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Cognitive distortions and ADHD in pathological gambling: A national longitudinal case-control cohort study

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Introduction: The primary outcome of our study was to assess the links between the level of cognitive distortions and the severity of gambling disorder. We also aimed at assessing the links between patient gambling trajectories and attention deficit and hyperactivity disorder (ADHD). *Materials and methods:* The study population ($n = 628$) was comprised of problem and non-problem gamblers of both sexes between 18 and 65 years of age, who reported gambling on at least one occasion during the previous year. Data encompassed socio-demographic characteristics, gambling habits, the South Oaks Gambling Screen, the Gambling Attitudes and Beliefs Survey – 23, the Wender Utah Rating Scale – Child, and the Adult ADHD Self-report Scale. *Results:* The cognitive distortions with the greatest correlation to the severity of gambling disorder were the "Chasing" and "Emotions." These two dimensions were able to distinguish between problem gamblers seeking treatment or not. While age of onset of gambling and length of gambling practice were not associated with the level of distorted cognitions, a period of abstinence of at least 1 month was associated with a lower level of distorted cognitions. The presence of ADHD resulted in a higher level of distorted cognitions. *Conclusion:* Cognitive work is essential to the prevention, and the treatment, of pathological gambling, especially with respect to emotional biases and chasing behavior. The instauration of an abstinence period of at least 1 month under medical supervision could be a promising therapeutic lead for reducing gambling-related erroneous thoughts and for improving care strategies of pathological gamblers.

Keywords: cognitive distortions, gambling, ADHD, chasing, emotions, adults

INTRODUCTION

Previously known as "pathological gambling" (PG), gambling disorder is a clinical entity within the addiction spectrum since DSM-5 (American Psychiatric Association, 2013). The empirical evidence of this connection to addictive disorders was partly based on the results of the fMRI studies as well as the links with cognitive distortions and deficit in decision-making (Clark et al., 2012; Potenza et al., 2003). PG is thought to arise through a combination of biological, social, and psychological risk factors (Blaszczynski & Nower, 2002).

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Past research into the judgment and decision-making of pathological gamblers has shown the importance of cognitive distortions. A study by Henslin (1967) helped highlight the concepts of illusion of control and magical thinking. Indeed, by observing a population of taxi drivers playing craps (a dice game), he found that these players thought that they could control the outcome of the game by varying the strength of the dice roll (a weak roll would yield a small number, in contrast to a strong roll). Another example in which players think that they can control the outcome is gambler's fallacy – after observing a streak of black five times at the roulette table, it can be hard for gamblers to avoid a feeling that "it is time for red now," which may be sufficient motivation to place a bet on red (Croson & Sundali, 2005; Gaissmaier, Wilke, Scheibehenne, McCanney, & Barrett, 2016).

All gamblers, including non-pathological gamblers, are susceptible to develop cognitive distortions. One of the defining features of gamblers' cognitions is the tendency to overestimate the likelihood of winning due to a variety of cognitive distortions in the processing of chance, skill, and probability (Clark, 2014; Ladouceur & Walker, 1996).

Many distortions are in fact specific cases of a more general misconception of randomness, and of an illusory perception of patterns in random sequences (Gaissmaier et al., 2016). The presence of such cognitive distortions among gamblers is widely documented (Clark, 2014).

A recent meta-analysis has shown that pathological gamblers are particularly prone to gambler's fallacy and thus believe that they are actually more likely to win in the future if they have just lost (Goodie & Fortune, 2013). Illusory beliefs in sequential dependencies in random sequences support the illusion of control in gamblers.

Furthermore, for Gaissmaier et al. (2016), a gamblers' willingness to readily accept illusory patterns in a random game could be a default state, with regard to betting, that needs to be overridden or at least combatted, which habitual gamblers fail to do.

According to Boutin (2010), in a gambling situation, players make decisions based on thoughts related to their emotions. Cognitive distortions would then be similar to illusions. Several studies have attempted to classify cognitive distortions, in particular Toneatto (2002). Although cognitive distortions are not a diagnostic criterion for gambling disorder, they play a key role in the development and maintenance of this disorder. Indeed, they modulate the relationships between gambling-related risks and the intensity of gambling behavior. A series of small wins can prompt illusions of control over random outcomes. Among non-problem gamblers (NPG), there is a relationship between irrationality and increasing the size of bets (Delfabbro & Winefield, 2000). This link between irrationality and increasing the size of bets has also been observed among both pathological and non-pathological gamblers (Rickwood, Blaszczynski, Delfabbro, Dowling, & Heading, 2010).

The concept of control is an important element in cognitive distortions. For this reason, illusion of control is the most widely studied cognitive distortion in the literature (Lambos & Delfabbro, 2007; Toneatto, Blitz-Miller, Calderwood, Dragonetti, & Tsanos, 1997). The illusion of control can be defined as the conviction that luck is a personal and stable characteristic that can be used and developed to maximize gains. Boutin (2010) stated that there are two types of illusion of control: one related to the game and the other to the gains. Although the degree of illusion of control is influenced by the characteristics of a game for all gamblers, this illusion is particularly strong among pathological gamblers. A study by Wohl and Enzle (2002) showed that in a game in which the results are based on pure chance (e.g., a lottery), individuals who were free to choose their ticket perceived themselves to be lucky, and thought that they had a greater chance of winning than individuals who were dealt with a random ticket. Similarly, a study by Griffiths (1994) supports the idea that the triggering of rolls by slot machine gamblers results in deluding themselves about their active participation in the game.

Pathological gamblers exhibit more cognitive distortions than recreational gamblers (Michalczuk, Bowden-Jones, Verdejo-Garcia, & Clark, 2011; Miller & Currie, 2008). These cognitions can be attenuated with treatment (Breen & Zuckerman, 1999), although higher baseline scores were a predictive factor of a poorer outcome in a Gamblers Anonymous program (Oei & Gordon, 2008). Three outcome variables were strongly related with gambling recovery: negative affectivity, cognitive distortions, and decision-making. Logistic regression identified the reduction of gambling cognitive distortions and better decision-making performance as the best predictors of gambling recovery, regardless of the type of treatment received. Beyond the standard outcome measures for gambling treatment, increased sensitivity to loss and decreased positive expectancies toward gambling are both key targets, that influence recovery, in gambling treatment (Rossini-Dib, Fuentes & Tavares, 2015). Gamblers, and especially pathological gamblers, are particularly prone to perceiving illusory patterns (Gaissmaier et al., 2016).

As noted by Michalczuk et al. (2011), the links between impulsivity, immediate reward, and the level of cognitive distortions could largely explain the severity of a gambling disorder. An impulsive nature could lead to an unquestioned acceptance of cognitive distortions during gambling. Positive urgency (the tendency to act recklessly after experiencing positive affects) is a predictor of increased gambling behavior (Cyders & Smith, 2008). The presence of attention deficit and hyperactivity disorder (ADHD) symptoms was positively correlated to scores on the obsessive–compulsive scale as well as the global severity index. Gambling behavior could thus be a maladaptive mechanism of regulating negative emotional states and stress (Aymamí et al., 2015). Moreover, probable existing ADHD symptoms were identified in 21.4% of gamblers. ADHD symptoms were associated with an earlier age of onset of gambling behavior, higher Barratt impulsivity scores (all three subscales), greater caffeine intake, poorer response inhibition (Stop-Signal test), and impaired decision-making [greater proportion of points gambled, Cambridge Gamble test (Chamberlain, Derbyshire, Leppink, & Grant, 2015)].

The primary outcome of our study was to assess the links, and quantify the predictive value, between the level of cognitive distortions and the severity of gambling disorder. We also aimed at assessing the links between cognitive distortions and gambling trajectory (especially age of onset, length of practice, and ability to stop gambling for at least

1 month), and between cognitive distortions and ADHD, we hypothesized that gamblers with ADHD were more likely to have higher levels of distorted cognitions.

The aim of our study was thus to investigate the relationship between cognitive distortions, gambling trajectory (especially length of gambling), ADHD, and a period of abstinence from gambling.

METHODS

Data collection

The present analysis was performed using baseline data, collected between 2009 and 2011, for the *JEU* cohort study. The *JEU* study involved a 5-year, longitudinal case-control cohort implemented at a national level. The *JEU* cohort consisted of 628 gamblers, divided into three groups, depending on whether they were non-problem or problem gamblers and on whether or not the latter had sought treatment: 256 NPG, 169 problem gamblers without treatment (PGWT), and 203 problem gamblers seeking treatment (PGST). NPG and PGWT were recruited in various gambling institutions and via the press in order to cover the broadest possible range of gambling activities. PGST were recruited in seven care centers among patients who had started treatment less than 6 months previously. Only participants who reported gambling on at least one occasion during the previous year and who were between 18 and 65 years of age were included in the study. [For more information about the *JEU* cohort study, please refer to the study protocol (Challet-Bouju et al., 2014).]

Measures

Gambling-related characteristics. Participants were questioned on their participation in various forms of gambling activities over the past year as well as their frequency of gambling, monthly gambling expenditure, age of onset of gambling, family history of problem gambling, and participants' ability to sustain a period of gambling abstinence of at least 1 month.

Participants were also interviewed and assessed based on the DSM-IV-TR (American Psychiatric Association, 2000) diagnostic criteria for PG. Gamblers who met at least three criteria were classified as problem gamblers, and all the other participants were classified as NPG. We used a non-standard threshold of three diagnostic criteria, instead of five, in order to also include subclinical forms of PG. The number of positive DSM-IV criteria for PG was also used as a dimensional score of gambling disorder severity.

Participants also completed two self-report questionnaires related to gambling. The South Oaks Gambling Screen (SOGS) by Lesieur and Blume (1987) was used to assess the self-reported severity of gambling disorder. The Gambling Attitudes and Beliefs Survey (GABS) was used to assess the irrational attitudes and beliefs about gambling (Breen & Zuckerman, 1999). The GABS-23 (Bouju et al., 2014) is a revised version of the original GABS. It consists of 23 items divided into five dimensions: Strategies, Chasing, Attitudes, Luck, and Emotions.

History of ADHD. In our study, we used two self-report questionnaires to screen for ADHD. The Wender Utah Rating Scale-Child (WURS-C) (Caci, Bouchez, & Baylé, 2010; Ward, Wender, & Reimherr, 1993) was used to conduct retrospective screening for ADHD during a participants' childhood, and was supplemented by the Adult ADHD Self-Report Scale (ASRS-v1.1) which screens for ADHD in adulthood (Kessler et al., 2005).

Statistical analysis

The primary objective was to examine the links between the level of cognitive distortions and the severity of gambling disorder. We performed analysis of variance (ANOVA) to verify the GABS-23 scores for each of the three groups of gamblers (NPG, PGWT, and PGST). Post-hoc Bonferroni tests were used to compare one group with another (in particular, NPG vs. PGWT and PGWT vs. PGST).

Second, we determined a threshold for the overall GABS-23 score, used to indicate a high level of cognitive distortions. The threshold was set at 37/100 based on a receiver operating characteristic (ROC) curve computed, to distinguish between problem and non-problem gamblers, from different GABS scores.

Third, in order to explore the links between gambling trajectory and gambling-related cognitions, we calculated Spearman's correlation coefficients between GABS-23 scores and the age of onset of gambling and the length of practice (interval between the age of onset and the current age of the participant). We also compared GABS-23 scores between participants with a late and an early onset of gambling (defined by an onset of gambling under 18 years, the legal age of gambling in France), and between gamblers who had sustained at least 1 month of abstinence since gambling onset and those that had not.

Finally, we examined the links between ADHD and gambling-related cognitions by comparing GABS-23 scores between ADHD and non-ADHD gamblers (AHDH gamblers were defined as having a WURS-C score above 46/100). We then calculated Spearman's correlation coefficients between GABS-23 scores and ADHD scores (WURS-C total score as well as inattention and hyperactivity scores from the ASRS).

The statistical analyses were carried out using SAS 9.3 software (SAS Institute, Inc., Vincennes, France).

Ethics

Participants were informed about the research and gave their written informed consent prior to their inclusion in the study. This study was approved by the French Research Ethics Committee (CPP) on January 8, 2009. All authors of this paper state that they complied with the Ethics standards of the Declaration of Helsinki.

RESULTS

Of the 628 gamblers forming the JEU cohort, 600 completed the GABS questionnaire (of which 251 were NPG, 165 were

PGWT, and 184 were PGST). As this questionnaire was fundamental to the present analysis, the 28 gamblers with missing data for the GABS were not included in the subsequent analyses.

Description of the sample

Table 1 presents the socio-demographic characteristics and the gambling trajectory and habits of the analyzed sample ($n = 600$). The sample was made up of a majority of males (66.3%). The overall level of integration was satisfactory, 63% of the sample were employed and the mean monthly income was almost €1,750 (which is much higher than the French minimum wage of approximately €1,100).

The onset of gambling was at approximately 20 years of age with a length of practice of about 23 years at the time of recruitment. The mean monthly expenditure on gambling (approximately €600) represented about one-third of the participants' monthly income, but this ratio displayed considerable variability due to the composition of the sample (about 58% were defined as problem gamblers). Despite the high proportion of NPG in the sample (42%), one-quarter of the sample gambled at least once a week. Almost two-thirds of the sample had sustained a period of abstinence of at least 1 month. One-quarter reported a family history of problem gambling.

The level of distorted cognitions was considered high in 65% of cases, of which 40% were PGST, 33% were PGWT, and 27% were NPG. This leads us to believe that distorted cognitions are a part of gambling practice even at a non-clinical stage.

Table 1. Description of the entire sample in terms of socio-demographics and gambling trajectory and habits ($n = 600$)

Socio-demographics	
Age	43.5 (12.9)
Gender (male)	66.3%
Monthly income (€)	€1,741 (€1,991)
Living alone	49.5%
Employed	63.3%
Education (≥high school graduate)	51.0%
Gambling trajectory and habits	
Age of onset of gambling	20.4 (9.2)
Length of gambling practice	23.1 (11.7)
Monthly expenditure in gambling	€601 (€1,525)
Frequency of gambling (≥1/week)	75.2%
Abstinence of at least 1 month	62.0%
Family history of gambling disorder	25.5%
High level of distorted cognitions (GABS ≥ 37)	64.8%

Note. For continuous variables, means are indicated with the standard deviation in parentheses.

Links between gambling-related cognition level and the severity of PG

Table 2 shows the comparison of GABS scores between the three groups of gamblers with a focus on the relationship between NPG and PGWT and between PGWT and PGST. Overall scores and dimensional scores from the GABS were found to differ significantly between the three groups of gamblers (NPG, PGWT, and PGST). Although only the Chasing and the Emotions dimensions were able to distinguish between problem gamblers seeking treatment or not. This statement is reinforced by the correlation between GABS scores and the number of positive DSM-IV criteria: Attitudes ($r = 0.33$, $p < .0001$), Emotions ($r = 0.62$, $p < .0001$), Strategies ($r = 0.33$, $p < .0001$), Luck ($r = 0.22$, $p < .0001$), Chasing ($r = 0.64$, $p < .0001$), and overall score ($r = 0.57$, $p < .0001$). Furthermore, the Chasing and Emotions dimensions were found to have the strongest correlation with PG severity (assessed by the number of positive DSM-IV criteria). The same pattern of results was observed with the SOGS scores.

Links between gambling trajectory and gambling-related cognitions

Contrary to expectations, the age of onset of gambling and the length of practice were not correlated with GABS scores (correlation coefficient lower than 0.3 and/or p-value over .05). Similarly, GABS scores were not significantly different between participants with a late or an early onset of gambling.

On the contrary, statistical differences in GABS scores [Strategies ($F = 4.61$, $p = .032$), Chasing ($F = 6.43$, $p = .012$), Emotions ($F = 4.70$, $p = .031$), and overall score

Table 2. Comparison of GABS scores between non-problem gamblers, problem gamblers without treatment, and problem gamblers seeking treatment ($n = 600$)

	Strategies GABS-S (score 0–100)	Luck GABS-L (score 0–100)	Attitudes GABS-A (score 0–100)	Chasing GABS-C (score 0–100)	Emotions GABS-E (score 0–100)	GABS-23 overall score (score 0–100)
NPG ($n = 251$)	34.60 (25.77)	34.40 (23.53)	49.16 (25.42)	24.73 (21.18)	23.96 (21.14)	33.37 (17.77)
PGWT ($n = 165$)	45.91 (26.06)	43.84 (24.45)	62.91 (21.74)	48.40 (24.35)	47.19 (22.76)	49.65 (16.78)
PGST ($n = 184$)	47.01 (22.59)	39.81 (25.58)	60.51 (18.39)	55.04 (20.76)	52.90 (21.08)	51.05 (15.42)
ANOVA between the three groups	$F = 16.73$ **$p < .0001$**	$F = 7.74$ **$p = .0005$**	$F = 23.05$ **$p < .0001$**	$F = 115.58$ **$p < .0001$**	$F = 110.99$ **$p < .0001$**	$F = 75.18$ **$p < .0001$**
Post-hoc Bonferroni tests						
Between NPG and PGWT	**$p < .0001$**	**$p = .0004$**	**$p < .0001$**	**$p < .0001$**	**$p < .0001$**	**$p < .0001$**
Between PGWT and PGST	$p = 1.0000$	$p = .3735$	$p = .9564$	**$p = .0151$**	**$p = .0418$**	$p = 1.0000$

Note. NPG: non-problem gamblers; PGWT: problem gamblers without treatment; PGST: problem gamblers seeking treatment. The values set in bold are statistically significant.

($F = 5.81$, $p = .016$)] were observed between gamblers who had sustained a period of abstinence of at least 1 month since gambling onset and those who had not. Participants who had sustained a period of abstinence scored lower on the GABS.

Links between ADHD and gambling-related cognitions

We hypothesized that gamblers with ADHD were prone to higher levels of distorted cognitions. Our hypothesis was confirmed as ADHD gamblers scored higher on every dimension (at least $p < .01$ for each dimension) of the GABS as well as on the overall score. Overall on the GABS score, ADHD gamblers had 10 more points than non-ADHD gamblers [mean GABS overall score for ADHD gamblers: 51.49 ($SD = 17.71$) and for non-ADHD gamblers: 41.06 ($SD = 18.41$); $F = 32.03$, $p < .0001$].

In order to investigate the relationship between distorted cognitions and ADHD in greater depth, we computed the scores of ADHD during childhood (WURS-C score) and of ADHD in adulthood (ASRS scores) and studied their correlation to GABS scores. The results are shown in Table 3. The relationship between ADHD and cognitive distortions seems to be mainly due to the Chasing and Emotions dimensions of the GABS score. The other dimensions do not display any significant correlation to the ADHD scores.

DISCUSSION

Cognitive distortions, mediated by an individual's way of thinking, represent a fundamental component in the onset and persistence of PG. In particular, two cognitive distortions, the illusion of control and gamblers' fallacy, are the focus of robust empirical support that transcends several methodologies and theoretical perspectives, and may fairly be considered to have positions of pre-eminence in the literature on cognitive distortions (Fortune & Goodie, 2012).

The links between cognitive distortions and the severity of gambling disorder have already been studied extensively in the literature (Cunningham, Hodgins, & Toneatto, 2014; Xian et al., 2008). Our results confirm this link and show that the level of cognitive distortion is correlated to the degree of severity of the disorder. Furthermore, the differences between the three groups of gamblers (non-problem, problem without treatment, and problem seeking treatment) were statistically significant for all dimensions of the GABS scale. This confirms that the level of cognitive distortions is a good discriminating factor of problem gambling behavior, which could enable us to identify the most at-risk gamblers at an early stage, and to target the type of intervention required (Mitrovic & Brown, 2009). In a study by Barrault and Varescon (2013), cognitive distortions were correlated to the severity of gambling disorder, particularly the inability to cease gambling behavior. Fortune and Goodie (2012) describe common heuristic techniques and associated cognitive distortions. They also develop treatment guidelines with cognitive intervention, math-based interventions, problem solving training, and relapse prevention. Their treatment guidelines insist on the importance of gambler's fallacy, the illusion of control, and the need to include delay discount and near-miss phenomenon's in the cognitive therapy.

Moreover, while all dimensions of the GABS scale differ between non-problem gamblers and problem gamblers, it is interesting to note that only the Chasing and Emotions dimensions of the GABS make it possible to distinguish between problem gamblers seeking treatment or not. The significant correlation with chasing is similar to the results found by Emond and Marmurek (2010), who reported that cognitive distortions were correlated with the "experientiality" of gamblers (as opposed to rational thought) and would be resistant to information on knowledge of probabilities. As suggested in a previous study on the subject (Bouju et al., 2014), this result could be explained by two phenomena. The first would be that the Chasing and Emotions dimensions bear a strong resemblance to some of the DSM diagnostic criteria (criterion 5: escape and criterion 6: chasing). It is reasonable to assume that problem gamblers

Table 3. Correlations between the level of distorted cognitions and ADHD scores in childhood and adulthood ($n = 599$)

		ADHD in childhood	ADHD in adulthood	
		WURS-C ($n = 599$)	ASRS inattention ($n = 598$)	ASRS hyperactivity ($n = 598$)
GABS Attitudes	r_s	0.25	0.20	0.17
	p-Value	<.0001	<.0001	<.0001
GABS Emotions	r_s	**0.33**	**0.34**	**0.32**
	p-Value	**<.0001**	**<.0001**	**<.0001**
GABS Strategies	r_s	0.23	0.22	0.22
	p-Value	<.0001	<.0001	<.0001
GABS Luck	r_s	0.19	0.15	0.21
	p-Value	<.0001	.0002	<.0001
GABS Chasing	r_s	**0.33**	**0.32**	**0.32**
	p-Value	**<.0001**	**<.0001**	**<.0001**
GABS-23 overall score	r_s	**0.36**	**0.34**	**0.34**
	p-Value	**<.0001**	**<.0001**	**<.0001**

Note. ADHD: attention deficit and hyperactivity disorder; r_s: Spearman's correlation coefficient. Correlations indicated in bold are those considered significant, that is, where $r_s \geq 0.3$ (at least moderate correlation) and the p-value <0.05.

seeking treatment are those with a higher level of disorder severity, which could also explain the similarity with these two dimensions. Another hypothesis is that, according to the positive and negative reinforcement model in PG (Abrams & Kushner, 2004), when gambling problems appear, positive reinforcements (wins, excitement from gambling) disappear and gradually make way for negative reinforcements (chasing and escape). For this reason, research on cognitive distortions and on negative affectivity is required to reduce problem gambling (Rossini-Dib et al., 2015).

Grant and Bowling (2015) found that the GABS predicted an attention bias in gambling cues, such as an index of brain sensitization, in regular gamblers, who may have developed a degree of brain sensitization toward gambling stimuli. They are therefore at greater risk of on-going influence by the motivational effects of environmental cues (prediction by incentive-sensitization theory).

We also found a correlation between the level of cognitive distortions and the maintenance of a period of abstinence of at least 1 month. Gamblers who had sustained a period of abstinence of at least 1 month displayed lower scores on all the dimensions of the GABS scale, compared to gamblers who had not conducted such an abstinence period (due to the lack of motivation or because they were unable to do so). Thus, a decrease in cognitive distortions (particularly chasing and emotions) could be observed with a decrease in gambling behavior. In therapeutic terms, the benefits of reducing gambling practice (number of days of gambling during the week) would also include the reduction in erroneous beliefs, thus indirectly helping to solve the gambling problem. It is important to note that these breaks in gambling practice must be sufficiently long in order to have an the level of cognitive distortions. Indeed, Blaszczynski, Cowley, Anthony, and Hinsley (2015) have previously demonstrated that short breaks, of a few minutes, during gambling activities could have a counterproductive effect by increasing craving. The ability to implement a gambling-free period of at least a month could encourage gamblers to put things into perspective and to exit the vicious circle of cognitive distortions, especially by getting out of a loss cycle (which one could correlate to the chasing item). However, it can be conversely assumed that gamblers with a lower level of cognitive distortions are also those most likely to be able to stop gambling for at least 1 month. Moreover, the role of self-efficacy is important: the fact that abstinence is correlated with the "Emotions" dimension implies that gambling has a significant emotional component for the gambler. A problem gambler could therefore experience great difficulty in giving up gambling activities, with possibly an impression of being incapable of giving up gambling due to an emotional void, perceived to be too great, caused by an abstinence from gambling. It can be assumed that giving up gambling completely under medical supervision for at least 1 month could help reinforce feelings of self-efficacy and reduce cognitive distortions, with a decrease in the severity of the disorder as a potential corollary. Indeed, in a previous analysis, we observed that giving up gambling for a period of at least 1 month was associated with a lower risk of changing status from non-problem gambler to problem gambler (Bruneau et al., 2016).

Another significant result of our research relates to the relatively unexplored relationship between cognitive distortions and the presence of ADHD. Gamblers with ADHD exhibited a higher level of cognitive distortions on all the dimensions of the GABS scale. In particular, we found a strong correlation between the ADHD score and the scores of the Emotions and Chasing dimensions of the GABS. First, with respect to the correlation with the Emotions dimension, it is possible to hypothesize that gamblers with ADHD would seek a negative, emotion-lowering, effect in gambling, for the purpose of self-regulation (Davtian, Reid, & Fong, 2012). Similarly, some authors have suggested that "among pathological and at-risk gamblers, a high level of impulsivity, or a history of anxiety disorders, constitutes risk factors for a comorbidity with ADHD" (Grall-Bronnec et al., 2011). It could thus be assumed that there is an overlap between ADHD and the pursuit of certain negative affects using gambling. For gamblers with ADHD, gambling could represent a secondary disorder complicating the clinical ADHD profile. Second, with respect to the correlation with the Chasing dimension, it is possible to hypothesize that a high level of impulsivity in patients suffering from ADHD could cause them to react immediately to losses by continuing to gamble in the hope of winning their money back; thus, increasing the level of Chasing within a session. The frequent association of these two disorders (PG and ADHD) can be noted (Aymamí et al., 2015). Furthermore, this is in line with the results of Waluk, Youssef, and Dowling (2016) who studied the prevalence of probable ADHD in treatment seeking problem gamblers and found that 24.9% screened positively for ADHD. The presence of probable ADHD appears to complicate the profile of problem gamblers seeking treatment. A systematic screening for gambling disorder in patients suffering from ADHD could be initiated; in the same way that the use of cocaine or another stimulants, for the purpose of regulation, can be explored.

Finally, via the ROC curve analysis, our study made it possible to establish a GABS-23 threshold score equal to 37, while to date none is in existence. From this overall score, cognitive distortions can now be considered with a problem threshold.

Our study involves a number of limitations. The first is the restricted amount of data collected. Indeed, some data, which may have had an influence on the level of cognitive distortions, were not collected (e.g., impulsivity, gambling motivation, etc.). Moreover, the choice of the GABS-23 questionnaire may be open to criticism, as this scale does not include all cognitive distortions, including, among others, the perceived inability to stop gambling [which is evaluated, e.g., in the Gambling Related Cognitions Scale (Raylu & Oei, 2004)]. However, the GABS includes subscales such as Emotions and Chasing. It is conceivable that the ability to stop gambling could be associated with the capacity to abstain from gambling for at least 1 month and accordingly with a decrease in cognitive distortions. Furthermore, we have no executive function measurements, which could have been complementary to the evaluation of cognitive distortions. However, we chose to restrict the assessment procedure to a limited number of questionnaires, in an attempt to maximize the acceptation of the procedure by participants.

CONCLUSION

Research on cognitive distortions is of major importance to the care of problem gamblers. The intensity of cognitive distortions is correlated with the severity of gambling problems and the presence of ADHD. Systematic detection of gambling problems in patients suffering from ADHD could also help to improve the care of subjects affected by problem gambling. Moreover, the cognitions with the strongest correlation to the severity of gambling disorder involved the desire to win back one's losses, and the emotional activation induced by gambling (both the excitement induced by gambling and the evasion from negative affects provided by gambling). A period of abstinence of at least 1 month under medical supervision could be a promising therapeutic pathway in the reduction of erroneous thoughts associated with gambling. This guideline could improve the outcome of gambling disorder.

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Authors' contribution: LR and CL conducted the literature search. LR, CL, MG-B, and GC-B drafted the first version of the manuscript. MG-B and GC-B designed the study and are responsible for the project management. AG conducted the statistical analysis. All authors (including those mentioned in the JEU Group) contributed to include the participants in the study. All authors read and approved the final manuscript.

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