al., 2009). Each image appeared four times, for 100 ms and 500 ms, in valid and invalid trials. Accuracy (errors) and response times (RTs) were recorded.

South Oaks Gambling Screen (SOGS; Lesieur and Blume, 1987; Italian translation by Cosenza et al., 2014). The SOGS assesses the severity of gambling problems in 20 items with a dichotomous answer (*yes/no*) concerning the frequency of gambling activities, the amount of money spent gambling, chasing losses, and the perceived inability to stop gambling. Scores of 0-2 indicate no gambling problems, scores of 3-4 indicate a risk profile for gambling problems, and a score of 5 or above denotes problem and (probable) pathological gambling. In the present study, the SOGS' Cronbach alpha (α=.90, 95% CI [.88, .92]) were considered of good reliability (Nunnally, 1978).

Gambling Craving Scale (GACS; Young and Wohl, 2009; translated into Italian for the present study). The GACS assesses nine items on a 7-point Likert scale (from *strongly disagree* to *strongly agree*), the subjective feeling of craving for gambling activities and comprises three subscales: desire (the immediate desire to gamble), anticipation (the anticipation of immediate and positive experiences from gambling), and relief (the immediate relief from negative states that was expected from gambling). Higher scores reflect stronger feelings of craving. In the present sample, Cronbach's alpha was .89 for the overall scale (95% CI [.85, .92]). The three subscales had adequate to excellent reliability for desire (α= .96, 95% CI [.94, .97]), anticipation (α= .71, 95% CI [.58, .81]), and relief (α= .81, 95% CI [.73, .88]).

Depression Anxiety Stress Scale (DASS-21; Henry and Crawford, 2005; Italian validation by Bottesi et al., 2015). The DASS-21 is the short version of the DASS and assesses psychological distress using 21 items, divided into three subscales (i.e., depression, anxiety and stress). Higher scores correspond to higher levels of negative mood states. The overall scale resulted in a Cronbach's alpha of .92 (95% CI [.90, .95]). The three subscales had good reliability scores for depression (α= .87, 95% CI [.82, .91]), anxiety (α= .83, 95% CI [.76, .88]) and stress (α= .84, 95% CI [.78, .89]).

Procedure

Before the experimental session, all participants signed an informed consent form approved by the research team's university ethics committee. The informed consent reported, in summary, that the study in which they were required to participate had the generic aim of evaluating the association between some psychological aspects and gambling behavior. They were assured about their anonymity in the study and about the possibility to withdraw at any time. Participants were tested individually in a quiet room, were seated 60cm from the monitor and were asked to read the instructions on the screen: "*Now you will see a series of images followed by a dot. Your task is to respond as quickly and accurately as possible by pressing the right button of the keyboard if the dot appears to the right side of the screen, and the left button of the keyboard if the dot appears on the left side of the screen. When you are ready, press the space bar to start".* The target buttons on the keyboard were "a" for left and "ù" for right and were clearly marked with white stickers. Immediately after the PT, participants were asked to complete the self-report measures. After data collection, participants were debriefed about the real purpose of the research and were thanked for their participation without monetary rewards.

Data preparation

After selecting the reaction times of correct responses, facilitation and disengagement biases were calculated. Facilitation scores were calculated by subtracting reaction times for gambling-related stimuli from neutral stimuli in valid trials (i.e., RTs valid/neutral-RTs valid/gambling). Disengagement scores were calculated by subtracting reaction times for neutral stimuli from gambling-related stimuli in invalid trials (i.e., RTs invalid/gambling-RTs invalid/neutral). Positive facilitation scores indicate shorter reaction times in detecting stimuli appearing in the same position of the gambling cues compared to neutral images. Positive disengagement scores indicate an engagement of attention on gambling-related cues compared to neutral stimuli. Avoidance biases correspond to negative values of facilitation and disengagement bias and indicate a tendency to avoid gambling stimuli. Values not different from zero indicate the absence of attentional biases.

Data analysis

Statistical analyses were performed with the IBM Statistical Package for the Social Sciences, version 20.0. The alpha significance level was set at .05. After removing outliers (RT<150 and >1000), a repeated analysis of variance 3 x 2 x 2 x 2 on reaction times (RTs) was run, with *group* (NPGs vs. PGs vs. PGTs) as between factor and *valence* (gambling vs. neutral), *validity* (valid vs. invalid), *cue presentation time* (100 ms vs. 500 ms) as within factors. Two mixed 3 x 2 ANOVAs were performed on facilitation bias scores with one between-participant factor (group: NPGs vs. PGs vs. PGTs) and two within-participant factors (facilitation bias at 100 and 500 ms). The same analysis was executed on disengagement bias scores. A single-sample t-test comparison was used to assess whether bias scores were significantly different from zero. Two univariate analyses of variance with craving (GACS), and emotional distress (DASS-21) as the dependent variables and two multivariate analyses of variance (MANOVA) with group as independent factor and the subscales of each measure as dependent were performed. Significant findings were followed by Bonferroni *post-hoc* tests. Associations among measures were assessed with zero-order correlations. More specifically, correlational analyses between significant attentional bias scores and DASS-21 and GACS total scores were carried out. If correlation coefficients were statistically significant, correlational analyses between attentional bias scores and the subscales of the measures (DASS-21 and GACS) were run.

Results

Performance on the modified PT

Reaction times (RTs) for correct responses were used for analyses. From a mixed ANOVA performed on RTs in the Modified Posner Task, significant main effect were found for Validity, $F(1,72) = 151.23$, $p<.001$, $\eta^2_p = .68$, and Time, $F(1,72) = 96.30$, $p<.001$, $\eta^2_p = .57$. RTs were faster for valid trials (RTs valid = 423.10; RTs invalid = 476.32) and for longer cue presentation (RTs 100 ms = 470.16; RTs 500 ms = 429.26), whereas the effect of Valence was not significant, $F(1,72) = 1.96$, $p = .17$ (see Table 2).

No significant interactions were found for Validity x Time, $F(1,72) = 0.21$, $p = .65$, Valence x Group, $F(2,72) = 0.25$, $p=.77$, Time x Group, $F(2,72) = 1.52$, $p=.22$, Valence x Validity, $F(1,72) = 0.11$, $p=.74$, and Valence x Time, $F(1,72) = 2.97$, $p=.09$. The significant Validity x Group effect, $F(2,72) = 4.87$, $p=.01$, $\eta^2_p = .12$, indicated that PGs and PGTs took more time to respond to valid (compared to invalid) trials, whereas the Valence x Validity x Group, $F(2,72) = 3.42$, $p=.04$, $\eta^2_p = .09$, showed that PGs had longer time reactions in responding to valid gambling-related trials compared to other groups. No significant interactions were found for Validity x Time x Group, $F(2,72) = 1.08$, $p=.34$, Valence x Validity x Time, $F(1,72) = 1.34$, $p=.25$, and Valence x Validity x Time x Group, $F(2,72) = 0.63$, $p =.53$.

INSERT TABLE 2 ABOUT HERE

From the mixed ANOVA performed on facilitation bias scores, a main effect of Time, $F(1,72) = 7.72$, $p<.01$, $\eta^2_p = .10$, and an effect of Group, $F(2,72) = 3.76$, $p=.03$, $\eta^2_p = .09$, were found. There was no Group x Time interaction, $F(2,72) = 2.29$, $p=.11$. Analysis on disengagement scores showed no statistical significance for the main effect of Time, $F(1,72) = 0.15$, $p=.70$, the main effect of Group, $F(2,72) = 0.92$, $p=.40$, nor the Group x Time, $F(2,72) = 0.06$, $p=.94$.

In order to test if bias scores differed significantly from zero, a single-sample t-test comparison for facilitation and disengagement bias was performed. Neither facilitation (100 ms: $t_{24} = 0.40$, $p=.69$; 500 ms: $t_{24} = 0.64$, $p=.53$) nor disengagement bias (100 ms: $t_{24} = 0.53$, $p=.60$; 500 ms: $t_{24} = 0.71$, $p=.48$) was found in the NPG group. In the PG group only, a facilitation bias at 100 ms ($t_{24} = 2.52$, $p=.02$), but not at 500 ms ($t_{24} = -0.93$, $p=.36$) (Figure 2), and no disengagement bias (100 ms: $t_{24} = 0.64$, $p=.53$; 500 ms: $t_{24} = 1.51$, $p=.14$) were observed. PGTs showed a facilitation (avoidance) bias at 500 ms ($t_{24} = -2.29$, $p=.03$), but not at 100 ms ($t_{24} = -0.87$, $p=.39$) and did not report disengagement bias (100 ms: $t_{24} = -.0.34$, $p=.74$; 500 ms: $t_{24} = -0.22$, $p=.83$) (Figure 3).

INSERT FIGURE 2 AND FIGURE 3 ABOUT HERE

Current clinical status

Emotional distress level (DASS-21) did not differ among groups, but a significant effect of the Group was found on the Stress subscale, with PGTs scored significantly higher than NPGs ($p<.01$). Regarding Depression and Anxiety scores, there were no differences among groups. Craving for gambling activities (on the GACS) differed significantly among groups, and *post-hoc* analysis showed that all comparisons were statistically significant, indicating that PGTs had lower levels of craving than NPGs ($p=.02$) and PGs ($p<.001$), whereas PGs showed higher levels of craving compared to the other groups ($p<.01$).

Further analysis also revealed a significant effect of the Group on all its three subscales (i.e., Desire, Anticipation, and Relief). Bonferroni *post-hoc* demonstrated that PGs had high Desire compared to NPGs ($p=.003$) and PGTs ($p<.001$), whereas the other two groups did not differ significantly. With regards to Anticipation, all the comparisons among groups were significantly different, with PGs having higher level of Anticipation craving compared to NPGs (p=.01) and PGTs (p<.001), and PGTs having lower levels of craving compared to NPGs (p<.001). With respect to Relief subscale, PGs showed higher levels of craving compared to NPGs (p=.03) and PGTs (p=.001) whereas the other differences did not reach significant difference (see Table 3).

INSERT TABLE 3 ABOUT HERE

Correlational analysis

Correlational analysis, executed in order to evaluate the relationships between measures, revealed significant associations between facilitation bias at 100 ms and anticipation craving (GACS) (r= .259; p= .02) and GACS total score (r= .274; p= .02).

Discussion

The present study aimed to establish which stage of information processing and which components of attentional bias are involved in the severity of gambling problems, using a group of non-problem gamblers (NPGs), a group of problem gamblers (PGs), and a group of abstinent pathological gamblers in treatment (PGTs) with a diagnosis of gambling disorder according to DSM-5 criteria (American Psychiatric Association, 2013). For the first time, attentional bias in abstinent pathological gamblers was evaluated, not with the scope to prove the efficacy of a specific model of psychotherapy, but in order to understand attentional biases pattern in the discontinuation of gambling activities. To answer these questions, a modified version of Posner Task (Posner, 1980) was used. The Posner Task is an attentional paradigm that allows the manipulation of cue presentation time, thus assessing both the early orientation (100 ms) and the maintenance of attention (500 ms).

Interestingly, each group had a specific attentional pattern. In NPGs, no difference between attentional detection of neutral and gambling-related stimuli was found, and was therefore in line with results of past studies showing that no attentional bias is observable in the absence of problem gambling (e.g., Brevers et al., 2011a, 2011b; Ciccarelli et al., 2016; Wolfling et al., 2011). PGs took less time to respond when presented with gambling-related pictures in the early orientation of attention. This finding is in line with several studies that have found that PGs are faster to detect gambling-related changes (Brevers et al., 2011a; McCusker and Gettings, 1997; Molde et al., 2010) and to react to probes replacing gambling-related stimuli

(Field and Cox, 2008). The findings of the present study also suggest that the repeated gambling experiences may make salient the addiction-related cues that were detected more easily and automatically.

Contrary to other studies (e.g., Grant and Bowling, 2015; Vizcaino et al., 2013), the present research did not find bias in the maintenance of attention among PGs. Reasons for this could include the various instruments used to assess biases, the exclusive evaluation of the maintenance stage of attention in these studies, and/or the different samples recruited (Grant and Bowling, 2015; Vizcaino et al., 2013). Furthermore, to check whether the non-significant disengagement biases were due to a lack of statistical power, a post-hoc power analysis with the program G*Power (Erdfelder, Faul, & Buchner, 1996) with power (1 - β) set at the recommended .80 level (Cohen, 1988) and α= .05 was conducted. Results showed that sample size should be increased up to N= 1,083,903 for the significant effect of Time, and to N= 8,484 for the significant effect of Group, in order to reach statistical significance at the .05 level. Therefore, it is legitimate to conclude that negative findings related to disengagement bias cannot be attributed to a limited sample size.

The PGTs showed an avoidance bias in the maintenance of attention, namely a shift of attention away from gambling-related pictures, which may suggest an attempt to ignore gambling stimuli. This finding highlighted that while PGs' attention was captured in an automatic and uncontrollable way by gambling cues, PGTs tried strategically to allocate attention away from gambling stimuli. However, these results could also be due to a reduced attentional shifting ability among PGTs. For instance, abstinent gamblers might feel negative emotions or distress when perceiving gambling stimuli. Consequently, such feelings could impede the correct processing of all of the stimuli following the gambling stimulus. In other words, both attention and/or feelings towards gambling stimuli could perhaps hamper the subsequent correct detection of neutral stimuli. However, the specific process is, the present study demonstrated a slower detection of neutral stimuli following presentation of gambling cues in abstinent gamblers only, and only in the valid condition. Further studies are needed to better explain the exact nature of these attentional patterns and the specific role of attentional avoidance or of negative emotions in detecting gambling stimuli. For instance, measuring heart rate and/or eye movements during a Posner task could be useful in fully understanding the psychophysiological pattern and eye orientation during gambling stimuli detection.

The lack of bias in the early attentional orientation in PGTs contrasts with the review by Field and Cox (2008), in which the authors stated that, differently from the slower aspects of attentional bias (that are likely to change under treatment), the automatic components of attention are not liable neither to control nor to modification. However, the authors themselves concluded that their assertion needs further empirical research. Additionally, the abstinence presumably deconditioned the PGT group from gambling stimuli. The absence of a baseline assessment of attentional bias in PGTs prevents us from understanding whether a change in the pattern of bias occurred during psychotherapeutic treatment. In this regard, specific clinical interventions aimed at reducing attentional bias (such as “attentional bias modification” programs) are necessary (Hønsi et al., 2013).

Another aim of the present study was to examine the relationship between attentional bias for gambling-related cues and craving. In contrast to previous studies (i.e., Brevers et al., 2011a; Wölfling et al., 2011), a relationship between craving and facilitation bias in the early orientation of attention emerged, confirming that, after repeated experience of gambling, gambling-related stimuli acquire salience, becomes the object of craving and triggers object addiction-related seeking behavior (Robinson and Berridge, 1993, 2008). These contrasting patterns of results across studies may be attributable to the different characteristics of samples that reported different levels of craving. In the study by Brevers et al. (2011a), participants were mainly PGs while, in the present study, approximately 68% of the PGs met the criteria for probable pathological gambling (SOGS $\geq$ 5). According to Young and Wohl (2009), the Gambling Craving Scale (GACS) allows the discrimination of different levels of gambling severity, since craving scores are higher among individuals with a more problematic gambling involvement.

Contrary to the hypothesis, the lack of association between emotional distress and attentional bias might be accounted for by a low negative affectivity at the time of assessment. Indeed, the Depression Anxiety Stress Scale (DASS-21) required people to indicate their emotional distress in the past two weeks and the analyses on scores of the scale revealed that there were no significant differences between the three groups. The only significant difference between groups was related to stress – high levels of stress were observed in PGTs, in line with studies that have reported stress to be an independent predictor of gambling urges (Elman et al., 2010) and that have demonstrated the role of stress in the onset, maintenance (Coman et al., 1997; Friedland et al., 1992) and relapse of problem gambling (McCartney, 1995).

Alternatively, the use of game as a way to ameliorate mood (Wood and Griffiths, 2007) may occur automatically, in the lack of awareness of one’s own emotional states. In this regard, previous studies have found that PGs lack emotional awareness (e.g., Mitrovic and Brown, 2009; Williams et al., 2012).

Limitations

Despite the many novel strengths of the present study, several limitations should be noted. Firstly, the absence of a measure of attentional bias in the PGT group at baseline prevents the comparison between before and after abstinence and, therefore, limits the understanding of attentional biases in the discontinuation of gambling and not. Secondly, the sample size restricts generalizing of the results. The findings need to be extended by further research on a larger sample of gamblers (NPGs, PGs and PGTs). Thirdly, the lack of a non-gambler group and female participants means there are limitations in elucidating the attentional biases across the gambling continuum and gender, limiting conclusions of the present research. Fourthly, given that the Posner Task is an indirect measure of attentional bias (i.e., it does not directly assess participants' eye movements) the present findings should be interpreted with caution and need to be corroborated by further future research using other attentional research paradigms. Finally, the study is limited to Italian gamblers. Extending this research to gamblers in other countries is needed to understand whether these findings are applicable to other populations. Future research also needs to clarify whether and how attentional biases are correlated with other aspects of gambling behavior.

Conclusions

To the authors’ knowledge, this is the first study to evaluate attentional biases, craving, and emotional distress in abstinent pathological gamblers undergoing treatment. The facilitation for gambling cues in the early orientation of attention in PGs, and the attentional avoidance from gambling stimuli in the maintenance of attention in PGTs suggest that attentional bias is an important factor both in the onset and in the extinction of gambling behavior. The observed association between the feeling of “wanting” gambling and facilitation in capturing gambling-related stimuli is in line with the incentive-sensitization model (Robinson and Berridge, 1993, 2008) that notes the importance of motivation in reinforcing addictive behaviors.

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