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Exploring the Relationship between Reward and Punishment Sensitivity and Gambling Disorder in a Clinical Sample: A Path Modeling Analysis

Susana Jiménez-Murcia[1,2,3] · Fernando Fernández-Aranda[1,2,3] · Gemma Mestre-Bach[1,2] · Roser Granero[2,4] · Salomé Tárrega[4] · Rafael Torrubia[5] · Neus Aymamí[1] · Mónica Gómez-Peña[1] · Carles Soriano-Mas[1,4,6] · Trevor Steward[1,2] · Laura Moragas[1] · Marta Baño[1] · Amparo del Pino-Gutiérrez[7] · José M. Menchón[1,2,6]

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Abstract Most individuals will gamble during their lifetime, yet only a select few will develop gambling disorder. Gray's Reinforcement Sensitivity Theory holds promise for providing insight into gambling disorder etiology and symptomatology as it ascertains that neurobiological differences in reward and punishment sensitivity play a crucial role in determining an individual's affect and motives. The aim of the study was to assess a mediational pathway, which included patients' sex, personality traits, reward and punishment sensitivity, and gambling-severity variables. The Sensitivity to Punishment and Sensitivity to Reward Questionnaire, the South Oaks Gambling Screen, the Symptom Checklist-Revised, and the Temperament and Character Inventory-Revised were

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✉ Susana Jiménez-Murcia
sjimenez@bellvitgehospital.cat

[1] Pathological Gambling Unit, Department of Psychiatry, Bellvitge University Hospital-IDIBELL, C/Feixa Llarga s/n, Hospitalet de Llobregat, 08907 Barcelona, Spain

[2] Ciber Fisiopatología Obesidad y Nutrición (CB 06/03), Instituto Salud Carlos III, C/Monforte de Lemos, 3-5. Pabellón 11-Planta 0, 28029 Madrid, Spain

[3] Department of Clinical Sciences, School of Medicine, University of Barcelona, Campus de Bellvitge - Pavelló de Govern, Feixa Llarga s/n, Hospitalet de Llobregat, 08907 Barcelona, Spain

[4] Departament de Psicobiologia i Metodologia de les Ciències de la Salut, Universitat Autònoma de Barcelona, C/Fortuna Edifici B, Bellaterra, Cerdanyola del Vallès, 08193 Barcelona, Spain

[5] Department of Psychiatry and Forensic Medicine, Institute of Neurosciences, School of Medicine, Autonomous University of Barcelona, Av. de Can Domènech, 737, 08193 Cerdanyola, Barcelona, Spain

[6] Ciber de Salud Mental (CIBERSAM), Instituto Salud Carlos III, C/Monforte de Lemos 3-5. Pabellón 11-Planta 0, 28029 Madrid, Spain

[7] Nursing Department of Mental Health, Public Health, Maternal and Child Health, Nursing School, University of Barcelona, Campus de Bellvitge - Pavelló de Govern, Feixa Llarga s/n, Hospitalet del Llobregat, 08907 Barcelona, Spain

administered to a sample of gambling disorder outpatients (N = 831), diagnosed according to DSM-5 criteria, attending a specialized outpatient unit. Sociodemographic variables were also recorded. A structural equation model found that both reward and punishment sensitivity were positively and directly associated with increased gambling severity, sociodemographic variables, and certain personality traits while also revealing a complex mediational role for these dimensions. To this end, our findings suggest that the Sensitivity to Punishment and Sensitivity to Reward Questionnaire could be a useful tool for gaining a better understanding of different gambling disorder phenotypes and developing tailored interventions.

Keywords Gambling disorder · Sensitivity to reward · Sensitivity to punishment · Gray's Reinforcement Sensitivity Theory · Path analysis · Personality

Introduction

Gambling is a common activity across societies and cultures and acts as little more than a form of entertainment for the vast majority of people, with different studies showing that between 70 and 90 % of the adolescent and adult population occasionally gamble (Abbott et al. 2004; Blinn-Pike et al. 2010; Gupta and Derevensky 1998). However, for 1.5 % of the adult population, gambling is a disorder with serious consequences (Becoña 2009). Relatedly, problem gambling rates in the European Union have been found to range from .3 to 3.1 % (Planzer et al. 2014). Gambling Disorder (GD) is defined as persistent and recurrent problematic gambling behavior leading to clinically significant impairment or distress (APA 2013). Epidemiological studies indicate that GD is more frequent in men than in women and that problem gambling behavior usually begins in adolescence or early adulthood (commonly with a later onset in women) (Cunningham-Williams et al. 1998; Welte et al. 2002). In order to improve treatment interventions, a better understanding of the mechanisms underpinning GD is needed.

GD is frequently associated with dysfunctional personality dimensions that often predate the emergence of GD pathology (Shenassa et al. 2012; Slutske et al. 2012). Individuals with GD are consistently characterized as highly impulsive and show temperament traits such as high novelty seeking, which is defined by the desire to approach potential rewards (Janiri et al. 2007). Nonetheless, high harm avoidance (shy, fearful behavior, with the tendency to avoid perceived punishment) has also been identified in patients with GD (Lobo et al. 2014; Moragas et al. 2015). These apparently opposing traits have led to the development of distinct models to define patient profiles according to the different motivations that give rise to gambling behavior (e.g. emotionally vulnerable vs. antisocial impulsive gamblers) (Blaszczynski and Nower 2002; Moragas et al. 2015), and raises the question as to whether gambling behavior may be adaptive in certain cases and used to mitigate the responses caused by the trials one must face in daily life (Williams et al. 2012).

Gray's Reinforcement Sensitivity Theory postulates that personality traits can be understood according to the sensitivity of brain systems that respond to punishment and reward. In its original form, this theory asserts that punishment sensitivity regulated responses to stimuli perceived as potentially dangerous, thereby leading individuals to their avoidance. Contrarily, reward sensitivity directs behavior towards appetitive stimuli that

provide immediate compensation (Gray 1970, 1982; Torrubia and Tobeña 1984; Torrubia et al. 2001). In clinical practice and for research purposes, the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ) (Torrubia et al. 2001) is a widely used instrument for assessing reward and punishment sensitivity levels. This questionnaire is consistent with Gray's Reinforcement Sensitivity Theory in that it addresses sensitivity to specific cues instead of a more generalized notion of sensitivity to reward and punishment. It's worth noting that Gray's Reinforcement Sensitivity Theory has undergone numerous revisions and that new systems, including the fight-flight-freeze-system (FFFS) (Corr and Poropat 2016; Gray and McNaughton 2000; McNaughton and Corr 2008, 2004), have also been added to this framework. These systems have been proposed to play a mediating role in determining behavioral responses, though the SPSRQ does not factor in these new constructs, but rather treats reward and punishment sensitivity as independent pathways.

High reward sensitivity has been associated with a wide range of psychopathologies including alcohol abuse (van Hemel-Ruiter et al. 2015), bipolar spectrum disorder (Alloy et al. 2012), eating disorders (Farmer et al. 2002), substance use (Boog et al. 2013), and behavioral addictions (Dong et al. 2013; Lawrence et al. 2014). In the specific context of gambling, reward and punishment processing play a pivotal role in deciding whether to reject a gamble or to "chase one's losses". Numerous studies have demonstrated that individual differences in punishment and reward sensitivity are linked to gambling problems (Balodis et al. 2014; Gaher et al. 2015; Mackillop et al. 2014). For example, Wardell et al. (2015) found in a community sample of problem gamblers that both punishment and reward sensitivity were related to gambling problems via enhancement/winning motives and negative-affect motive pathways, respectively. These findings dovetail with other research in substance abuse demonstrating that individuals with high reward sensitivity are inclined to seek out the rewarding effects of substances (Franken and Muris 2006), while individuals with high punishment sensitivity are driven to use substances as a means of enhancing mood since they are more liable to have negative emotions (Voigt et al. 2009). Furthermore, high reward sensitivity has been found to undermine treatment seeking in problem gamblers (Sztainert et al. 2014).

Much neuroimaging research to date has sought to identify how shared symptom clusters in gambling disorder and substance use (craving, withdrawal, loss of control, etc.) may be related to dysfunctional neural circuitry (Potenza 2013). Theories on behavioral addiction underscore the importance of the mesolimbic system and the prefrontal cortex in reward sensitivity, with alterations in the former being associated with cue reactivity and craving, and the latter with poorer executive functioning characterized by diminished inhibition control (van Holst et al. 2010). Functional magnetic resonance imaging (fMRI) studies with GD patients have repeatedly found evidence of hyperactivity in the ventral striatum during the anticipation of monetary reward and uphold the concept of future delayed rewards being overrun by an eagerness to maximize immediate compensation in these patients (Quester and Romanczuk-Seiferth 2014).

To the best of our knowledge, few studies have thus far examined the complex interactions between reward and punishment sensitivity, personality traits, and GD severity in treatment-seeking populations (Balodis et al. 2014; Gaher et al. 2015; Mackillop et al. 2014; Wardell et al. 2015). More specifically, the mediating role of reward and punishment sensitivity in individuals with certain personality traits and gambling behavior has yet to be explored. Some research in community samples have suggested that punishment sensitivity might have a protective role from developing problem gambling, yet its association with gambling severity in GD patients remains unknown (Gaher et al. 2015). Thus, in this study we aimed to assess punishment and reward sensitivity levels in treatment-seeking GD

patients, and to explore the clinical, personality, and sociodemographic differences between patients with high and low levels of punishment and reward sensitivity. We also sought to explore the mediating role of punishment and reward sensitivity in the association between novelty seeking, harm avoidance–two personality dimensions highly linked to addictive behaviors (Dong et al. 2013; Boog et al. 2013)–and gambling severity via path analysis.

Our first hypothesis was that high reward and punishment sensitivity scores would be strongly associated with GD severity. Secondly, as our previous research on personality traits in GD patients has described a phenotype of patients with high harm avoidance who are responsive to negative reinforcement (Alvarez-Moya et al. 2010; Moragas et al. 2015), we hypothesized that punishment sensitivity would mediate the association between harm avoidance and GD severity in our path analysis. Thirdly, we hypothesized that our path analysis would identify a mediating role for reward sensitivity between novelty seeking and GD severity, being that other research has found high levels of both reward sensitivity and novelty seeking to be linked to impulsivity-related components of GD (Mackillop et al. 2014).

Methods

Participants

A sample of 831 GD patients who attended our Unit between 2011 and 2014 was considered. All the patients were consecutive referrals for assessment and treatment and were diagnosed according to DSM-IV-TR criteria. These patients were recodified post hoc using DSM-5 criteria. The sample was predominantly male (91.5 % men, $n = 760$) and the majority of the individuals were of community origin (94.7 %, $n = 787$). The mean age of the sample was 42.5 years (SD = 13.1) and the mean age of onset was 37.9 years (SD = 14.1). Most patients did not have a secondary-school level of education (57.3 %), did not have a partner (41.5 % single, n = 345; 13.2 % divorced-separated, $n = 110$) and were tobacco consumers (59.9 %, $n = 498$). A substantial number of patients also abused alcohol (15.9 %, $n = 132$) and/or other substances (9.3 %, $n = 77$). (Table 1 includes additional demographic information about the sample). The Hospital Ethics Committee approved the study, and informed signed consent was obtained from all participants.

Clinical Measures

DSM-5 criteria (APA 2013)

Patients were diagnosed with pathological gambling if they met DSM-IV-TR criteria (APA 2000). It should be noted that with the release of the DSM-5 (APA 2013), the term pathological gambling was replaced with GD. All patient diagnoses were reassessed and recodified post hoc and only patients who met DSM-5 criteria for GD were included in our analysis.

Table 1 Sample demographics and descriptives (N = 831)

Age (years-old); *mean (SD)*	42.49	(13.1)
Age of onset (years-old); *mean (SD)*	37.89	(14.1)
Gender; *n(%)*		
Males	760	(91.5 %)
Females	71	(8.5 %)
Origin; *n(%)*		
Community	787	(94.7 %)
Other	44	(5.3 %)
Education level; *n(%)*		
Primary	476	(57.3 %)
Secondary	286	(34.4 %)
University	69	(8.3 %)
Civil status; *n(%)*		
Single	345	(41.5 %)
Married-together	376	(45.2 %)
Divorce-separated	110	(13.2 %)
Employment status; *n(%)*		
Employed	396	(47.7 %)
Previous consultations due to GD; *n(%)*	166	(20.0 %)
Tobacco use; *n(%)*	498	(59.9 %)
Number of cigarettes/day; *mean (SD)*	11.2	(12.3)
Alcohol use; *n(%)*		
Low	687	(82.7 %)
Abuse	132	(15.9 %)
Risk of dependence	12	(1.4 %)
Other substance use; *n(%)*	77	(9.3 %)

SD standard deviation, *GD* gambling disorder

South Oaks Gambling Screen (SOGS) (Lesieur and Blume 1987)

This questionnaire uses 20 items to assess cognitive, emotional, and behavioral aspects related to problem gambling by measuring the severity of gambling activity (responses ranging from 0 to 20). This questionnaire discriminates between non-problem gambling (from 0 to 2), light problem gambling (from 3 to 4) and problem gambling (from 5 to 20, with higher scores being indicative of greater gambling severity). A Spanish version of the questionnaire was used (Echeburúa et al. 1994) and it that has proved to be reliable, with good temporal stability (test–retest r = .98) and internal consistency (Cronbach's alpha = .94).

Symptom Checklist-Revised (SCL-90-R) (Derogatis 1994)

This is a 90-item self-report questionnaire designed to measure psychological distress and psychopathology. It explores 9 dimensions or psychopathological profiles: somatization, obsession-compulsion, interpersonal sensitivity, depression, anxiety, anger-hostility, phobic anxiety, paranoid ideation, and psychoticism. In addition, it includes three global indices, which are a Global Severity Index (GSI), to measure overall psychological distress; a Positive Symptom Distress Index (PSDI), to measure the intensity of symptoms;

and a Positive Symptom Total (PST), to measure self-reported symptoms. Spanish validation of this scale (González de Rivera 2001) showed good internal consistency with Cronbach's alphas between .81 and .90.

Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ) (Torrubia et al. 2001)

The SPSRQ is a 48-item self-report questionnaire that contains 24 questions on sensitivity to reward and 24 about sensitivity to punishment with a dichotomous (yes/no) response format and the score for each scale is a summation of the affirmative responses. The magnitude of the score indicates the level of sensitivity to reward and sensitivity to punsihment. In this study, three groups were considered and compared: a normal (T-score under 60), subclinical (T-score between 60 and 70) and clinical (T-score higher than 70) group. These standard T-scores were obtained transforming raw scores using the normative data from the original questionnaire. Both scales demonstrated good internal consistency (sensitivity to punishment, $\alpha = .81$–$.83$; sensitivity to punishment, $\alpha = .73$–$.76$) and the SPSRQ showed acceptable reliability and validity. This questionnaire is based on the original version of Gray's Reinforcement Sensitivity Theory and does not include the less clearly defined Fight-flight-freeze-system, which has been proposed to be activated by the presence of aversive stimuli in order to promote fight or escape behavior. Various revisions and competing theories have incorporated findings from different areas in psychology and neuroscience to attempt to elucidate the interplay of these systems (Corr and Poropat 2016; Gray and McNaughton 2000; McNaughton and Corr 2008, 2004), though these issues will not be addressed as they are beyond the scope of this article.

Temperament and Character Inventory-Revised (TCI-R) (Cloninger 1999)

This questionnaire consists of 240 items that assess personality traits according to seven personality factors. They are divided into four factors for temperament and three for character. Temperamental traits include sensation seeking, harm avoidance, reward dependence and persistence and the character traits include self-directedness, cooperation and self-transcendence. These different personality dimensions have demonstrated adequate reliability-validity in the Spanish population (Gutiérrez-Zotes et al. 2004) with Cronbach's alphas between .77 and .84.

Alcohol Use Disorders Identification Test (AUDIT) (Saunders et al. 1993)

This test was developed as a simple screening method for excessive alcohol consumption. The AUDIT consists of 10 questions exploring consumption levels, symptoms of dependence, and alcohol-related consequences. Internal consistency has been found to be high, and rest-retest data have suggested high reliability (.86) and a sensitivity of around .90. Specificity in different settings and for different criteria averages .80 or more (Martínez 1999). The suggested cutoffs are 1–7 for low alcohol use, 8–15 for alcohol abuse, and 16 or higher for risk of alcohol dependence.

Other Socio-Demographic and Clinical Variables

Additional demographic, clinical, and social/family variables related to gambling were measured using a semi-structured, face-to-face clinical interview described elsewhere (Jiménez-Murcia et al. 2006, 2007). The gambling behavior variables covered included the number of previous treatment attempts, the type of problem gambling, the age of onset of gambling behavior and of gambling-related problems, the average monetary investment in a single gambling episode, the maximum amount bet in a single episode, and the total amount of accumulated debts. In addition, the interview explored some maintaining factors such as gambling to chase one's losses or to avoid negative emotional states, magical thinking and the illusion of control ritualistic behavior.

Procedure

Patients were assessed by trained and licensed psychologists and psychiatrists with more than 15 years of experience assessing and treating GD patients. Further information regarding gambling behavior was also gathered via a semi-structured face-to-face interview. Sociodemographic and additional clinical information was taken, and patients individually completed the questionnaires required for this study (requiring approximately two hours) before initiating outpatient treatment.

Statistical Analysis

Analyses were carried out and figures were created with Stata13 for Windows. Analysis of variance (ANOVA) adjusted for the covariates: patients' sex and age, and compared the means of clinical measures between patients who were split into sensitivity to reward and sensitivity to punishment normal, subclinical and clinical groups. Polynomial contrasts in ANOVA assessed the presence of linear and/or quadratic trends. Partial correlation coefficients, also adjusted for sex and age, measured the association between sensitivity to punishment and sensitivity to reward raw scores and clinical measures ($|R| > .30$ was considered high effect size). The Simes-Bonferroni method was used to control Type-I error due to multiple comparisons (Simes 1986). It is included in the Familywise error rate stepwise procedures, and offers a more powerful test than the classical Bonferroni correction.

Structural equation modeling (SEM) tested the mediation model between personality traits, sensitivity to reward and sensitivity to punishment levels and gambling level (SOGS-total score), through path analysis. SEM constitutes an extension of multiple regression modeling that can be used for both confirmatory and exploratory modeling, with the aim to estimate the magnitude and significance of hypothesized causal connections into a set of variables (von Oertzen 2010). Path analysis is used in this study as a case of SEM with exploratory aims, with the advantage (compared to classical regression models) to allow the inclusion of multiple relationships among a set of variables, including meditational associations. Participants' sex and age were included in the pathways as covariates. The maximum-likelihood estimation (MLE) method of parameter estimation was used and goodness-of-fit was evaluated using standard statistical measures (Bentler 1990): the root mean square error of approximation (RMSEA), Bentler's Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI), and the standardized root mean square residual (SRMR). Adequate model fit was considered non-significant by χ^2 tests and if the following criteria

were met: RMSEA <.08, TLI >.9, CFI >.9 and SRMR <.1. The global predictive capacity of the model was measured by the coefficient of determination (CD).

Results

Sensitivity to Reward and Sensitivity to Punishment Levels

Table S1 (see supplementary material) includes clinical variables of the study sample. Table 2 describes the prevalence of sensitivity to reward and sensitivity to punishment scores for the total sample, and for the stratum defined by sex and age. Statistical differences were found comparing men and women (a higher proportion of women had subclinical and clinical scores) and age groups (the higher the age, the higher the proportion of patients with subclinical and clinical scores).

Association Between Reward and Punishment Sensitivity and Clinical Measures

Table 3 contains the distribution and comparison of means (adjusted for sex and age) in clinical measures for the normal-subclinical-clinical sensitivity to reward and sensitivity to punishment groups. A positive linear trend was found in the sensitivity to punishment group with respect to gambling severity (measured with the DSM-5 total criteria and the SOGS-total score) and psychopathology symptoms (SCL-90-R scores); the higher the sensitivity to punishment score, the higher the gambling severity and psychopathology symptom levels. In terms of personality profiles, a positive linear trend was found between harm avoidance and self-transcendence, and sensitivity to punishment. A negative linear trend was found for reward dependence, self-directedness and cooperativeness, and sensitivity to punishment. No significant associations were found between reward and punishment sensitivity and alcohol consumption.

With respect to sensitivity to reward, the same linear trend was obtained, but quadratic trends were also significant for many other clinical measures, in the sense that differences between normal and subclinical/clinical groups were higher than differences between subclinical and clinical groups.

Table 4 includes the partial correlation coefficients, adjusted for sex and age, measuring the association between the sensitivity to reward and sensitivity to punishment raw scores and the clinical variables analyzed in the study. Sensitivity to punishment levels positively correlated with all SCL-90-R subscales, and with TCI-R harm avoidance scores. Sensitivity to punishment was also negatively associated with TCI-R self-directedness scores. Sensitivity to reward positively correlated with gambling levels (DSM-5 criteria and SOGS-total scores), SCL-90-R scores (except for somatization, phobic anxiety and PSDI) and TCI-R novelty seeking scores. Sensitivity to reward negatively correlated with TCI-R self-directedness and cooperativeness scores.

Mediational Model for Personality Traits, Reward and Punishment Sensitivity Levels and Gambling Levels

Table S2 (supplementary material) includes the correlation-matrix for the variables considered for the path analysis. Figure 1 shows the standardized coefficients of the SEM,

Table 2 Prevalence (%) of participants in clinical ranges for sensitivity to punishment and sensitivity to reward

	Total	Sex		$\chi^2(df = 2)$	p	Age group (years-old)			$\chi^2(df = 4)$	p
	N = 831	Female *n = 71*	Male *n = 760*			18–35 *n = 254*	36–55 *n = 421*	55–70 *n = 156*		
Punishment										
Normal	76.8	60.6	78.3	15.74	<.001	84.3	72.7	75.6	15.48	.004
Subclinical	19.1	28.2	18.3			13.8	21.4	21.8		
Clinical	4.1	11.3	3.4			2.0	5.9	2.6		
Reward										
Normal	75.5	45.1	78.3	51.68	<.001	83.9	70.5	75.0	15.55	.003
Subclinical	16.2	26.8	15.3			11.4	19.2	16.0		
Clinical	8.3	28.2	6.4			4.7	10.2	9.0		

Clinical ranges: normal = T-score under 60, subclinical = T-score between 60 and 70, clinical = T-score above 70

Table 3 ANOVA comparison of clinical variables based on sensitivity to punishment, sensitivity to reward, and clinical group

	Sensitivity to punishment					Sensitivity to reward				
	Means (adjusted)			*Polynomial trends (*p*)		Means (adjusted)			*Polynomial trends (*p*)	
	Normal $N = 638$	Subclin. $N = 159$	Clinical $N = 34$	Linear	Quadr.	Normal $N = 627$	Subclin. $N = 135$	Clinical $N = 69$	Linear	Quadr.
Maximum bets (euros)	1280.6	781.6	1404.9	.907	.834	1289.4	706.1	1235.8	.907	.532
Mean bets (euros)	155.3	95.0	96.4	.907	.845	156.5	88.1	108.6	.815	.728
Cumulate debts (euros)	13,719.9	6462.1	7276.7	.907	.845	13,746.7	7507.7	5731.2	.815	.847
Alcohol (AUDIT: Total)	4.19	4.16	5.33	.211	.325	4.20	4.00	5.00	.264	.297
SOGS: Total score	9.72	11.15	11.14	**.016**	.128	9.68	11.41	10.76	**.012**	**.002**
DSM-5: Total criteria	6.58	7.41	7.74	**.002**	.330	6.54	7.50	7.62	**.001**	.065
SCL-90: Somatization	.85	1.37	1.80	**<.001**	.656	.83	1.42	1.56	**<.001**	**.020**
SCL-90: Obsess./compulsive	1.01	1.69	2.12	**<.001**	.274	1.00	1.67	1.94	**<.001**	**.028**
SCL-90: Interp. sensitivity	.90	1.71	2.15	**<.001**	.116	.89	1.67	2.03	**<.001**	**.028**
SCL-90: Depressive	1.44	2.05	2.48	**<.001**	.424	1.42	2.06	2.30	**<.001**	**.044**
SCL-90: Anxiety	.91	1.61	1.87	**<.001**	.116	.90	1.62	1.77	**<.001**	**.010**
SCL-90: Hostility	.85	1.32	1.27	**.007**	.113	.85	1.33	1.27	**<.001**	**.014**
SCL-90: Phobic anxiety	.39	.95	1.55	**<.001**	.736	.39	.88	1.37	**<.001**	.977
SCL-90: Paranoid Ideation	.88	1.38	1.60	**<.001**	.227	.86	1.37	1.54	**<.001**	.058
SCL-90: Psychotic	.82	1.44	1.69	**<.001**	.116	.81	1.42	1.63	**<.001**	**.028**
SCL-90: GSI score	.97	1.58	1.94	**<.001**	.206	.95	1.58	1.80	**<.001**	**.020**
SCL-90: PST score	44.40	62.31	69.10	**<.001**	.116	44.13	61.82	66.38	**<.001**	**.014**
SCL-90: PSDI score	1.81	2.19	2.40	**<.001**	.335	1.80	2.21	2.30	**<.001**	**.028**
TCI-R: Novelty seeking	108.9	109.4	104.4	.081	.362	109.0	109.1	107.1	.325	.675
TCI-R: Harm avoidance	98.2	113.8	122.4	**<.001**	.362	97.9	113.7	118.8	**<.001**	**.007**
TCI-R: Reward dependence	99.9	97.2	94.8	**.050**	.960	100.0	97.3	95.7	**.030**	.768
TCI-R: Persistence	108.1	108.4	107.1	.808	.873	108.3	108.3	106.1	.457	.768

Table 3 continued

	Sensitivity to punishment					Sensitivity to reward				
	Means (adjusted)			*Polynomial trends (*p*)		Means (adjusted)			*Polynomial trends (*p*)	
	Normal $N = 638$	Subclin. $N = 159$	Clinical $N = 34$	Linear	Quadr.	Normal $N = 627$	Subclin. $N = 135$	Clinical $N = 69$	Linear	Quadr.
TCI-R: Self-directedness	132.4	118.0	111.8	**<.001**	.362	132.8	118.4	113.2	**<.001**	.121
TCI-R: Cooperativeness	133.5	127.3	126.8	**.049**	.362	133.6	126.9	127.9	**.023**	.121
TCI-R: Self-transcendence	61.7	65.5	69.6	**.008**	.960	61.8	64.9	67.7	**.006**	.931

* *p values* includes Bonferroni-Simes correction for multiple statistical comparisons. Results adjusted for sex and age

Bold significant contrast

Table 4 Association of sensitivity to reward and sensitivity to punishment levels with clinical variables (N = 831)

	Punishment	Reward
Maximum bets (euros)	−.03	−.01
Mean bets (euros)	−.04	−.01
Cumulate debts (euros)	.00	.07
Alcohol use-abuse (AUDIT: Total)	.06	.13
SOGS: Total score	.19	**.35**
DSM-5: Total criteria	.26	**.36**
SCL-90: Somatization	**.35**	.22
SCL-90: Obsess./compulsive	**.45**	**.30**
SCL-90: Interp. sensitivity	**.51**	**.30**
SCL-90: Depressive	**.43**	**.30**
SCL-90: Anxiety	**.44**	**.30**
SCL-90: Hostility	**.30**	**.30**
SCL-90: Phobic anxiety	**.43**	.20
SCL-90: Paranoid Ideation	**.36**	**.34**
SCL-90: Psychotic	**.43**	**.30**
SCL-90: GSI score	**.48**	**.31**
SCL-90: PST score	**.48**	**.33**
SCL-90: PSDI score	**.35**	.26
TCI-R: Novelty seeking	−.05	**.35**
TCI-R: Harm avoidance	**.60**	.04
TCI-R: Reward dependence	−.18	.03
TCI-R: Persistence	−.07	.27
TCI-R: Self-directedness	**−.47**	**−.42**
TCI-R: Cooperativeness	−.24	**−.33**
TCI-R: Self-Transcendence	.15	.28

Bold good effect size (|R| > .30). Partial correlation adjusted for sex and age covariates

adjusted for sex and age, testing the mediational pathways between personality traits, sensitivity to reward and sensitivity to punishment levels and gambling severity (DSM-5 criteria). This model obtained an adequate goodness-of-fit: RMSEA = .030, CFI = .997, TLI = .984 and SRMR = .019. The global predictive capacity was moderate (CD = .12).

Novelty seeking and harm avoidance were positively and directly associated with the total gambling level (the higher the TCI-R scores, the higher the SOGS-total score). Sensitivity to reward and sensitivity to punishment also positively correlated with gambling severity. The testing of the mediational role of sensitivity to reward and sensitivity to punishment in the relationship between personality and gambling level showed that: a) sensitivity to punishment levels mediated between harm avoidance and gambling severity (higher scores for this personality trait predicted higher sensitivity to punishment scores, and higher sensitivity to punishment levels correlated with higher gambling severity); b) sensitivity to punishment did not mediate between novelty seeking and DSM-5 criteria; and c) sensitivity to reward mediated between novelty seeking and gambling severity (higher scores in this personality trait were associated with higher sensitivity to reward scores, and higher sensitivity to reward predicted higher gambling severity); d) in this same line, sensitivity to reward mediated between harm avoidance and gambling severity.

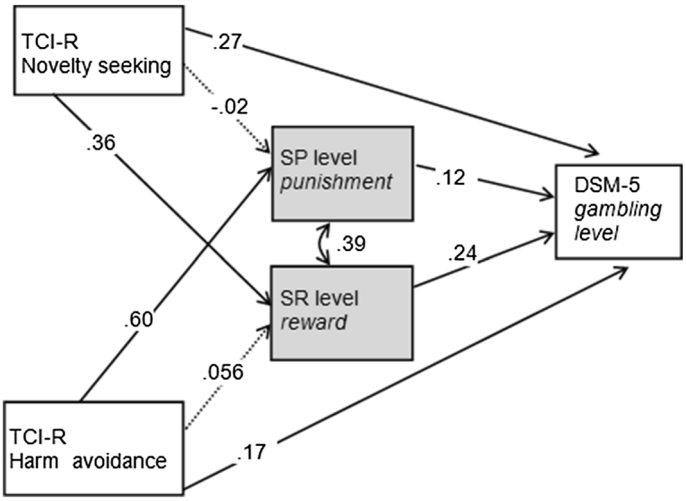

Fig. 1 Structural equation model. Standardized coefficients obtained from the mediational model for the TCI-R personality traits novelty seeking and harm avoidance, SPSRQ raw scores and DSM-5 gambling criteria (SEM results adjusted for sex and age covariates). *Continuous line*: significant coefficient. *Dashed line*: non-significant coefficient (N = 831)

Discussion

The present study assessed the effects of punishment and reward sensitivity, personality traits and sociodemographic characteristics on gambling severity levels and overall psychopathology. Keeping with our first hypothesis, heightened punishment and reward sensitivity were both positively associated with gambling severity. As expected, we also confirmed associations between novelty seeking and reward sensitivity, and between harm avoidance and punishment sensitivity. Likewise, our Structural Equation Model (SEM) revealed that punishment and reward sensitivity have a mediating role between these personality traits and gambling severity.

Reward sensitivity was positively associated with gambling severity and this result is consistent with other findings (Balodis et al. 2014; Gaher et al. 2015), as well as with results from an array of other behavioral and substance addictions (Dissabandara et al. 2014; Dong et al. 2013; Wardell et al. 2011). Within the context of gambling, patients with high reward sensitivity may be especially drawn to the accumulation of anticipation while betting, regardless of whether the economical or social outcomes are positive. This dysfunctional response to reward in gamblers has recently been given neurobiological support by a study using the blockade of D2-receptors with sulpiride, which found impaired reward versus punishment learning in controls, but not in gamblers (Janssen et al. 2015). Relatedly, high levels of reward sensitivity were strongly associated with overall psychopathology. The cross-sectional nature of this study does not allow us to determine whether high levels of reward sensitivity are a risk factor for psychological symptomatology or alternatively, if patients' reported psychopathology is a consequence of their gambling behavior (Jauregui et al. 2016).

High punishment sensitivity was also predictive of greater gambling severity and psychological distress and is indicative of the existence of both positive and negative

reinforcement motives in GD. Individuals with high levels of punishment sensitivity report greater irritability and alterations in accurately perceiving events in everyday life, thus possibly subserving gambling motivations (Hundt et al. 2013; Wardell et al. 2015). Findings related to punishment sensitivity have so far been inconsistent, with some studies suggesting that high levels of punishment sensitivity might lead to the use of gambling as a form of experience escapism and avoidance motivation (MacLaren et al. 2015), whereas others have found that moderate levels of punishment sensitivity can have a protective effect, which reduces the incitation of problem behaviors (Jonker et al. 2014). Our results showing that increased severity is associated with both high sensitivity to punishment and high sensitivity to reward is consistent with other research showing wide-ranging symptomatology among both clinical and non-clinical groups with high levels of these traits (Hundt et al. 2013; Loxton and Dawe 2001). Given these findings, clarification for the heterogeneity of motivations supporting gambling disorder is needed.

Significant differences in punishment and reward sensitivity levels were found between sexes with women being more likely to exhibit both clinical punishment and reward sensitivity levels. Previous studies suggest that the personality profile of women with GD is characterized by introspective features and inhibition which leads to the use of gambling as a means to regulate negative affective states (Granero et al. 2009; Smith et al. 2015). Consequently, the presence of greater punishment sensitivity scores in women with GD, which implies the enactment of evasive behavior when facing threateningly perceived stimuli, is in line with this notion. Likewise, higher reward sensitivity scores, viz. the search for immediate reward, in women with GD could be indicative of a specific subgroup of women with higher impulsivity (Loxton et al. 2008). In this sense, numerous studies have demonstrated that GD is a heterogonous disorder in which different subtypes can be identified depending upon the extent to which a series of biopsychosocial risk factors intervene (Alvarez-Moya et al. 2010; Blaszczynski and Nower 2002; Jiménez-Murcia et al. 2013; Ledgerwood and Petry 2010). From this explicative model, a endophenotype of women presenting high levels of comorbidity and emotional distress has been identified (Suomi et al. 2014). This endophenotype is characterized by dysfunctional personality traits (impulsivity, thoughtlessness, pessimism, apprehension and poor social integration) and elevated GD severity (Granero et al. 2014).

As described in other research, our results found that higher punishment and reward sensitivity scores were linked to older age (Subramaniam et al. 2015; Tse et al. 2012). Age is understood to be a strong moderator of both the course and the evolution of GD (Granero et al. 2014). Though there is still a lack of consensus among GD clinicians and researchers, some have posited that older individuals with GD present severity levels similar to their younger counterparts (Ariyabuddhiphongs 2011). Nonetheless, other researchers have found GD to be more severe in younger samples (Fattore et al. 2014; Granero et al. 2014; Jiménez-Murcia et al. 2010; Kessler et al. 2008), suggesting that being younger than 29 years of age could be a risk factor for developing GD (Johansson et al. 2009). This discrepancy between results could be explained by the age of GD onset, which has been shown to be relevant in its prognosis (Jiménez-Murcia et al. 2015). As such, an older patient with an earlier onset of gambling problems is more likely to present higher GD severity, with this protracted behavior leading to greater disturbances in the patient's personal life, as well as greater comorbidity (Burge et al. 2004; Tse et al. 2013). A clear distinction can be found in the case of older individuals who begin gambling later in life as a result of age-specific stressors (e.g. retirement, the loss of loved ones). These individuals tend to use gambling as a means to escape negative emotions but do not display high

impulsivity levels or novelty seeking to the same extent as younger gamblers (Clarke 2008).

There is a paucity of studies linking GD with punishment and reward sensitivity, and personality traits such as novelty seeking and harm avoidance. Even so, it has been established in other populations that harm avoidance is predictive of BIS whereas novelty seeking is predictive of BAS (Mardaga and Hansenne 2007). Correspondingly, our SEM found both a direct and indirect association between higher novelty seeking scores and GD severity. Whereas some studies have found no correlation between punishment sensitivity and GD severity (O'Connor et al. 2009), our results showed that both harm avoidance and punishment sensitivity were linked to higher gambling levels. Nonetheless, other studies have postulated that a certain degree of sensitivity to punishment could have a protective role in the development of addictive behaviors, such as alcohol use (Jonker et al. 2014). Interpretation of this finding should take into consideration the fact that distinct GD profiles have previously been described, and that these could be partly explained by our SEM model. One profile could be described as being more novelty seeking, more impulsive, and as using gambling for the sake of immediate reward, whereas the other profile uses gambling as a coping strategy and presents higher harm avoidance traits (Moragas et al. 2015).

While this study has its strengths, there are some caveats that should be highlighted. Despite the large size of the study sample, women were still less represented than men (as is usual in clinical GD samples). It is possible that some gender differences may not have been detected due to a lack of statistical power. In addition, all data used in this study were collected from individuals who were voluntarily attending GD treatment. For this reason, the generalizability of our results to community populations should be tested in future studies. Also, no significant differences were found between patients with sub-clinical and clinical levels of RPS, suggesting that categorically dividing patients into subgroups is unnecessary and that it could be more beneficial to solely examine RPS from a dimensional standpoint. Finally, given that previous literature has described the existence of unique GD phenotypes, associations of overall punishment and reward sensitivity scores with clinical variables may be unable to entirely describe these differences. Future research should investigate other possible mechanisms contributing to these relationships.

In conclusion, the SPSRQ has the potential to become a helpful tool for better understanding the motivational phenotypes of gambling disorder and for untangling implicated psychopathological and psychosocial factors. Future research should examine whether this instrument can be applied for the early detection of gambling problems as well as for distinguishing different GD patient clusters while taking personality, psychopathological and sociodemographic variables into account. The creation of such profiles could potentially strengthen preventative interventions and aid in personalizing treatment interventions.

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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