



Original article

Impulsivity and cognitive distortions in different clinical phenotypes of gambling disorder: Profiles and longitudinal prediction of treatment outcomes

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ABSTRACT

Background: Impulsivity and cognitive distortions are hallmarks of gambling disorder (GD) but it remains unclear how they contribute to clinical phenotypes. This study aimed to (1) compare impulsive traits and gambling-related distortions in strategic versus non-strategic gamblers and online versus offline gamblers; (2) examine the longitudinal association between impulsivity/cognitive distortions and treatment retention and relapse.

Methods: Participants seeking treatment for GD (n = 245) were assessed for gambling modality (clinical interview), impulsive traits (Urgency, Premeditation, Perseverance and Sensation Seeking [UPPS] scale) and cognitive distortions (Gambling Related Cognitions Scale) at treatment onset, and for retention and relapse (as indicated by the clinical team) at the end of treatment. Treatment consisted of 12-week standardized cognitive behavioral therapy, conducted in a public specialized clinic within a general public hospital.

Results: Strategic gamblers had higher lack of perseverance and gambling-related expectancies and illusion of control than non-strategic gamblers, and online gamblers had generally higher distortions but similar impulsivity to offline gamblers. Lack of perseverance predicted treatment dropout, whereas negative urgency and distortions of inability to stop gambling and interpretative bias predicted number of relapses during treatment.

Conclusions: Individuals with online and strategic GD phenotypes have heightened gambling related biases associated with premature treatment cessation and relapse. Findings suggest that these GD phenotypes may need tailored treatment approaches to reduce specific distortions and impulsive facets.

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1. Introduction

Gambling disorder (GD) is a behavioural addiction characterised by an excessive and interfering pattern of gambling, leading to significant clinical symptoms and social impairments [1]. It is also

described as a rather heterogeneous disorder [2] that presents high rates of treatment dropouts and relapses [3–5]. An important source of heterogeneity is gambling modality, which is commonly grouped into two broad categories: strategic gambling (a structured approach or attempt to use knowledge of the game to influence or predict the outcome and produce a profit, e.g.: poker cards, dice, sports betting or stock market) and non-strategic gambling (a non-structured approach which involves little or no decision making or skill; gamblers cannot influence the outcome, e.g. lotteries, slots-machines or bingo) [6]. Studies have found that strategic gamblers show more severe problems and poorer clinical outcomes than non-strategic gamblers for still unclear reasons [7]. Heterogeneity has further increased with the growth of online gambling modalities (in contrast to the offline ones), for which we are still developing standard models of care [8], based on the patients' gambling activity and the perception of impairment related to each modality [9]. Identifying the cognitive drivers of these different GD phenotypes, which can lead to develop personalized treatment approaches, has been deemed essential to navigate this heterogeneity with the aim of improving the outcomes of current interventions [10]. Elevated impulsivity and gambling-related cognitive distortions are key cognitive mechanisms of GD and sensitive to individual differences, but it is still unclear how they contribute to different GD phenotypes.

Impulsivity is a multifaceted construct that reflects the tendency to act quickly without sufficient consideration of the consequences of actions. People with GD generally show high levels of impulsivity and its role in treatment response has been widely acknowledged [11–14]. Impulsivity is highly linked to different impairments across multiple cognitive domains [15]. For instance, literature on addictive behaviours (including substance use disorder and GD) report the presence of alterations on inhibitory control, lack of goal maintenance and difficulties when anticipating long-term outcomes [16,17]. Moreover, different studies highlight the association between affective impulsivity (i.e. the tendency to engage in impulsive behaviours when experiencing certain emotions) and GD severity [18,19]. Cognitive distortions are irrational beliefs about gambling outcomes and the capacity to influence them [20,21], such as beliefs that one can control gambling related wins or that continued gambling will recoup lost money [22,23]. The causality of these distortions in GD is believed to be bidirectional as they seem to be risk factors for both the development and maintenance of the disorder and to remit spontaneously with the disorder even when not directly treated [24]. It should be noted that cognitive distortions are a transdiagnostic feature for the occurrence and maintenance of mental disorders –such as depression [25], anxiety [26], obsessive compulsive disorder [27], eating disorders [28], among others. Furthermore, impulsivity and cognitive distortions seem to have overlapping neural substrates, as individual variations in both of these domains are linked to dopamine availability in striatal regions [29,30]. Although impulsivity and cognitive distortions are meaningfully interrelated [13], few studies have concurrently assessed them. So far, studies have reported elevated cognitive distortions and trait impulsivity in patients with GD compared to healthy controls [12] and specific associations between cognitive distortions and some facets of impulsivity (i.e.: urgency and sensation seeking) but not others (i.e.: lack of premeditation and lack of perseverance) [24]. Moreover, Navas et al. (2017), classified recreational and problematic gamblers according to their gambling preference (strategic vs. non-strategic) and found higher cognitive distortions among those who preferred strategic games, whilst no differences were found for trait impulsivity [31].

Consistent evidence shows that strategic versus non-strategic and online versus offline gambling modalities reflect distinctive clinical phenotypes. GD patients with strategic gambling are

described to be younger, with higher levels of psychopathology and alexithymia [7,32], elevated cognitive distortions [33,34] and greater disinhibition and sensation seeking than those with non-strategic gambling [32]. Non-strategic gamblers tend to process information in a more automatic way and are more inclined to trust their intuition than the strategic gamblers [35]. With regard to offline versus online gamblers, the latter tend to be younger, more educated and present more co-occurring alcohol and cannabis use [24,29–31]. Since impulsivity and cognitive distortions contribute to GD development and maintenance, they are likely to differ among these clinical phenotypes and contribute to different treatment pathways [31,37]. However, there is a dearth of research on the role of impulsivity and cognitive distortions in different GD clinical phenotypes and related treatment outcomes [32,38,39].

This study sought to characterise profiles of impulsivity and cognitive distortions in the strategic/non-strategic and online/offline GD clinical phenotypes, and the longitudinal association between these profiles and treatment outcomes. Thus, our first aim was to compare strategic vs. non-strategic gamblers and online vs. offline gamblers on multidimensional measures of impulsivity and cognitive distortions. Our second aim was to examine the association between individual variation in impulsivity and cognitive distortions (at treatment onset) and clinical outcomes following GD treatment (3-months follow-up). Based on previous studies exploring cognitive distortions as a function of gambling preferences [31], we hypothesised that strategic and online gamblers would have generally higher cognitive distortions than non-strategic and offline gamblers, and that elevated distortions and impulsivity (particularly, negative urgency, which have been linked to poorer outcomes in substance addictions) would predict higher treatment dropouts and relapses.

2. Methods

2.1. Design

This study analyses cross-sectional and longitudinal data. At baseline, the concurrence (covariance) of trait impulsivity and cognitive distortions was estimated, as well as the comparison of these traits according to gambling preferences (strategic vs. non-strategic and online vs. offline). Afterwards, patients received cognitive behavioural group therapy (CBT) and the longitudinal predictive capacity of the pre-treatment measures (independent variables: trait impulsivity and cognitive distortions) on treatment efficiency (outcomes: dropout and relapses) was estimated.

2.2. Participants

The study was comprised of 245 male consecutive treatment seeking patients diagnosed with GD according to DSM-5 criteria [1] and who attended to a GD unit, which belongs to a general public health hospital, between July-2016 and August-2018. Due to missing data and inability to complete the whole assessment, 40 participants were excluded from the sample. The final sample consisted of 205 participants (mean age = 42.38 years, S.D = 13.55, age range = 18–77). The participants were enrolled in the study when they first attended the GD unit for its assessment before starting treatment (CBT group therapy). After accepting to be part of the study and completing the whole assessment (at baseline), 27 participants did not start the assigned treatment and 78 participants have either not yet been assigned to treatment (waiting list) or presented missing data thus they have not been included in the treatment outcome analyses (i.e.: treatment dropout and relapse rates). For this specific longitudinal analysis the sample was comprised of 100 participants (mean age = 43.2 years, S.D = 13.4, age range = 19–77). All participants

were recruited from the GD Unit within the Department of Psychiatry at Bellvitge University Hospital. This hospital oversees the treatment of very complex cases as it is certified as a tertiary care centre for the treatment of behavioural addictions. Only patients who sought treatment for GD as their primary health concern were admitted to this study. GD is more frequent in men than women [40,41] thus very few women seek treatment for GD at our unit; consequently, only males were included in this study and data from women will be included in a future study once the sample has achieved enough statistical and clinical power. Exclusion criterion for being part of the treatment protocol were: (a) history of chronic medical illness or neurological condition that might affect the assessment; (b) brain trauma, a learning disability or intellectual disabilities; (c) age under 18.

Written informed consent was obtained before participation in the study, which was approved by the Ethics Committee of University Hospital of Bellvitge in accordance with the Helsinki Declaration of 1975 as revised in 1983 (reference number PR095/16). Participants received no additional compensation for being part of the study.

2.3. Cognitive behavioural therapy intervention

Participants received the protocolized CBT outpatient treatment of our unit which consisted on a 16 weekly group sessions lasting 90 min each. This treatment protocol has previously been described and it has shown an adequate effectiveness for GD in both short and medium terms [42–44]. The main goal of the intervention is to eventually arrive at full abstinence by training the patients to implement CBT strategies in order to minimize GD maladaptive behaviours. The key topics covered during treatment are: psychoeducation (GD definition, course and vulnerability factors, etc.), stimulus control (such as money management and avoidance of potential triggers), reinforcement and self-reinforcement, response prevention, cognitive restructuring focused on illusions of control over gambling, problem solving and relapse prevention techniques. CBT groups were conducted by an experienced clinical psychologist and a clinically trained co-therapist. Only patients who do not have other severe comorbid psychiatric disorders and that need GD treatment can be part of the group therapy, otherwise patients follow individual therapy.

2.4. Measures

GD diagnosis and GD severity: Patients were assessed with the DSM-5 criteria [1] via a face-to-face clinical interview and the Spanish validation of SOGS [45,46], which is a 20-item diagnostic questionnaire that discriminates between probable pathological, problem and non-problem gamblers. Internal consistency in our sample was of 0.715. Demographic and social variables related to gambling were also measured in all participants.

UPPS-P Impulsive behaviour scale [47] is a 59-item questionnaire to assess five different features of trait impulsivity: Lack of Perseverance, Lack of Premeditation, Sensation Seeking, Negative Urgency and Positive Urgency. The UPPS-P has satisfactory psychometric properties, which have also been proven in its Spanish adaptation [48]. The α values for the different UPPS-P scales in our sample ranged from 0.756 to 0.940.

Gambling-related cognitions scale (GRCS; [49]) is a 23-item questionnaire to assess a variety of gambling-related cognitions both in the general population and in disordered gambling. It measures five different cognitive domains: interpretive bias (GRCS-IB; e.g. “Relating my winnings to my skill and ability makes me continue gambling”), illusion of control (GRCS-IC; e.g. “I have specific rituals and behaviours that increase my chances of

winning”), predictive control (GRCS-PC; e.g. “Losses when gambling are bound to be followed by a series of wins”), gambling-related expectancies (GRCS-GE; e.g. “Gambling makes things seem better”) and perceived inability to stop gambling (GRCS-IS; e.g. “I’m not strong enough to stop gambling”). The GRCS, has adequate psychometric properties both in its original version and in its Spanish adaptation [50]. The α values for the different GRCS subscales in our sample ranged from 0.767 to 0.933.

Treatment dropout and relapse rates: Dropout and relapse rates were considered as indicators of treatment outcomes. A relapse indicates that the patient presented a full gambling episode once CBT treatment started, regardless of whether the relapse occurs with the specific type of the gambling preference or another. That means any gambling episode constitutes a relapse in the present study. A dropout was established if the patient missed a treatment session on three or more occasions without prior notifying the clinician.

2.5. Analysis

The statistical analysis was carried out with Stata15 for Windows. For the cross-sectional analysis (baseline measures) we explored the associations between different gambling related variables (severity, cognitive distortions and trait impulsivity) through partial correlation coefficients (R) adjusted by age and GD duration. Due to the strong association between the statistical significance of R -coefficients and the sample size, the partial correlation effect sizes were established as follow: poor-low $|R| > 0.10$, moderate-medium $|R| > 0.24$ and large-high $|R| > 0.37$. These thresholds correspond to a Cohen’s- d of 0.20, 0.50 and 0.80 respectively [51]. The baseline clinical profile comparison based on gambling preference (non-strategic vs. strategic and offline vs. online) was conducted with analysis of variance (ANOVA) adjusted by the covariates age and GD duration. The mean difference of the effect size was estimated with Cohen’s- d coefficient: poor-low $|d| > 0.20$, moderate-medium $|d| > 0.5$ and large-high $|d| > 0.8$ [52]. In order to control for multiple comparisons type-I error [53] the Simes’ method was implemented, which is included in the Family wise error rate stepwise system and is more powerful than the classical Bonferroni correction.

Also, we longitudinally assessed the predictive capacity of trait impulsivity and cognitive distortions (independent variables) on CBT outcomes (dependent variables: presence of relapses during treatment and dropout of treatment) through multiple binary logistic regressions adjusted by age and GD duration. The modeling was defined in two blocks: block 1 entered and fixed the covariates (age and GD duration), block 2 added and tested the independent variables (i.e.: trait impulsivity and cognitive distortions). The fitting of the final logistic regressions was tested with Hosmer-Lemeshow (goodness-of-fit was considered if $p > .05$), and the global capacity of the predictors with the Nagelkerke’s pseudo- R^2 coefficient increase (ΔR^2), comparing blocks 1 and 2 of the logistics.

3. Results

3.1. Characteristics of the sample at baseline

Table 1 includes the descriptive data of the sample (before starting CBT treatment). The majority of participants were born in Spain (almost 93%), were single (46.3%) or lived with a stable partner (41.0%), had primary education (62.9%), were in active employment (61.0%) and their socioeconomic status (measured by the Hollingshead index; [54]) was low (87.8%). The mean age of GD was 22.8 years (SD = 10.0) and the mean duration of GD was 15.1 years (SD = 12.3). The prevalence of tobacco use was 54.6%, alcohol

Table 1
Descriptive for the cross-sectional sample (n = 205).

Sociodemographics	n	Percent	Clinical profile	α	Mean	SD
OriginSpain	190	92.7%	Age (years-old)		42.38	13.55
Other country	15	7.3%	Onset of gambling (years-old)		22.79	10.00
Civil statusSingle	95	46.3%	Duration of gambling (years)		15.12	12.33
Married-partner	84	41.0%	DSM-5 total criteria		6.92	1.96
Separated-divorced	26	12.7%	SOGS total score	.715	14.66	4.78
Studies levelPrimary	129	62.9%	Total number of games		3.14	2.78
Secondary	59	28.8%	Cumulate debts, lifetime (euros)		7906	15430
University	17	8.3%	Mean bets-episode (euros)		64	82
Social indexLow	114	55.6%	Maximum bets-episode (euros)		574	633
Middle-low	66	32.2%	GRCS Gambling expectancies	.855	12.15	7.42
Middle	21	10.2%	GRCS Illusion of control	.767	7.86	5.28
Upper-middle and Upper	4	2.0%	GRCS Predictive control	.784	16.65	8.71
EmploymentUnemployed	80	39.0%	GRCS Inability to stop gambling	.806	16.92	8.31
Employed	125	61.0%	GRCS Interpretive bias	.792	13.41	7.24
Prevalence of substances use	n	Percent	GRCS Total	.933	66.94	30.55
Tobacco	112	54.6%	UPPS-P Lack of premeditation	.756	24.60	7.77
Alcohol	57	27.8%	UPPS-P Lack of perseverance	.824	22.08	6.15
Other illegal drugs	22	10.7%	UPPS-P Sensation seeking	.847	27.21	8.68
Prevalence of psych. diseases	n	Percent	UPPS-P Positive urgency	.940	31.56	11.51
Any comorbid psychiatric disease	62	30.2%	UPPS-P Negative urgency	.874	31.96	8.45

Note. SD: standard deviation. Cronbach's alpha in the sample.

use 27.8% and other illegal drugs 10.7%, and 30.2% of the sample reported problems due to other psychiatric disorders. See Table 1 for frequency distributions of trait impulsivity, cognitive distortions and other gambling related variables.

Non-strategic gamblers were younger ($p = .002$), with an earlier age of onset ($p < .001$) and a longer duration of the GD ($p = .001$) than strategic gamblers. No differences were found between these two groups when comparing the rest of the sociodemographic variables ($p > 0.05$ for all the variables). Differences also emerged comparing the offline vs. online gamblers in: age (younger age in online gambling; $p < .001$), duration of problematic gambling (lower duration in online gambling; $p = .003$), civil status (online gamblers were predominantly single -61.5%- whereas offline gamblers were mainly married or divorced -58.8%-; $p = .039$) and education (online gambling was more frequent in patients with higher education; $p = .002$).

3.2. Association between gambling variables

Table 2 contains the partial correlation matrix (adjusted by age and GD duration). Considering GD severity (DSM-5 criteria, lifetime debts and bets per gambling-episode), positive correlations were found between lifetime debts and lack of perseverance, as well as between maximum bets-per gambling episode and

GRCS-IS and GRCS-total. Many positive correlations were also found between cognitive distortions (GRCS scores) and trait impulsivity (UPPS-P scores). Namely, GRCS-GE correlated with all trait impulsivity measures; GRCS-total and GRCS-IS correlated with all trait impulsivity subscales but sensation seeking; GRCS-IB correlated with positive and negative urgency, GRCS-PC only correlated with lack of perseverance.

3.3. Comparison of the impulsivity/cognitive distortions profile based on clinical phenotypes

Table 3 contains the comparison of cognitive distortions and trait impulsivity in patients with non-strategic gambling vs. strategic gambling as well as offline vs. online gambling (ANOVA adjusted by age and GD duration). Statistical differences between strategic and non-strategic gamblers were as follow: higher mean scores of GRCS-GE, GRCS-IC, GRCS-total and lack of perseverance in patients with strategic gambling than in patients with non-strategic gambling. All these associations presented a mean difference of effect size within the low range. Regarding offline vs. online gamblers, statistical differences with effect sizes into the medium-moderate range were found in all the GRCS scales (i.e.: online gamblers had higher GRCS means) but in GRCS-IS, which achieved statistical significance but low effect size.

Table 2
Partial correlations (adjusted by age and duration of the gambling) (n = 205).

	1	2	3	4	5	6	7	8	9	10
1 GD: DSM-5 criteria	—									
2 GD: Lifetime debts	.032	—								
3 GD: Bets-episode, mean	-.036	.271[†]	—							
4 GD: Bets-episode, max.	-.003	.285[†]	.468[†]	—						
5 GRCS Gambling expectancies	.147	.221	.085	.210	—					
6 GRCS Illusion of control	.193	.131	.047	.135	.563[†]	—				
7 GRCS Predictive control	.076	.170	.075	.190	.685[†]	.630[†]	—			
8 GRCS Inability to stop gambling	.137	.149	.134	.244[†]	.540[†]	.435[†]	.585[†]	—		
9 GRCS Interpretive bias	.219	.173	.055	.206	.636[†]	.551[†]	.705[†]	.624[†]	—	
10 GRCS Total	.180	.206	.100	.242[†]	.832[†]	.738[†]	.886[†]	.791[†]	.856[†]	—
11 UPPS-P Lack premeditation	.047	.221	.002	.111	.349[†]	.195	.196	.286[†]	.229	.304[†]
12 UPPS-P Lack perseverance	.077	.251[†]	-.011	.073	.360[†]	.220	.258[†]	.341[†]	.223	.344[†]
13 UPPS-P Sensation seeking	-.020	-.018	-.040	.038	.264[†]	.128	.162	.187	.168	.224
14 UPPS-P Positive urgency	.092	.142	.011	.055	.297[†]	.207	.216	.280[†]	.262[†]	.308[†]
15 UPPS-P Negative urgency	.068	.082	.125	.119	.262[†]	.196	.209	.368[†]	.298[†]	.328[†]

Note1. [†]Bold: effect size into the moderate ($|r| > 0.24$) to high range ($|r| > 0.30$).

Table 3

Comparison of the clinical profile based on the gambling subtype: ANOVA adjusted by age and duration of the gambling.

	Non-strategic		Strategic		p	d	Offline		Online		p	d
	n = 145		n = 60				n = 153		n = 52			
	Mean	SD	Mean	SD			Mean	SD	Mean	SD		
GRCS Gambling expectancies	11.34	6.89	14.10	8.22	.028*	0.36	11.14	7.32	15.10	7.17	.002*	0.55†
GRCS Illusion of control	7.27	5.10	9.29	5.63	.025*	0.38	7.25	5.21	9.66	3.31	.008*	0.55†
GRCS Predictive control	16.06	8.31	18.08	9.58	.176	0.23	15.22	8.35	20.88	8.71	.001*	0.66†
GRCS Inability stop gambling	16.53	8.02	17.84	9.02	.357	0.15	16.12	8.43	19.27	7.81	.028*	0.39
GRCS Interpretive bias	12.83	7.08	14.83	7.52	.106	0.27	12.25	7.24	16.84	6.47	.001*	0.67†
GRCS Total	64.02	28.56	74.00	34.43	.046*	0.32	61.93	30.32	81.69	28.04	.001*	0.68†
UPPS-P Lack premeditation	24.37	7.91	25.16	7.45	.554	0.10	24.59	8.12	24.65	6.69	.968	0.01
UPPS-P Lack perseverance	21.46	6.15	23.58	5.94	.043†	0.35	21.99	6.32	22.33	5.66	.757	0.06
UPPS-P Sensation seeking	27.77	9.10	25.87	7.59	.186	0.23	27.55	9.00	26.21	7.70	.361	0.16
UPPS-P Positive urgency	31.97	11.36	30.57	11.93	.473	0.12	31.87	12.01	30.62	9.96	.527	0.11
UPPS-P Negative urgency	32.13	8.66	31.55	7.98	.687	0.07	32.30	8.42	30.96	8.55	.357	0.16

Note. SD: standard deviation.

* Bold: significant comparison (.05 level).

† Bold: effect size into the moderate (|d|>0.50) to high range (|d|>0.80).

3.4. Predictive capacity of impulsivity and gambling-related cognitions on CBT outcome

Table 4 contains the results of the logistic models (adjusted by age and GD duration) measuring the predictive capacity of trait impulsivity and cognitive distortions on treatment outcome. Three different models were computed: a) trait impulsivity dimensions (UPPS-P scales); b) cognitive distortions (GRCS subscales); and c) cognitive distortions total score (GRCS-total). The patients with higher risk of relapses were the ones with higher negative urgency/GRCS-IS, or lower GRCS-IB. Also, patients with higher levels of lack of perseverance presented higher risk of dropout. The predictive capacity of cognitive distortions and trait impulsivity were higher for the presence of relapses than for treatment dropout. The highest increase in the Nagelkerke's pseudo-R was in GRCS

subscales ($\Delta R^2 = .207$), followed by the UPPS-P scales ($\Delta R^2 = .207$), as predictors of relapses.

4. Discussion

We showed that patients with GD and online phenotypes have generally higher cognitive distortions than those with offline phenotypes, whereas strategic phenotypes have higher distortions related to gambling expectancies and illusion of control and less perseverance than non-strategic phenotypes. Although differences were of small-medium effect size, individual variations in these features significantly predicted clinical outcomes. Specifically, lack of perseverance predicted dropout and inability to stop and interpretative biases longitudinally predicted risk of relapse. These findings suggest the need to incorporate specific treatment

Table 4

Predictive capacity of impulsivity and cognitive biases on the CBT outcomes: logistic regression adjusted by age and GD severity at baseline (DSM-5 criteria)(n = 100).

Criteria	Predictors included in the block-2	B	SE	p	OR	95%CI(OR)	
Relapses	Impulsivity; $\Delta R^2 = .122$						
	UPPS-P Lack of premeditation	0.020	0.046	.658	1.021	0.932	1.117
	UPPS-P Lack of perseverance	0.039	0.055	.482	1.040	0.933	1.159
	UPPS-P Sensation seeking	0.015	0.031	.630	1.015	0.955	1.079
	UPPS-P Positive urgency	-0.022	0.034	.510	0.978	0.916	1.045
Relapses	UPPS-P Negative urgency	0.080	0.045	.047*	1.084	1.011	1.184
	Cognitive biases; $\Delta R^2 = .207$						
	GRCS Gambling expectancies	0.070	0.052	.177	1.073	0.969	1.188
	GRCS Illusion of control	0.009	0.066	.895	1.009	0.887	1.147
	GRCS Predictive control	-0.034	0.052	.506	0.966	0.874	1.069
Relapses	GRCS Inability to stop gambling	0.126	0.040	.002*	1.134	1.049	1.225
	GRCS Interpretive bias	-0.095	0.054	.048*	0.909	1.012	1.010
	Cognitive biases; $\Delta R^2 = .020$						
	GRCS Total	0.010	0.008	.237	1.010	0.994	1.026
	Dropout	Impulsivity; $\Delta R^2 = .070$					
UPPS-P Lack of premeditation		-0.024	0.042	.568	0.976	0.898	1.061
UPPS-P Lack of perseverance		0.086	0.051	.048*	1.089	1.013	1.204
UPPS-P Sensation seeking		0.038	0.028	.168	1.039	0.984	1.098
UPPS-P Positive urgency		-0.016	0.032	.613	0.984	0.923	1.048
Dropout	UPPS-P Negative urgency	0.012	0.041	.771	1.012	0.933	1.098
	Cognitive biases; $\Delta R^2 = .028$						
	GRCS Gambling expectancies	0.015	0.044	.735	1.015	0.931	1.106
	GRCS Illusion of control	-0.013	0.056	.814	0.987	0.885	1.101
	GRCS Predictive control	0.024	0.044	.581	1.025	0.940	1.117
Dropout	GRCS Inability to stop gambling	0.020	0.031	.518	1.021	0.959	1.086
	GRCS Interpretive bias	-0.059	0.044	.185	0.943	0.864	1.029
	Cognitive biases; $\Delta R^2 = .001$						
	GRCS Total	0.001	0.008	.993	1.000	0.985	1.015

Note. *Bold: significant parameter (.05 level).

strategies to reappraise biases and reduce impulsivity in strategic/online gamblers.

Broadly higher cognitive distortions in online gamblers suggest that this clinical phenotype is more severe, complex and likely to require specific treatment approaches [37,55–57]. It remains unclear if cognitive distortions precede and influence preferences for online gambling options, or if online gambling modalities disproportionately affect cognitive distortions. Regardless of aetiology, our findings stress the need to specifically target these cognitions during the treatment of these patients. In agreement with previous evidence [31,33,34] strategic gamblers also showed heightened cognitive distortions, specifically gambling-related expectancies and illusion of control which can act as gambling maintaining factors. We also found for the first time that strategic gamblers had greater lack of perseverance, a facet associated with low conscientiousness and inability to focus on complex tasks, which seems to be at odds with the preference for strategic games. In this context, lack of perseverance may put strategic gamblers at greater risk of accumulating losses [58]. Cognitive and impulsivity profiles have potential to inform new models of care in the currently evolving GD treatment space. Strategic gamblers are day by day more differentiated from non-strategic gamblers and the rise of online gamblers with the bigger internet use have increased interest of researchers and clinicians alike [36,59,60].

These findings in strategic and online gamblers are even more relevant given the predictive capacity of cognitive distortions and trait impulsivity on treatment outcomes (i.e.: relapses and dropout of treatment). In terms of impulsivity, a study carried out with online poker players (strategic and online gamblers) found that the inability to stop gambling and the illusion of control were good predictors of pathological gambling [55]. Moreover, sensation seeking and negative urgency were found to be predictors of GD severity [61]. Nevertheless, regarding motor impulsivity, Grant et al. (2012) did not find differences between strategic and non-strategic gamblers [62]. More specifically, lack of perseverance predicted dropping out of treatment, which reflects that the tendency to not persist in an activity that can be complex –e.g., therapy guidelines for GD– or boring poses a significant challenge for treatment retention. The association between lack of perseverance and dropouts was also found by Mestre-Bach et al., 2018 [63], who also reported that negative urgency predicted relapses and found no significant results in sensation seeking, lack of premeditation or positive urgency. Nevertheless, in contrast to what has been found in the current study, elevated punctuations on sensation seeking increased the risk of dropouts [63]. Also, severe GD patients that presented high scores in psychopathology, low persistence and low reward dependence at baseline, had poor progress in GD severity during treatment and follow-up compared to other severe patients [64]. Furthermore, beliefs of inability to stop gambling (a cognitive distortions more highly observed in online and strategic gamblers), predicted the number of relapses during treatment. It is known that higher relapses during treatment are associated with poorer abstinent success rates, which predispose patients towards a higher risk of chronicity and prompts the need to specifically target these cognitions during the intervention. The results have important clinical implications for improving current treatment outcomes by personalizing approaches according to specific GD phenotypes.

Contrary to previous findings [57], we found no associations between cognitive distortions and GD severity. However, higher scores in cognitive distortions were linked to higher bets-episodes, a proxy of binge gambling. Additionally, we were able to replicate previous work regarding the associations between cognitive distortions and trait impulsivity together with the role of negative urgency in treatment outcome. This reflects that what is prompting more relapses in our sample is the tendency to act

impulsively when experiencing negative affect (e.g., frustration, fear, anxiety or sadness). A recent study exploring different impulsive and compulsive related domains implicated in GD treatment outcome also revealed the relevance of negative urgency in the number of relapses during treatment [11,48]. Although research with GD samples is still scarce, a current meta-analysis of substance-related addictions has proposed that negative urgency is associated with poorer psychotherapy outcomes [65].

This study has several strengths including a large representative sample of treatment-seeking gamblers who were consecutively recruited across two years, and a longitudinal design that follows the course of a standardized treatment which is the current gold standard for GD. There are also limitations derived from this naturalistic approach. First, the sample was composed of treatment-seeking patients with GD, and findings may not generalize to other community samples or to all levels of disordered gambling from general population. Second, our sample is restricted to male patients with GD because we have comparatively very few female patients and we are recruiting for an extended period to have enough statistical power in future studies. Further studies should include female participants and different community samples. It will be necessary to continue expanding clinical samples of women to explore if the results obtained in men are confirmed or if, given the very specific characteristics of women with GD, the findings suggest the existence of other relationships. Finally, the self-reported nature of some of the data can lead to recall bias.

In conclusion, we provide the first systematic characterization of impulsivity and cognitive distortions profiles in different GD clinical phenotypes and evidence of specific facets and cognitive distortions that predict GD treatment outcomes. Online gamblers have overall higher distortions and strategic gamblers have less perseverance and more irrational expectancies and illusions of control. Cognitive distortions, low perseverance and high emotion-driven impulsivity predicted poorer treatment outcomes. The results are highly relevant for improving current treatments by targeting specific cognitions and traits that can lead to a more successful therapy.

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