Ciccarelli, M., Cosenza, M Griffiths, M.D., Nigro, G., & D'Olimpia, F. (2019). Facilitated attention for gambling cues in adolescent problem gamblers: An experimental study. *Journal of Affective Disorders,* 252, 39-46.

Abstract

Studies investigating attentional biases in gambling have observed that problem gamblers' attention is biased toward gambling cues. Despite the increase of gambling among adolescents, to date, no study has ever examined the role of attentional bias in adolescent gambling, as well as the relationships between adolescent gambling severity, craving, and alcohol use.

Methods

The present study comprised 87 adolescent participants. Based on South Oaks Gambling Screen Revised for Adolescents (SOGS-RA) scores, participants were assigned to non-problem or problem gamblers groups. Participants performed a modified Posner Task (with cue presentation times at 100 and 500 ms) to assess attentional biases. Following the experiment, participants completed the Gambling Craving Scale (GACS) and the Alcohol Use Disorders Identification Test (AUDIT).

Results

Compared to non-problem gamblers, problem gamblers displayed facilitation bias for gambling cues at 500 ms and reported higher levels of craving and alcohol consumption. Results also indicated that alcohol use correlated with facilitation bias.

Limitations

The recruitment of a predominantly male sample and the use of an indirect measure of attentional bias may have affected the findings concerning attentional processes.

Conclusions

The present study provides the first empirical evidence of attentional processes in adolescent gambling, and confirms the role of attentional biases, craving, and alcohol use being associated factors in adolescent problem gambling. The results of the present study stress the importance of attentional biases in the initial stages of problem gambling and suggest the need for clinical interventions aimed at reducing attentional bias before they became automatic. Overall, the present study stressed the role of attentional bias as both facilitator and a consequence of gambling involvement.

1. Introduction

Attentional biases comprise a preferential attentional allocation towards stimuli that are related to the individual's area of concern (Robinson and Berridge, 2008) and have been suggested as main factors in both the maintenance of addictive behaviors and relapse among those who are abstinent (Field and Cox, 2008). Empirical evidence suggests that attentional biases are a consequence of classical conditioning process. Here, a neutral stimulus, repeatedly followed by a reward (e.g., pleasure), becomes salient and acquires motivational properties, so that it catches the attention, increases subjective craving, and "thus guides behaviour to the incentive" (Robinson and Berridge, 1993, p. 261; see also Bouton, 2000; Franken, 2003; Field and Cox, 2008; McCusker, 2001; Ryan, 2002; Sayette et al., 2000). Other scholars have related attentional bias to the individual's current concerns (Cox, Fadardi, and Pothos, 2006; Cox, Klinger, and Fadardi, 2006; Cox and Klinger, 1988, 1990, 2004). More specifically, the motivation to obtain the addiction-related object results in biased information processing, making individuals selectively oriented towards the detection of relevant stimuli in the environment.

Essentially, these models share the view that attentional bias and craving have a mutual excitatory relationship such that increases in one leads to increases in the other, a process that is likely to result in compulsive stimulus seeking and (substance/stimulus) self-administration. Applying this hypothesis to gambling disorder, craving, acting in tandem with attentional bias, increases the gambling-related stimuli's salience, which, in turn, steers attention and its biases. The automatic processing of these stimuli hampers the detection of others (Kastnern et al., 1998) and drives gambling behaviors (Boffo et al., 2018), contributing to the severity of addiction (Robinson and Berridge, 1993, 2008).

In the field of gambling, attentional biases have been explored using different samples, procedures and paradigms (Hønsi et al., 2013). Using the Addiction Stroop Task, three studies (i.e., Boyer and Dickerson, 2003; McCusker and Gettings, 1997; Molde et al., 2010) have found evidence of attentional bias compared to one study that did not (i.e., Atkins and Sharp, 2003). The three studies showed that problem gamblers (compared to controls) showed slower reaction times to both general and preferred gambling-related words (McCusker and Gettings, 1997; for similar results, see also McGrath et al., 2018), thus establishing the specificity of gambling-related attentional biases. However, because it is unclear whether the Addiction Stroop Task should be considered as a measure of initial orienting (Cox, Fadardi, and Pothos, 2006) or disengagement of attention (Field et al., 2009), succeeding studies have employed diverse paradigms. For example, Brevers et al. (2011a) recorded participants' eye movements using eye-tracking technology. Compared to non-gamblers, problematic gamblers exhibited more gaze fixation counts on (and spent more time looking at) gambling-related cues, suggesting that gamblers automatically detect gambling stimuli and have a difficulty in disengaging attention away from such stimuli. In another study, using the Attentional Blink Task in combination with eye-tracker, Brevers et al. (2011b) observed that, under conditions of limited attention, problem gamblers were more likely to identify gambling-related words than neutral words, thus showing enhanced attentional bias for gambling at the encoding level.

Diskin and Hodgins (1999) investigated the maintenance of attention by asking participants to press a response bar as soon as they noticed a light while they were playing on a video lottery terminal. The authors noted that problematic gamblers, as compared to occasional gamblers, were captured by gambling stimuli such that they reacted slower to an external stimulus during a gambling session. Using another paradigm, Ciccarelli et al. (2016a, 2016b) adopted a modified Posner Task that, through manipulation of cue presentation time, allowed the assessment of the initial stage (100 ms) and maintenance (500 ms) of attention. While healthy gamblers did not show any preferential deployment of attention, pathological gamblers (that are, 'problem gamblers' and 'probable pathological gamblers') were found to be faster in detecting gambling cues as compared to neutral ones (Ciccarelli et al., 2016a), demonstrating a facilitated attention for gambling cues. In the second study, these findings were replicated and, in addition, the authors found that gamblers currently in treatment took longer to react to gambling cues (i.e., they showed an avoidance bias, a strategic shift of attention away from gambling cues, which may suggest an attempt to ignore gambling stimuli and remain abstinent) (Ciccarelli et al., 2016b).

In summary, studies in the extant literature, albeit with a few exceptions (i.e., Atkins and Sharpe, 2003; Diskin and Hodgins, 2001; Zack and Poulos, 2004, 2007), demonstrated that the spatial attention of problem gamblers is biased towards gambling cues in both the initial orienting, namely the automatic stage of information processing (Brevers et al., 2011a, Ciccarelli et al., 2016a, 2016b), and in the maintenance of attention, namely the conscious and intentional stage of information processing (Brevers et al., 2011a; Diskin and Hodgins, 1999; Grant and Bowling, 2015; McGrath et al., 2018; Vizcaino et al., 2013; Wölfling et al., 2011).

Although research on attentional processes in gambling is relatively wide, it is not exhaustive (see Hønsi et al., 2013 for a review). Indeed, the role of attentional bias in adolescent gambling has been neglected to date. This is arguably surprising given how popular gambling is among youth (Molinaro et al., 2014). Broadly speaking, studies have consistently demonstrated that adolescents tend to gamble more than adults and have higher prevalence rates of problem gambling (Gupta and Derevensky 2000; Volberg et al., 2010). In Italy (where the present study was carried out), adolescents gamble less than adults but there is a higher prevalence of problem gambling (see Calado et al., 2017 for a review). Studies examining attentional biases in adolescents would be useful in as much as adolescents may show different pathways than adults, indicating when and how attentional biases occur in gambling. The main aim of the present study was – for the first time – to empirically investigate attentional processes for gambling and neutral stimuli among adolescent problem gamblers (compared to non-problem gambling peers). The second aim was to evaluate the relationship between attentional bias and craving in adolescent gambling. In the substance addiction literature, a meta-analytic review found a significant (albeit modest) association between attentional bias and craving (Field et al., 2009; see Field and Cox, 2008 for a review). In the gambling field, only a handful of studies have examined this relationship. Brevers et al. (2011a) and Wölfling et al. (2011) observed no relationship, and explained these findings by hypothesizing that the too high or too low levels of gamblers' craving could have eliminated any such relationship. Recent studies have found automatic facilitation bias to be correlated with craving, suggesting that the urge to gamble may facilitate the detection of gambling stimuli in the environment (Ciccarelli et al., 2016a, 2016b; see also Molde et al. 2010). As there is little clarity about the association between attentional bias and craving, and because no study to date has examined this relation in adolescent gambling, the present study aimed to fill these gaps.

A final point to note is the frequent co-occurrence of specific addictive behaviors (e.g., Gerstein et al., 1999; Welte et al., 2001). This co-occurrence has been explained by the 'cross-cue reactivity' hypothesis. Through the repeated use of two substances simultaneously (for instance tobacco and alcohol), stimuli initially related to one substance can become conditioned for the other (i.e., one comes to act as a conditioned stimulus for the other and elicits cravings for both behaviors) (e.g., Burton and Tiffany, 1997; Drobes, 2002; Traylor et al., 2011). Because adolescent gambling often co-occurs with alcohol consumption (Barnes et al., 2009; Hurt et al., 2008; Nigro and Cosenza, 2016; Tackett et al., 2017; see Rahman et al., 2014 and Rash et al., 2016 for reviews), alcohol consumption has been found to reduce attentional resources, which are primary allocated to the most salient events in a given situation (e.g., Mocaiber et al., 2011). Consequently, there could be an interaction effect between gambling and alcohol consumption that could lead to a faster or slower times in responding to gambling stimuli in easier or harder context (e.g. different stimulus presentation times).

In summary, the present study investigated the interplay between attentional biases, craving, and alcohol consumption among adolescents. Based on previous studies on adults and compared to non-problem adolescent gamblers, it was hypothesized that adolescent problem gamblers would report facilitated attention for gambling stimuli. Furthermore, attentional bias for gambling stimuli would be related to craving and to alcohol intake, especially in problem gamblers.

2. Methods

2.1. Participants

A sample of 92 Italian adolescents attending the second, third, fourth, and fifth year of a secondary school in the area of Caserta participated in the study. The South Oaks Gambling Screen Revised for Adolescents (SOGS-RA; Winters et al., 1993) was used to examine respondents' gambling behavior. The SOGS-RA scale identifies three types of gamblers: 'non-problem gamblers' (SOGS-RA score ≤ 1); 'at risk gamblers' (SOGS-RA = 2–3); and 'problem gamblers' (SOGS-RA score ≥ 4). To be defined as gamblers, respondents had to report having been involved in a gambling activity at least once in the previous year. According to this criterion, five participants were excluded from further analyses. Furthermore, since no significant differences were found in attentional biases, craving, and alcohol intake between 'gamblers at-risk' and 'problem gamblers', they were combined into a single group for the present study, in line with previous studies (e.g., Blinn-Pike et al., 2010; Ciccarelli et al., 2016a; Lee et al., 2011). The final sample comprised 87 gamblers (94.3% males) aged 16 to 20 years (M_{age} = 17.54 years; *SD* = 0.89), more specifically 54 'non-problem gamblers' (NPG) and 33 'problem gamblers' (PG).

2.2. Measures

South Oaks Gambling Screen Revised for Adolescents (SOGS-RA; Winters et al., 1993; Italian version by Chiesi et al., 2013). The SOGS-RA is a self-report instrument assessing adolescent gambling severity over the past 12 months. More specifically, the scale assesses the frequency of participation in different gambling activities, the loss of control on the game, chasing losses, the influence of gambling habits on school performance and relationships, and feelings of gambling-related guilt. Only 12 items (yes/no) are used to calculate the score. Individuals who score from 0-1 are classified as non-problem gamblers (Level 1), whereas those who score from 2-3 are classified as at-risk gamblers (Level 2), and those with a score of 4 or more are classified as problem gamblers (Level 3) (Winters et al., 1995). Level 0 is attributed to adolescents that report no past year gambling. The Italian version of the SOGS-RA (Colasante et al., 2014) has acceptable internal consistency (Cronbach's alpha = 0.78).

Modified version of Posner Task (PT; Posner, 1980): The modified PT is a computerized exogenous cueing task that detects attentional biases. Eighty color pictures (350 x 350 pixels), 40 'gambling' pictures and 40 'neutral' pictures, matched for color, shape, and perceptual features (e.g., brightness, complexity) were chosen among non-copyrighted images from the internet. The pictures, similar for arousal and pleasure, were previously (see Ciccarelli et al., 2016a) rated as very relevant (gambling pictures: mean gambling relevance = 7.26) or not relevant (neutral pictures: mean gambling relevance = 0.65). Gambling pictures included slot machines, chips, lottery tickets, and neutral pictures included petrol pumps, buttons, and watches.

The task comprised 160 trials and lasted approximately seven minutes. For each trial, a fixation cross ("+") (ITI; 1 cm in height) on a grey background between two rectangles was presented. After 1000ms, the fixation cross disappeared and was followed by a single image (cue), gambling-related or neutral, in the left or in the right side of the screen for a fixed period of 100ms or 500ms, in order to investigate biases in the initial orienting and in the maintenance of attention (Field and Cox, 2008; Field et al., 2009), respectively. The target (a blue dot) was presented immediately after cue offset for 1500ms, in the same (valid trial) or on the opposite side of the cue (invalid trial). An inter-trial interval of 1000ms was used, during which the fixation point remained at the centre of the grey screen, and after which the next trial appeared. The order of trial presentation (gambling vs. neutral) was randomized.

According to Posner (1980), 80% of the trials were valid (128 trials, 64 gambling and 64 neutral) and 20% were invalid (32 trials, 16 gambling and 16 neutral). The modified Posner Task was carried out using the experimental software

SuperLab 4.0 and the operating system Windows 8 on a personal computer with a 15.6” monitor. Participants were seated 60 cm from the monitor and were asked to press a button on a keyboard based on the location of the dot appearance (“a” for left and “ù” for right). Participants were required to respond to the dot as quickly and accurately as possible. Accuracy and response times (RTs) were recorded.

Gambling Craving Scale (GACS; Young and Wohl, 2009; translated into Italian for the present study). The GACS is a validated and reliable measure of gambling-related craving. The scale comprises nine items divided into three subscales, each of which assesses a different dimension of the craving construct: *desire* (e.g., “I have an urge to gamble”), *anticipation* (e.g., “Gambling would be fun right now”), and *relief* (e.g., “If I were gambling now, I could think more clearly”). Respondents are asked to indicate agreement on a 7-point Likert scale (from “strongly disagree” to “strongly agree”). High scores reflect strong feeling of craving. In the present study, because of the low number of items (N<10), we evaluated the mean inter-item correlation. As recommended by Briggs & Cheek (1986), optimal mean inter-item correlation values range from .2 to .4. Mean inter-item correlation for the total scale (r =.23) and for each subscale was optimal: desire (r=.41), anticipation (r=.31), and relief (r=.43).

Alcohol Use Disorders Identification Test (AUDIT; Saunders et al., 1993; translated into Italian for the present study). The AUDIT is one of the most used instruments to assess alcohol consumption. The test comprises 10 self-report items concerning the amount and frequency of drinking alcohol, alcohol dependence, and problems caused by drinking alcohol. Respondents have to indicate agreement on a 4-point Likert scale (from “never” to “almost daily”). A score of 8 or more indicates a strong likelihood of harmful alcohol consumption. In the present study, Cronbach’s alpha was adequate at .78.

3. Procedure

The research team’s university Psychology Department ethics committee approved the present study. Informed consent from the head of the school and from participants, or their parents if minors, was obtained prior to enrolment. Participants were informed that they would be participating in an anonymous and exploratory study on gambling behavior, from which they could withdraw at any time. Participation in the study was voluntary. Individually, each participant performed the Modified version of Posner Task and then completed the self-report scales in a quiet room of the school. Participants were allowed as much time as necessary to complete the scales. The experimenter assisted participants in reading and understanding the instructions but, once the experimental session began, the experimenter moved away until the participant had finished. After data collection, participants were debriefed, revealing the purpose of the research.

4. Data preparation

From the Posner task, trials with errors ($M = 2.01\%$) and outliers (RT < 150 and > 1000) were excluded from analyses (Koster et al., 2004). Facilitation biases (= Reaction Times [RTs] valid/neutral - RTs valid/gambling) and disengagement biases (=RTs invalid/gambling - RTs invalid/neutral) were computed from reaction times to correct responses, separately for 100ms and 500ms presentation times. Positive facilitation bias scores indicate that attention is oriented on gambling cues more than on neutral cues. Positive disengagement bias scores indicate a difficulty in disengage attention from gambling-related cues compared to neutral cues. Negative facilitation and disengagement bias scores indicate avoidance biases, namely a tendency to avoid gambling cues.

5. Statistical analyses

The IBM Statistical Package for the Social Sciences, version 20.0 was used to analyze the data. The alpha significance level was set at .05. A mixed analysis of variance 2 x 2 x 2 x 2 on RTs with Group (non-problem gamblers vs. problem gamblers) as between factor and Valence (gambling vs. neutral), Validity (valid vs. invalid), and cue presentation Time (100ms vs. 500ms) as within-factors was conducted. Two mixed ANCOVA 2 x 2 with one between-participant factor (Group: non-problem gamblers vs. problem gamblers), two within-participant factors (bias scores at 100ms and 500ms), and AUDIT scores as covariate was run on facilitation and on disengagement bias scores. To assess whether bias scores were significantly different from zero, a single-sample *t*-test was performed on facilitation and disengagement biases. In order to examine craving differences between groups, a mixed analysis of variance with Group (non-problem gamblers vs. problem gamblers) as the between-participants factor, and GACS subscales (Anticipation, Desire, and Relief) as within-participants factor was executed. A univariate analysis of variance on alcohol consumption total score (AUDIT) with the Group (non-problem gamblers vs. problem gamblers) as independent variable was run. Furthermore, in order to better understand the interplay in problem gamblers between attentional bias and alcohol consumption on one hand, and bias and craving on the other, correlation analyses.

6. Results

6.1. Modified Posner Task

A main effect was found for Validity ($F_{1,85} = 173.47$, $p < .001$, $\eta^2_p = .67$), and Time ($F_{1,85} = 65.63$, $p < .001$, $\eta^2_p = .44$), due to faster RTs on valid ($M = 401.46$ms) than on invalid trials ($M = 450.43$ms), and in the 500ms condition ($M = 411.21$ms) compared to the 100ms condition ($M = 440.68$ms). The significant main effect of Group indicated that problem gambling group showed longer RTs than non-problem gamblers ($F_{1,85} = 4.90$, $p = .03$, $\eta^2_p = .05$). Furthermore, the interaction between Valence and Group tended towards significance ($F_{1,85} = 3.07$, $p = .08$, $\eta^2_p = .03$), with problem gamblers showing longer RTs in gambling and neutral trials than non-problem gambling counterparts (see Table 1).

The effect of Valence ($F_{1,85}$ = 0.33, p = .57, η^2_p = .004), Validity x Group ($F_{1,85}$ = 0.01, p = .75, η^2_p = .001), Validity x Time ($F_{1,85}$ = 0.73, p = .40, η^2_p = .01), Time x Group ($F_{1,85}$ = 0.81, p = .37, η^2_p = .01), Valence x Validity ($F_{1,85}$ = 2.31, p = .13, η^2_p = .03), and Valence x Time ($F_{1,85}$ = 0.11, p = .74, η^2_p = .001) were not statistically significant.

INSERT TABLE 1 ABOUT HERE

The interactions Valence x Validity x Group ($F_{1,85}$ = 0.75, p = .39, η^2_p = .01), Valence x Time x Group ($F_{1,85}$ = 0.01, p = .90, η^2_p = .00), Validity x Time x Group ($F_{1,85}$ = 0.005, p = .94, η^2_p = .00), Valence x Validity x Time ($F_{1,85}$ = 0.02, p = .89, η^2_p = .00), and Valence x Validity x Time x Group ($F_{1,85}$ = 0.14, p = .71, η^2_p = .002) were not statistically significant.

From the ANCOVA executed on facilitation bias scores, a main effect of Group emerged ($F_{1,84}$ = 6.61, p = .01, η^2_p = .07), indicating that problem gamblers (M = 6.64, 95% confidence interval, or CI = [0.79, 12.48]) showed higher scores on facilitation bias than non-problem gamblers (M = -3.13, 95% CI = [-7.64, 1.39]). Both the effect of Time ($F_{1,84}$ = 2.47, p = .12, η^2_p = .03), and the interaction between Group and Time ($F_{1,84}$ = 0.65, p = .42, η^2_p = .01) were not statistically significant. The effect of AUDIT ($F_{1,84}$ = 0.02, p = .89, η^2_p = .00) was not significant, whereas the interaction between AUDIT and facilitation bias ($F_{1,84}$ = 3.41, p = .07, η^2_p = .04) demonstrated a tendency towards significance.

The ANCOVA on disengagement bias scores showed a tendentially significant effect of Time ($F_{1,84}$ = 3.22, p = .08, η^2_p = .04), whereas Group ($F_{1,84}$ = 0.15, p = .70, η^2_p = .002, PG: M = 2.61, 95% CI = [-7.78, 13.01]; NPG: M = 5.24, 95% confidence interval, or CI = [-2.79, 13.27]), and Group x Time ($F_{1,84}$ = 1.10, p = .30, η^2_p = .01) effects were not significant. Moreover, analysis revealed significant interaction effects between AUDIT and disengagement bias ($F_{1,84}$ = 5.81, p = .02, η^2_p = .06), with participants with more frequent alcohol intake score showing higher and positive disengagement scores at 100ms and negative disengagement scores at 500ms. The effect of AUDIT was not significant ($F_{1,84}$ = 0.06, p = .81, η^2_p = .001).

The single-sample *t*-test performed to assess whether bias scores differed significantly from zero revealed that non-problem gamblers showed either facilitation bias (100ms: t_{53} = -1.09, p = .28; 500ms: t_{53} = -0.62, p = .54) nor disengagement bias (100ms: t_{53} = 1.42, p = .16; 500ms: t_{53} = 0.53, p = .60). A facilitation bias tending towards significance at 100ms (t_{32} = 1.84, p = .07), and a facilitation bias at 500ms (t_{32} = 2.10, p = .04) emerged in the problem gambling group, whereas no disengagement bias (100ms: t_{32} = 0.30, p = .76; 500ms: t_{32} = 0.39, p = .70) was observed (Figure 1).

INSERT FIGURE 1 ABOUT HERE

6.2. Group characteristics

The ANOVA executed on the GACS subscales yielded a main effect of Group ($F_{1,84}$ = 23.96, p < .001, η^2_p = .22) and a significant interaction between Group and craving ($F_{2,83}$ = 8.34, p < .001, η^2_p = .17). Problem gamblers scored higher on Anticipation (p < .001) and tended to score higher on Relief subscale (p = .06), than non-problem gamblers (Table 2).

The AUDIT score differed between groups, with problem gamblers reporting significantly higher alcohol consumption than non-problem gamblers ($F_{1,85} = 8.91$, $p < .01$, $\eta^2_p = .09$).

INSERT TABLE 2 ABOUT HERE

6.3. Correlations

In non-problem gambling group, disengagement bias at 500ms was negatively related to GACS Desire (r = -.46; p = .0004). In problem gambling group, facilitation bias at 100ms was positively associated with AUDIT total score (r = .41; p = .019). Correlations between facilitation bias and GACS scores (r < .18; p >.08) and between biases and SOGS-RA (r < .12; p >.20) were not statistically significant.

7. Discussion

The present study is the first to investigate the attentional pattern for gambling cues in two groups of adolescent gamblers (problem and non-problem) using a modified version of the Posner Task with exposure times assessing early processing and maintenance of attention. The study also assessed the interplay among attentional biases, craving, and alcohol use. Results revealed that adolescent problem gamblers have a facilitation bias for gambling stimuli in the maintenance of attention (i.e., at 500ms). This finding is in line with previous studies that (using eye-gaze monitoring) reported more gaze fixations and time spent looking at gambling-related stimuli in adult problem and pathological gamblers, as compared to healthy controls (Brevers et al., 2011a; Grant and Bowling, 2015; Vizcaino et al., 2013). However, Ciccarelli et al. (2016a, 2016b), adopting the same tool (i.e., Posner Task), found facilitation biases in the initial orienting of attention (i.e., at 100ms) in adult gamblers. To shed light on these contrasting results, it is helpful to consider that the samples differed in age and, consequently, are likely to have differed in both gambling history and involvement. In the gambling studies literature, the severity of adolescent gambling is often indicated as precursor to adult problem gambling (Carbonneau et al., 2015; Slutske et al., 2003; Welte et al., 2008; Winters et al., 2005), so, even if the age of gambling onset was not assessed in the present study, it is conceivable that adolescent problem gamblers have a shorter gambling history than adults. In the light of the above, it is reasonable to assume that with the repeated exposure to gambling experience, the strategic bias found among adolescents (i.e., in the maintenance stage of attention, at 500ms) becomes automatic among adults (i.e., in the early engagement of attention, at 100ms). In other words, in the initial stage of the disorder, gamblers (that is, individuals that are frequently exposed to gambling stimuli) direct attention towards gambling stimuli because of the pleasure (or its expectation) and the relief from negative emotional states resulting from gambling (e.g., Ciccarelli et al., 2017; Cosenza et al., 2018; Nigro et al., 2017; Dickerson et al., 1996; Wood and Griffiths, 2007) that make betting stimuli attractive *per sè*. Over time, with the greater acquired familiarity with gambling stimuli, attentional biases become increasingly automated, and no longer liable to conscious control (e.g., Cox and Klinger, 1988, 1990, 2004; Cox, Klinger, and Fadardi, 2006). In line with this hypothesis, a recent study observed temporal fluctuations in anxiety-related attentional bias as a function of contextual variables (Cox et al., 2017; see also Kruijt et al., 2016), suggesting the dynamic and variable nature of attentional bias. In the present authors' view, these findings support the presence of a variability in attentional bias that could be related to gambling involvement duration. In future research, the precise nature of the relationship between strategic and automatic biases should be clarified, specifically trying to identify the factors that lead to automaticity in attentional processes (for instance, evaluating attentional pattern in both adult and adolescent gamblers controlling for age of gambling onset). It is also conceivable that adolescent gamblers were not familiar with the adopted stimuli such to easily detect and discriminate gambling cues from neutral ones at a very low presentation time (i.e., 100ms). This would explain why the facilitation bias in the initial orienting of attention found among youth problem gamblers did not quite reach statistical significance. Alternatively, the selected pictures may not have been so relevant for adolescents. For instance, their favorite game may have been underrepresented in the Posner Task. Consequently, in future research it may be useful matching gambling stimuli with gambling preference, in line with McGrath et al. (2018).

The present findings highlight the importance of strategic facilitation biases in adolescent problem gambling and are in line with the incentive-sensitization theory of addiction (Robinson and Berridge, 1993, 2008). According to this theory, the observed attractiveness of gambling-related cues is due to the dopamine system that, after repeated exposure, attributes 'incentive salience' to them, transforming "ordinary 'wanting' into excessive drug craving" (Robinson and Berridge, 1993, p. 247). This sensitization makes gambling stimuli easier to detect and, at the same time, difficult to draw attention away from, contributing to the maintenance of addiction-related seeking behavior (Franken, 2003).

Differently from what was expected (Ciccarelli et al., 2016a, 2016b; Molde et al., 2010), there was no association between facilitation bias and craving. This was probably due to the small variation of Gambling Craving Scale scores among participants. Indeed, adolescent problem gamblers, compared to adult problem gamblers (Ciccarelli et al., 2016a, 2016b), scored lower on the GACS, revealing lower levels of craving, at least at the time of data collection. More specifically, adolescent problem gamblers' craving did not concern the expectation of relief from negative affect derived from engaging in gamble (the Relief scale) or the immediate desire to gamble (the Desire scale), but the expectation that gambling would be fun (the Anticipation scale; for similar results, see Brevers et al., 2011a). Therefore, their levels of craving appear to be tied to the more strictly playful aspects of gambling. Furthermore, since the GACS scale discriminates different levels of gambling severity, with higher craving scores indicating a more severe gambling involvement (Young and Wohl, 2009), these results appear to indicate a lower severity of gambling involvement in adolescents as compared to adult samples in literature. In fact, problem gamblers represented a small percentage of the present sample (15%). A systematic investigation of the relationship between craving and attentional processes is an important target for future research that should include a broader range of adolescent gambling severity in order to make clearer predictions about the nature and directionality of the relationship between the two processes.

The observed association between alcohol use and gambling severity confirms the reciprocal influence between these two addictions (e.g., Barnes et al., 2002; Desai et al., 2005; Duhig et al., 2007; Liu et al., 2009; Rahman et al., 2014). Individuals who gamble are more likely to drink alcohol (Griffiths et al., 2010; Tobias-Webb et al., 2018), and individuals who drink alcohol are more likely to gamble (French et al., 2008). In addition, some studies have underlined the addictive effect of substance abuse on gambling severity. For instance, as compared to non-substance abusing gamblers, substance-abusing gamblers scored lower on both impulse control and future time orientation (Petry, 2001), reported greater gambling severity and gambling at earlier ages, and had different gambling motivations (Liu et al., 2009). Likewise, results of the present study outline that alcohol use affected the attentional polarization towards gambling stimuli in problem gamblers, enhancing the easy detection of and a difficulty in disengagement from gambling cues, which in turn fosters gambling behavior. In line with the hypotheses, the present findings could be interpreted in the light of the 'cross-cue reactivity' (Zacny, 1990), according to which, when a substance and a behavioral addiction co-occur, "one substance comes to act as a conditioned stimulus for the other substance" (Wulfert et al., 2016, p. 30). Therefore, it is possible that alcohol cues have become conditioned stimuli for gambling cues. Future studies are needed to both establish the reliability of the association between attentional bias for gambling and alcohol use and to further test the hypothesis relating to cross-cue reactivity.

The present results could have important clinical implications. Facilitated attention for gambling cues found among adolescent problem gamblers implies a great likelihood of identifying gambling stimuli in the environment and a consequent difficulty in focusing attentional resources elsewhere. This confirms the importance of attentional bias in the maintenance of gambling disorder and suggests the opportunity to implement attentional bias modification programs to prevent more severe gambling involvement among youth. In fact, for the treatment of disordered gambling among adult samples, great attention has recently been paid in testing the effectiveness of training programs that modify the attentional deployment of individuals with a bias towards gambling-related stimuli (Boffo et al., 2017; Wittekind et al., 2019). Clinical interventions concerning attentional bias could be useful especially in light of the type of bias found in adolescent gamblers, namely a strategic facilitation in the later stages of attentional processing. In line with research on alcohol abusers in treatment (Noel et al., 2006; Stormark et al., 1997), "automatic components of attentional bias that may be difficult to consciously control", whereas "slower components…might be modified by effortful cognitive processes" (Field and Cox, 2008, p. 16).

8. Limitations

Several limitations should be noted when interpreting the findings of the present study. First, the recruitment of a predominantly male sample, along with the absence of non-gambler group, limits the conclusions that can be drawn. Replicating the research with more female gamblers may be useful in expanding the knowledge base concerning attentional bias in adolescent gambling and enhance the present findings. However, the literature concerning problem gambling clearly shows that males are significantly more likely to be problem gamblers compared to females (see Calado and Griffiths [2016] for a comprehensive review on problem gambling prevalence worldwide). A further limitation of the present study concerns the lack of a priori power analysis to determine an adequate sample size. Although previous studies have used smaller samples, it cannot be ruled out that the absence of significant effects might be due to inadequate sample size. Further studies with more participants for each group are needed, after calculating an *a priori* power analysis. In order to demonstrate the existence of attentional bias for gambling-related stimuli, the inclusion of an appropriate control group of non-gamblers is also recommended (Field and Cox, 2008). Furthermore, all the participants in the present study were Italian from one locality. Future studies should therefore be carried out in other countries to rule out any cultural biases. Furthermore, the use of direct measures (e.g., eye tracking) and indirect measures (such as the Posner Task) simultaneously are likely to provide a more complex and detailed measure of attention. Finally, in the light of the 'cross-cue reactivity', future studies should be conducted controlling for alcohol and other potential substance addictions.

9. Conclusions

The present study is the first to investigate attentional patterns for gambling and neutral cues in adolescent problem and non-problem gamblers and to assess the relationships between attentional biases, craving, and alcohol misuse. Adolescent problem gamblers showed a facilitation bias for gambling stimuli, reported higher craving, and a more problematic alcohol consumption when compared with non-problem gamblers. More specifically, adolescent problem gamblers' attention was facilitated for gambling cues only in the maintenance of attention, thus denoting a strategic and intentional bias, differently from adult gamblers that have been found to process gambling stimuli automatically, without control or awareness (Ciccarelli et al., 2016a, 2016b). Although it needs further research to be confirmed, the present findings, compared with the literature on adults, appears to suggest that in the initial stage of gambling disorder, the attentional orientation towards gambling stimuli is conscious and intentional, driven by motivational aspects such as craving and anticipation of pleasure, but, with the increased familiarity with gambling, it becomes automatic. Moreover, the results shed light on the possible addictive effect of alcohol consumption on attentional bias for gambling cues.

These findings have two implications. Firstly, attentional patterns may reflect the severity of gambling involvement, or, at least, the duration of gambling involvement. Secondly, the findings suggest the need for clinical interventions to desensitize gamblers to the easy detection of gambling stimuli, given the widely documented difficulty in reversing or eliminating the automatic aspects of attentional bias (e.g., Cox, Fadardi, and Pothos, 2006; Noel et al., 2006; Stormark et al., 1997).

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