TESIS DOCTORAL

REGULACIÓN AFECTIVA Y JUEGO DE AZAR: INVESTIGACIÓN BÁSICA Y APLICACIONES CLÍNICAS

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AFFECTIVE REGULATION AND GAMBLING: BASIC RESEARCH AND CLINICAL APPLICATIONS

Juan Francisco Navas

Directores:

Dr. José Cesar Perales

Dr. Antonio Maldonado

Departamento de Psicología Experimental

Centro de Investigación Mente, Cerebro y Comportamiento (CIMCYC)

Universidad de Granada.

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Publicaciones de la tesis

Navas, J. F., Billieux, J., Perandrés-Gómez, A., López-Torrecillas, F., Cándido, A., & Perales, J. C. (2017). Impulsivity traits and gambling cognitions associated with gambling preferences and clinical status. *International Gambling Studies, 17*(1), 102–124.

Del Prete, F., Steward, T., Navas, J. F., Fernández-Aranda, F., Jiménez-Murcia, S., Oei, T. P., & Perales, J. C. (2017). The role of affect-driven impulsivity in gambling cognitions: A convenience-sample study with a Spanish version of the Gambling-Related Cognitions Scale. *Journal of Behavioral Addictions, 6*(1), 51–63.

Navas, J. F., Verdejo-García, A., López-Gómez, M., Maldonado, A., & Perales, J. C. (2016). Gambling with rose-tinted glasses on: Use of emotion-regulation strategies correlates with dysfunctional cognitions in gambling disorder patients. *Journal of Behavioral Addictions, 5*(2), 271–281.

Navas, J. F., Contreras-Rodríguez, O., Verdejo-Román, J., Perandrés-Gómez, A., Albein-Urios, N., Verdejo-García, A., & Perales, J. C. (2017). Trait and neurobiological underpinnings of negative emotion regulation in gambling disorder. *Addiction, 112*(6), 1086–1094.

Note: Los capítulos que conforman la presente tesis son artículos que se han publicado en revistas científicas. Su contenido ha sido adaptado para la presente tesis y, por lo tanto, no son totalmente coincidentes con la versión publicada.

RESUMEN/SUMMARY

Resumen

El trastorno por juego de azar (TJA) se incluye dentro de la categoría diagnóstica de *Trastornos adictivos y relacionados con sustancias*, en la quinta versión del Manual Diagnóstico y Estadístico de Enfermedades Mentales (DSM5, por sus siglas en inglés; APA, 2013). La prevalencia mundial estimada del TJA oscila entre el 0.1 y el 3.4 por ciento (Calado y Griffiths, 2016), mientras que en España se sitúa en torno al 0.9 (Dirección General de Ordenación del Juego [DGOJ], 2015).

El objetivo general de la presente tesis es examinar algunos de los procesos de generación y regulación afectiva más relevantes en el juego de azar, que pueden explicar la transición hacia la adicción, su desarrollo y mantenimiento (Limbrick-Oldfield, van Holst, y Clark, 2013; van Holst, van den Brink, Veltman, y Goudriaan, 2010), así como los altos niveles de heterogeneidad que se han observado entre poblaciones de jugadores (Blaszczynski y Nower, 2002). El estudio de estos procesos puede ser esencial para conseguir una mayor individualización de las intervenciones clínicas.

La presente tesis se estructura de la siguiente manera. En la sección de *Introducción* se define qué es el afecto y la regulación afectiva y se expone cómo los procesos de generación y regulación afectiva (incluyendo la sensibilidad a la recompensa y al castigo, diversas facetas de impulsividad y la regulación emocional) podrían asociarse a (1) diferencias individuales en preferencia por modalidades de juego, (2) manifestaciones cognitivas del juego, esto es, distorsiones cognitivas asociadas al funcionamiento del azar y a la sobrestimación de la capacidad personal para controlar y predecir los resultados del juego y (3) la severidad del juego y sus consecuencias clínicas.

En la segunda sección (*Justificación, objetivos e hipótesis*) se detallan los diferentes objetivos e hipótesis relacionados con el estudio de las asociaciones mencionadas, que se abordan en los cinco estudios que se incluyen en los cuatro capítulos de la sección de *Memoria de estudios*.

El objetivo del estudio descrito en el Capítulo 1 fue disociar la influencia de la severidad del TJA y de las preferencias por determinadas modalidades de juego sobre la sensibilidad a la recompensa y al castigo, la impulsividad rasgo, la impulsividad en la elección (i.e. tendencia a preferir recompensas inmediatas pequeñas en vez de recompensas demoradas en el tiempo de mayor magnitud), así como sobre las

distorsiones cognitivas relacionadas con el juego. Los jugadores con TJA en comparación con jugadores regulares (i.e. jugadores que no cumplen los criterios para el diagnóstico de TJA) mostraron mayor sensibilidad a la recompensa, impulsividad en la elección e intensidad de distorsiones cognitivas relacionadas con el juego. Asimismo, se hallaron diferencias a nivel de impulsividad rasgo. Por otro lado, los jugadores que preferían modalidades de juego Tipo I (i.e. cartas, otros juegos de casino [incluyendo ruleta], y apuestas de habilidad) mostraron mayor sensibilidad a la recompensa y mayor fuerza de las distorsiones cognitivas relacionadas con el juego que jugadores que preferían modalidades de juego Tipo II (i.e. máquinas tragaperras, loterías y bingo). Éstos a su vez manifestaron mayor impulsividad en la elección que los jugadores Tipo I.

El objetivo del estudio descrito en el Capítulo 2 fue examinar las asociaciones de las distorsiones cognitivas de juego con la impulsividad rasgo en una muestra de jugadores con TJA y jugadores regulares. Los resultados mostraron cómo la intensidad de estas distorsiones estaba asociada con la severidad del juego y con las dimensiones afectivas del modelo UPPS-P (i.e. búsqueda de sensaciones y urgencia positiva y negativa), pero no con sus dimensiones cognitivas (i.e. falta de perseverancia y falta de premeditación).

El principal objetivo del estudio del Capítulo 3 fue examinar el conjunto de asociaciones entre las distorsiones cognitivas relacionadas con el juego, estrategias de regulación emocional y la severidad del juego en una muestra de jugadores con TJA comparados con controles sanos. Los resultados mostraron que estrategias que son habitualmente reconocidas como promotoras de bienestar emocional estaban vinculadas a la fuerza global de diversas distorsiones cognitivas relacionadas con los resultados del juego y a la severidad del trastorno.

En el Capítulo 4 se describen dos estudios complementarios en los que se examinó, por un lado, las diferencias entre pacientes con TJA y controles sanos en el uso disposicional de estrategias de regulación emocional y en la activación cerebral durante la regulación de emociones negativas en una tarea de laboratorio de *reappraisal* (i.e. cambio deliberado del significado de un evento emocional) bajo resonancia magnética funcional, y, por el otro, su asociación con la urgencia negativa (i.e. la pérdida de control bajo estados emocionales intensos de corte negativo) del modelo de impulsividad UPPS-P. Los resultados indicaron que los pacientes con TJA tenían una tendencia a usar más frecuentemente que los controles la supresión emocional (i.e. la inhibición del componente expresivo de una emoción) y que esta estrategia estaba

asociada a una mayor urgencia negativa en el grupo clínico (pero no en el grupo de controles sanos). Asimismo, los pacientes con TJA mostraron una mayor activación del cortex premotor y prefrontal medio izquierdos mientras regulaban sus emociones en la tarea de *reappraisal*. Además, la urgencia negativa estaba asociada a una mayor activación del cortex prefrontal medio izquierdo solo en el grupo de jugadores con TJA.

En la cuarta sección correspondiente a la *Discusión general, conclusiones y perspectivas futuras* se ahonda en estas cuestiones y se proponen además implicaciones clínicas y potenciales líneas de investigación futuras que se derivan de este trabajo. Adicionalmente, se incluye un subepígrafe en el apartado de conclusiones en el que se presenta brevemente un modelo teórico, *The Gambling Space Model* (GSM; Navas, Billieux, Verdejo-García, y Perales, 2018), que hemos propuesto recientemente y en el que se integran de manera coherente los diferentes resultados obtenidos en este trabajo.

En dicho modelo se contempla la existencia de cuatro dimensiones que desempeñan un papel central en la vulnerabilidad y desarrollo del TJA, siendo además todas ellas fuentes de variabilidad entre poblaciones de jugadores. Las dos primeras se refieren a *la sensibilidad a las propiedades apetitivas* y *a los componentes de reforzamiento negativo del juego*, los cuales están parcialmente relacionados con la sensibilidad a la recompensa y al castigo, y podrían explicar una alta participación en actividades de juego por sus motivos puramente recompensantes y/o como un modo de mejorar el estado afectivo. Además, especialmente la primera de ellas, al interactuar con las propiedades intrínsecas de los juegos de azar, podría moldear las preferencias individuales por determinados modalidades.

La tercera dimensión es la *desregulación emocional generalizada*, que hace referencia al déficit en el funcionamiento de mecanismos implícitos (o *model-free*) de regulación emocional, relacionados con estructuras prefrontales ventrales (Etkin, Büchel, y Gross, 2015), y que se reflejarían en una elevada urgencia negativa (Navas et al., 2018). El funcionamiento alterado de estos mecanismos podría implicar la necesidad de implementar control por medio de mecanismos de regulación emocional explícita, relacionados con estructuras prefrontales dorsales (Etkin et al., 2015). Teniendo en cuenta además que la urgencia negativa puede ser un sello distintivo de psicopatología externalizante (Johnson, Tharp, Peckham, Carver, y Haase, 2017), se sugiere que ésta puede ser un marcador de la complicación del TJA, y, por tanto, un factor de especial relevancia clínica.

La cuarta dimensión refleja un mecanismo de *elaboración cognitiva motivada y de autoengaño*, que hace referencia al uso motivado de estrategias de regulación emocional –regulación emocional explícita o *model-based*– en combinación con distorsiones cognitivas relacionadas con el juego. Esta dimensión podría representar un mecanismo protector del ego con una base emocional que podría contribuir al mantenimiento del juego a través de la reducción de las consecuencias negativas del mismo y del incremento del valor de sus propiedades apetitivas. Este mecanismo podría ser especialmente relevante en jugadores con una preferencia por juegos de casino, cartas y de apuestas de habilidad (juegos Tipo I), que se caracterizarían entre otras cuestiones por una elevada confianza personal en su maestría para ganar en el juego (Myrseth, Brunborg, y Eidem, 2010).

Finalmente, la quinta sección se reserva para la mención de la tesis como doctorado internacional (*International doctorate*), y consiste en una resumen ampliado de la tesis en inglés.

Summary

In 2013, the American Psychiatric Association included gambling disorder in the category of *substance-related and addictive disorders*, in the Diagnostic and Statistical Manual of Mental Disorders (DSM5; APA, 2013). Gambling disorder is currently the only *non-substance-related addictive disorder* recognized as such. The worldwide lifetime prevalence of gambling disorder hovers around 0.1 and 3.4% (Calado & Griffiths, 2016); while in Spain, its estimated lifetime prevalence is 0.9% (Dirección General de Ordenación del Juego [DGOJ], 2015).

The general aim of the present thesis is to examine affect generation and regulation processes relevant to understand gambling behavior and its transition towards addiction (Limbrick-Oldfield, van Holst, & Clark, 2013; van Holst, van den Brink, Veltman, & Goudriaan, 2010), as well as the high level of individual heterogeneity among gamblers (Blaszczynski & Nower, 2002). Advances in this area are regarded here as necessary steps to tailor clinical interventions.

This thesis is structured as follows. In the *Introduction* section, we define affect and affect regulation and we expose how processes of generation and regulation of affective states (including reward and punishment sensitivity, affect-driven impulsivity facets, and emotion regulation) are related to (1) individual differences in gambling preference patterns, (2) cognitive manifestations of gambling, including cognitive distortions involving misattribution of gambling outcomes and overestimation of personal control or predictive ability in gambling settings, and (3) severity of gambling and its clinical consequences.

In the second section (*Rationale, aims and hypothesis*) we detail the different aims and hypothesis related to the associations mentioned, as addressed in the five studies comprised by the four chapters of the *Studies* section.

In the study described in Chapter 1, we examined the potential associations of sensitivity to reward and punishment, impulsive choice (i.e. the tendency to prefer immediate small rewards over of delayed but larger ones), impulsivity trait (i.e. the dispositional tendency to act rashly) and gambling-related cognitive distortions, with gambling preferences and clinical status, in a sample of regular non-problem and disordered gamblers. The aim was to discriminate which of these processes are related to individual preferences for certain types of games, to the severity of gambling, or to both. Results showed, on the one hand, that disordered gamblers in comparison to

regular ones present higher reward sensitivity, negative and positive urgency, impulsive choice, and intensity of gambling-related cognitive distortions, but lower lack of perseverance. On the other hand, Type I gamblers (preferring card and casino games [including roulette], and skill-based bets) compared to Type II (preferring slot machines, lotteries and bingo) showed higher reward sensitivity and gambling-related cognitive distortions. Besides, Type II gamblers showed higher impulsive choice (i.e. less tolerance to delayed rewards) than Type I gamblers.

The aim of the study described in Chapter 2 was to examine associations between gambling-related cognitive distortions and impulsivity traits in a sample of disordered gamblers and regular ones. Results showed that the intensity of these distortions was associated with the severity of gambling and the affect-driven traits of the UPPS-P model (i.e. sensation seeking, positive and negative urgency) but not with its cognitive traits (i.e. lack of perseverance and lack of premeditation).

The study of Chapter 3 was aimed at examining the set of associations between gambling-related cognitive distortions and emotion regulation strategies and gambling severity in a sample of disordered gamblers. Results showed that strategies that are customarily regarded as wellbeing promoting were associated with the global strength of gambling-related cognitive distortions and with severity of gambling disorder.

In Chapter 4 we describe two complementary studies aimed at examining, on the one hand, differences between disordered gamblers and healthy controls in the dispositional use of emotion regulation strategies and in brain activity during regulation of negative emotions in a reappraisal lab-task (i.e. deliberated change of the meaning of an emotion) under functional magnetic resonance; and, on the other hand, their association with negative urgency (i.e. the tendency to loss control under the influence of intense negative emotional states) from the UPPS-P model. Results revealed that disordered gamblers in comparison to healthy controls show a greater proneness to use emotional suppression (i.e. the inhibition of the expressive component of an emotion) and higher activation of left premotor and middle frontal cortices while regulating negative emotions. Additionally, negative urgency was linked to the tendency to use emotional suppression and left middle frontal cortex activation during cognitive reappraisal, exclusively in disordered gamblers.

In the fourth section (*General discussion, conclusions and future perspectives*) we discuss in depth the results from the studies in thesis, and propose potential future lines of research derived from this work. In order to wrap the main results up, and to

provide a general and coherent view of their theoretical relevance, we include an epigraph in which we briefly present a theoretical model –*The Gambling Space Model* (GSM; Navas, Billieux, Verdejo-García, & Perales, 2018)– that we have recently proposed, partially as results of the evidence from the studies presented in this thesis.

In the GSM four affective dimensions play different roles in shaping gambling disorder vulnerability, development, and individual variability in gamblers' populations. The two first dimensions refers to *sensitivity to appetitive properties and negative reinforcement components of gambling*, which are partially related to reward and punishment sensitivity, and may explain a high enrollment in gambling activities driven by positive or coping motives, respectively. Both dimensions, but especially the former, could interact with gambling features in shaping individual gambling preferences.

The third dimension is *generalized emotion dysregulation*, which refers to the malfunctioning of implicit or *model-free* emotion regulation mechanisms related to ventral prefrontal regions (Etkin, Büchel, & Gross, 2015), and is reflected by heightened negative urgency (Navas, Billieux, Verdejo-García, & Perales, 2018). Indirectly, deficits in this mechanism involve the necessity to implement control by means of explicit emotion regulation mechanism, related to dorsal prefrontal structures (Etkin et al., 2015). Given that negative urgency is a hallmark of externalizing psychopathology, the possibility exists that this dimension would be a marker of gambling disorder complication, and, thereby a factor with special clinical relevance.

The fourth dimension represents a mechanism of *cognitive elaboration and self-deception*, which refers to the motivated use of emotion regulation strategies –intentional or *model-based* emotion regulation– in combination with gambling-related cognitive distortions. This mechanism seems to play and ego-protective function, and may contribute to the maintenance of gambling by curbing the negative consequences of gambling and/or enhancing its appetitive properties. This mechanism could be especially distinctive of gamblers preferring card and casino games, and skill-based bets (Type I gamblers), who are characterized by overconfidence and an increased sense of mastery at gambling (Myrseth, Brunborg, & Eidem, 2010).

Finally, the fifth section (*International doctorate*) is reserved for meet the requirements for obtaining the international doctorate mention and consists of an extended summary of the present thesis.

I. INTRODUCCIÓN

Índice de la introducción

Un puñado de monedas está en juego… Giran las ruletas, los rieles, los dados... Los galgos apuran sus fuerzas… El crupier da la vuelta al "river". Los jugadores contenemos la respiración, algunos rezan, otros ríen… ninguno gana. ¿Dónde perdimos la emoción, la diversión, nuestro dinero, la vida? Persiguiendo las luces de neón, el as de picas… la última jugada…, la maestra.

Basado en el testimonio de un jugador

Esta tesis analiza el complejo mundo del afecto en el universo del juego de azar.

1. El trastorno por juego de azar: conceptualización actual

En 2013 la Asociación Americana de Psiquiatría incluyó el trastorno por juego de azar (TJA) dentro de la categoría diagnóstica de *Trastornos adictivos y relacionados con sustancias*, en la quinta versión del Manual Diagnóstico y Estadístico de Enfermedades Mentales (DSM5, por sus siglas en inglés¸ APA, 2013). El TJA es el único trastorno adictivo no relacionado con sustancias que se reconoce actualmente como tal. Esta transferencia de la categoría en la que estaba recogido anteriormente (*Trastornos del control de los impulsos no clasificados en otros apartados*) bajo el nombre de juego patológico, implica algo más que un mero cambio de nombre (DSM-III, IV and IV-TR; APA, 1980, 1994, 2000). Supone el reconocimiento de que tiene importantes puntos en común con los trastornos adictivos relacionados con sustancias. Este cambio se basó en un amplio conjunto de resultados provenientes de los campos de la epidemiología, la neurobiología, y la psicología clínica y experimental, entre otros (Potenza, 2013), que demostraban sus similitudes en factores de vulnerabilidad, anomalías en el funcionamiento cerebral, expresiones conductuales y eficacia de ciertos tipos de tratamientos clínicos (e.g. Goudriaan, Oosterlaan, de Beurs, y van den Brink, 2004; Petry, 2006; Leeman y Potenza, 2012).

La visión del DSM5 de los trastornos adictivos implica también cambios importantes en su conceptualización. En versiones previas de este manual, los diagnósticos eran dicotómicos, es decir, en función del cumplimiento de un número determinado de criterios, una persona podía recibir un diagnóstico de abuso o dependencia. Actualmente, los diagnósticos se realizan en tres niveles de severidad. Así, el cumplimiento de entre cuatro y nueve criterios supondría la

existencia de un trastorno cuya severidad podría ser media (4-5 criterios), moderada (6-7) o severa (8-9). A pesar de que diversos criterios diagnósticos para el TJA son comunes a los de los trastornos relacionados con sustancias, como la tolerancia, el síndrome de abstinencia, la pérdida de control sobre la conducta y la interferencia en el funcionamiento cotidiano, también hay varios criterios que son específicos. La experiencia de *craving* se incluye en los trastornos relacionados con sustancias pero no en el TJA, mientras que jugar bajo el influjo de afectos negativos intensos (distrés) es un criterio diagnóstico del TJA sin correspondencia en los primeros.

La prevalencia mundial estimada del TJA oscila entre el 0.1 y el 3.4 por ciento, dependiendo del método y los criterios utilizados. Se estima además que en torno al 4 por ciento de la población presenta un juego de azar problemático (Calado y Griffiths, 2016); es decir, aquel que produce consecuencias negativas personales y/o para terceras partes, las redes sociales del jugador o para la comunidad, pero que no es lo suficientemente grave como para ser diagnosticado como TJA ([i.e. de 1 a 3 de los criterios del DSM5] Ferris y Wynne, 2001; Griffiths, 2004). En España la prevalencia estimada a lo largo de la vida del TJA y de juego problemático es del 0.9 y del 4.4 por ciento, respectivamente (Dirección General de Ordenación del Juego [DGOJ], 2015). No obstante, diversos informes actuales sugieren que estos números podrían estar actualmente aumentando (Conolly, Fuller, Jones, Maplethorpe, Sondaal, y Wardle, 2017; Calado, Alexandre y Griffiths, 2017; Nowak y Aloe, 2013).

2. Justificación de la presente tesis

Uno de los desafíos para políticos, investigadores, clínicos y otros agentes sociales involucrados en el tratamiento del TJA y su prevención es identificar y describir procesos centrales en el desarrollo de la adicción al juego de azar, para así ayudar a los individuos potencialmente vulnerables a mantener el control sobre la conducta de juego. Teniendo en cuenta que los tratamientos basados en evidencia son solo efectivos en un porcentaje moderado de jugadores de azar (Echeburúa, Salaberría y Cruz-Sáez, 2014; Rash y Petry, 2014), un desafío añadido es identificar perfiles de jugadores resistentes al tratamiento. Esto incluiría también a algunos grupos de jugadores que están actualmente creciendo en número (Gainsbury, Russell, Hing, Wood, Lubman, y Blaszczynski, 2015; Griffiths, Wardle, Orford, Sproston, y Erens, 2009; MacKay, Bard, Bowling, y Hodgins, 2014) o que se espera que aumenten como resultado de un

mercado de juego rápidamente cambiante. La presente tesis se centra en el estudio de procesos afectivos que pueden ser útiles para entender el TJA, y para explicar los altos niveles de heterogeneidad que se han observado entre poblaciones jugadores. De esta manera, se espera contribuir a una mayor individualización de las intervenciones clínicas.

El resto de esta introducción está dirigido, en primer lugar, a definir y perfilar el concepto de afecto y su regulación y a describir algunos de los términos afectivos que son de especial relevancia en el campo de la adicción. Este esfuerzo conceptual es necesario para evitar en la medida de lo posible algunos de los malentendidos terminológicos que son comunes en la investigación afectiva (Scherer, 2005; Thayer, Åhs, Fredrikson, Sollers, Wager, 2012). En segundo lugar, se exponen brevemente los aspectos principales de la investigación en juego de azar que inspiran la presente tesis: (a) el grueso de estudios que muestran cómo anomalías en el procesamiento de las recompensas y castigos y el autocontrol son comunes tanto al TJA como a los trastornos relacionados con sustancias (e.g. Goudriaan, Yücel y van Holst, 2014); (b) la propuesta de una teoría de adicción centrada en el afecto que lo sitúa como un eje central de la adicción (Cheetham, Allen, Yücel, y Lubman, 2010); y (c) el hecho de que el TJA no es un trastorno unitario y de que tal variabilidad dentro de las poblaciones de jugadores pueda estar relacionada con procesos afectivos (e.g. Blaszczynski y Nower, 2002).

3. Conceptualización de afecto, regulación afectiva y términos relacionados

La falta de una definición concisa y clara de conceptos afectivos claves es una fuente de controversia y desentendimiento en la investigación afectiva (Scherer, 2005). Así, es necesario definir y ubicar adecuadamente qué es el afecto, la regulación afectiva y una serie de términos que tienen importancia central en los trastornos adictivos. Con este objetivo en mente y teniendo en cuenta su influencia, tomaremos el trabajo de Gross y colaboradores como marco de referencia (e.g. Gross y John, 2003; Gross, 1998). Gross (2014) –siguiendo la visión clásica de Scherer (1984)– propuso la utilización del término afecto como una categoría de alto nivel para referirse a estados que implican en primera instancia una discriminación gruesa de valencia; es decir, una valoración en términos de placer y displacer. En niveles inferiores se ubican diversos estados afectivos entre los que se encuentran las *emociones* y los *impulsos* (Gross y Thompsom, 2007).

Grosso modo, las *emociones* pueden definirse como estados que engloban un grupo de respuestas psicofisiológicas relativamente rápidas que son elicitadas por sucesos biológicamente relevantes para los individuos (Scherer, 2005). Adicionalmente, las emociones preparan a los organismos para acciones más específicas (Gross, 2014; Scherer, 2005). Esta característica central de las emociones las vincula al campo de la motivación, y, por tanto, al término *impulso*, tal y como se explica en mayor detalle a continuación. La motivación puede definirse como una tendencia afectiva que orienta al individuo a aproximarse o evitar estímulos positivos o negativos (Elliot, 2006). Esta visión molar de la motivación en un continuo de aproximación-evitación está enraizada en la idea clásica de que los organismos se guían por *impulsos* (i.e. energía producida por necesidades fisiológicas; Woodworth, 1918) para acercarse al placer y huir del dolor (Dollard y Miller, 1950; Feltman y Elliot, 2012; James, 1890). Ésta es además una de las bases conceptuales para algunas teorías de personalidad. Por ejemplo, Gray (1981) plantea la existencia de dos sistemas básicos de personalidad, el Sistema de Activación Conductual (BAS, por sus siglas en inglés) que controla las tendencias de aproximación a fuentes de reforzamiento, y el Sistema de Inhibición Conductual (BIS, por sus siglas en inglés) que es responsable de detectar conflictos afectivos y regular la conducta para evitar estímulos aversivos (Gray, 1981, 1995; Corr, 2016; Torrubia, Ávila, Moltó, y Caseras, 2001).

Por otro lado, las teorías modernas del aprendizaje asumen que existen dos clases de fuerzas motivacionales que controlan las conductas; aquellas basadas en la representación cognitiva de un objetivo particular (*control dirigido a metas* o *model-based* en términos computacionales) y aquellas controladas por los estímulos (*control dirigido por estímulos* o *model-free*) (Balleine y Dickinson, 1998; O'Doherty, Cockburn, y Pauli, 2017). Esta visión es útil para entender dos procesos motivaciones centrales para la adicción. El *control dirigido a metas* se relaciona con el componente hedónico de la motivación (*liking*) que guía a priori explícitamente la conducta, es decir, los individuos son guiados por la representación cognitiva del placer o alivio asociados a la experiencia o evitación de recompensas y castigos, respectivamente. El *control dirigido por estímulos* se relaciona con el componente de anticipación de tales estados afectivos positivos (*wanting*). En este sentido, aquellos estímulos que han sido previamente asociados con placer o evitación del dolor adquieren poder motivacional (*saliencia de incentivo)* por medio de mecanismos de aprendizaje asociativo, y

pueden así elicitar por sí mismos conductas de búsqueda-evitación (Berridge, 2012, Robinson y Berridge, 2001).

Más allá de estos procesos de generación afectiva, cabe señalar qué se entiende por regulación afectiva. Ésta hace referencia a los procesos involucrados en influir sobre la experiencia de estados afectivos, incluyendo, por tanto, la regulación emocional y el control de impulsos (Gross, 2014). La regulación emocional se refiere específicamente a aquellos procesos dirigidos a modular la experiencia y expresión de emociones, ya sea iniciarla, incrementarla, reducirla o ponerle fin (Gross, 2014; Gross y John, 2003). Se han utilizado diversos términos dicotómicos para describir la naturaleza de los procesos de regulación emocional, como, por ejemplo, *intencional*/*explícita/controlada* en contraposición a *incidental*/*implícita/automática*. Estos términos denotan la necesidad o no de cierto grado de monitorización consciente para regular emociones, implicando de esta manera más o menos nivel de conciencia (Gross, 2008; 2014). Además, mientras el primero representa una regulación emocional guiada por las metas del individuo, la segunda se refiere a aquella dirigida por estímulos (Gross, 2008; 2014). Etkin, Büchel y Gross (2015) tendieron un puente hacia un marco de modelación computacional para entender los procesos psicológicos y neurobiológicos subyacentes a la regulación emocional. Así, propusieron que estas dos vías para regular emociones pueden ser entendidas en términos de control *model-based* y *model-free*, respectivamente. Mientras el primero supone la implementación de un modelo interno de las metas personales para guiar la regulación –como ocurre en el caso del *reappraisal cognitivo* (i.e. el cambio deliberado del significado de un estado emocional)– y recluta regiones fronto-parietales; el segundo funciona basado en señales de error de predicción –como ocurre en la extinción del miedo condicionado y en la regulación del conflicto emocional– e involucra el funcionamiento del cortex cingulado ventral anterior y el cortex prefrontal ventromedial (Etkin et al., 2015).

Por otro lado, el control de impulsos ha sido también incluido bajo el término *autocontrol*; que entre otros procesos, como el control de respuestas motoras preponderantes, incluye aquellos que intervienen en superar con éxito impulsos no deseados (Hofmann, Schmeichel, y Baddeley, 2012). En este sentido, la *impulsividad* y su homólogo neuropsicológico, la *desinhibición*, que son términos de especial relevancia en la investigación en adicción, pueden ser localizados en el extremo opuesto del continuo del autocontrol.

Es importante tener en cuenta que existe una amplia gama de constructos que de una manera u otra reflejan alteraciones en el procesamiento afectivo, incluyendo su regulación. Para la presente tesis se ha realizado una selección de algunos de ellos, tal y como se refleja y justifica en las siguientes secciones de esta introducción. Pero de manera general el porqué de dicha selección responde a un intento de utilizar constructos fundamentados en procesos psicobiológicos descritos y apuntalados por investigación de vanguardia en el campo de la neurociencia cognitiva y del comportamiento (e.g. Gray 1995; Etkin et al., 2015) y, de esta manera, trasladar esté conocimiento al campo del TJA.

4. Principales procesos afectivos psicobiológicos relacionados con la adicción involucrados en el trastorno por juego de azar

En los últimos 20 años una corriente principal de investigación en el TJA ha estado centrada en el estudio de los procesos centrales de los trastornos adictivos (Limbrick-Oldfield, van Holst, y Clark, 2013; van Holst, van den Brink, Veltman, y Goudriaan, 2010). Cuando la idea original de esta tesis se perfiló en el año 2014, ya existía evidencia convincente de la importancia específica de la *alteración en el procesamiento de recompensas y castigos* y la *falta de autocontrol* en el TJA (Bechara, 2005; Everitt y Robbins, 2005; Goldstein y Volkow, 2011; Robinson y Berridge, 2001, 2008).

4.1. Alteración en el procesamiento de recompensas y castigos

Los modelos teóricos seminales del juego de azar ya enfatizaban la importancia de la *alteración en el procesamiento de las recompensas y castigos* en el TJA (i.e. Blaszczynski y Nower, 2002; Sharpe, 2002). Estos modelos resaltan la relevancia de procesos de condicionamiento conductual y plantean que diferencias individuales en la sensibilidad a las recompensas y castigos (e.g. el nivel de *arousal* producido por ganancias o pérdidas monetarias) son un marcador de vulnerabilidad para el desarrollo de conductas problemáticas con el juego de azar. Además reconocen que esta actividad tiene propiedades recompensantes en sí misma, ya sea por reforzamiento positivo o negativo (e.g. alivio de estados emocionales negativos), que la convierten en una conducta que puede ser utilizada específicamente como una estrategia para mejorar el estado afectivo (e.g. Wood & Griffiths 2007).

Con respecto al procesamiento de la recompensa, hay que tener en cuenta que su estudio en la investigación del juego ha resultado ser más espinoso de lo esperado (Limbrick-Oldfield et

al., 2013), tal y como ocurre en los trastornos adictivos relacionados con sustancias (Hommer, Bjork, y Gilman, 2011). Esta cuestión podría deberse a que el procesamiento de la recompensa incluye una serie de procesos interrelacionados que pueden ser analizados a múltiples niveles y siguiendo diferentes metodologías (e.g. Luijten, Schellekens, Kühn, Machielse, y Sescousse, 2017; van Holst, van Timmeren, y Goudriaan, 2017). Más allá de estas sutilezas, cuya discusión está lejos del alcance de la presente tesis, las revisiones más comprehensivas sobre el procesamiento de la recompensa en juego realizadas hasta 2014 (Limbrick-Oldfield et al., 2013; Goudriaan et al., 2004; 2014; van Holst et al., 2010) convergen en señalar que existen en el TJA (a) una excesiva reactividad psicofisiológica y (b) sesgos atencionales a señales relacionadas con el juego, así como (c) alteraciones cerebrales durante la anticipación (*wanting*) y recepción (*liking*) de recompensas monetarias. En relación a esta última cuestión, cabe señalar que la literatura es inconsistente, ya que se ha encontrado en poblaciones de jugadores de azar tanto híper como hipo-reactividad en el sistema cerebral de recompensa y regiones afines (Balodis, Kober, Worhunsky, Stevens, Pearlson, y Potenza, 2012; de Ruiter, Veltman, Goudriaan, Oosterlaan, Sjoerds, y van Den Brink, 2009; Reuter, Raedler, Rose, Hand, Gläscher, y Büchel, 2005; Sescousse, Barbalat, Domenech, y Dreher, 2013; van Holst, Veltman, Büchel, van den Brink, y Goudriaan, 2012). Actualmente, si existe una excesiva o disminuida reactividad a la recompensa a nivel cerebral en el TJA sigue siendo una cuestión en debate (van Holst et al., 2017a).

El estudio de la híper/hipo-reactividad a las recompensas se ha complementado con estudios de sensibilidad a la recompensa como rasgo de la personalidad. De acuerdo con la teoría psicobiológica de Gray, comentada con anterioridad (Gray, 1981, 1995; ver también Carver y White, 1994; Corr, 2016), este rasgo es la expresión conductual de un sistema que gobierna las tendencias de aproximación a las recompensas y a los estímulos que las señalan. Así, el BAS, que es uno de los pilares básicos de la personalidad, está íntimamente relacionado con el sistema cerebral de recompensa (Costumero, Barrós-Loscertales, Bustamante, Ventura-Campos, Fuentes, y Ávila, 2013). Se ha sugerido que una hiperreactividad del BAS subyacería a una alta sensibilidad a la recompensa rasgo; un hecho que impulsaría a las personas con este rasgo a buscar sistemáticamente fuentes de recompensas (Corr, 2016).

A pesar de que este rasgo solo puede capturar parcialmente la sensibilidad a las recompensas monetarias, se ha utilizado profusamente en la investigación de juego de azar. Así,

una alta sensibilidad a la recompensa rasgo predice el inicio en actividades de juego y el juego a nivel problemático en muestras comunitarias (e.g. Loxton, Nguyen, Casey y Dawe, 2008). Sin embargo, la evidencia sobre su papel en el TJA es inconsistente. Mientras un grupo de estudios sugiere que el jugadores con TJA tienden a presentar una elevada sensibilidad a la recompensa comparado con controles (e.g. Goudriaan, Oosterlaan, de Beurs, y van den Brink, 2006), otros estudios fallan en hallar tal patrón (e.g. Leiserson y Pihl, 2007; ver también MacLaren, Fugelsang, Harrigan, y Dixon, 2011, para una revisión exhaustiva de términos relacionados). Esta inconsistencia podría deberse al menos a dos razones. La primera es que los cambios en la sensibilidad a la recompensa pueden ocurrir en función del estadio de adicción. La progresión del trastorno adictivo podría alterar gradualmente la capacidad reforzante de reforzadores naturales (Goldstein y Volkow, 2011). En segundo lugar, los jugadores pueden diferir en su sensibilidad a la recompensa en función de sus preferencias por determinadas modalidades de juego. En este sentido, los jugadores que prefieren juegos estratégicos o de habilidad (e.g. póker, carreras de caballos, apuestas deportivas) suelen mostrar una sensibilidad a la recompensa aumentada en comparación con aquellos jugadores con una preferencia por juegos de puro azar (e.g. máquinas tragaperras, bingo, loterías; Balodis, Thomas, y Moore, 2014; Sharpe, Tarrier, Schotte, y Spence, 1995).

Por otro lado, tal y como se comentó al inicio de esta sección, la importancia del sensibilidad al castigo también es señalada como un elemento central en el TJA por los modelos teóricos de juego más influyentes (i.e. Blaszczynski y Nower, 2002; Sharpe, 2002). Hay que tener en cuenta que la fuente esencial de castigo en el juego es la pérdida monetaria y que el juego de azar es una actividad con utilidad económica negativa a largo plazo, es decir, es más probable perder dinero que ganarlo cuando se apuesta de manera regular. Por tanto, entender las anomalías en su procesamiento puede ayudar a explicar por qué una conducta con estas características puede establecerse.

Existe evidencia sobre la insensibilidad a las pérdidas en jugadores con TJA. Ésta proviene de estudios experimentales que muestran (a) una perseverancia en la elección de opciones punitivas en tareas de toma de decisiones en el laboratorio (Goudriaan, Oosterlaan, de Beurs, y van den Brink, 2005), (b) una dinámica temporal anormal del procesamiento del *feedback* negativo (e.g. Torres, Catena, Cándido, Maldonado, Megías, y Perales, 2013) y (c) anomalías en la actividad cerebral durante el procesamiento de pérdidas monetarias reales (activación reducida

de diversas regiones fronto-estriatales; Balodis et al., 2012; de Ruiter et al, 2009; Romanczuk-Seiferth, Koehler, Dreesen, Wüstenberg, Heinz, y 2015).

Otra relevante fuente de evidencia sobre la insensibilidad a las pérdidas en el trastorno de juego de azar proviene de estudios del campo de la personalidad. De acuerdo con la teoría de Gray, la sensibilidad al castigo refleja el funcionamiento de otro de los pilares de la personalidad, es decir, el BIS (Gray, 1981, 1995; Corr, 2016). Este sistema puede ser responsable de regular la conducta para evitar potenciales amenazas, siendo así sensible a estímulos aversivos (Gray, 1981, 1995; Corr, 2016; Torrubia et al., 2001).

A primera vista, aquellas personas con un alto reactividad del BIS deberían tener mayor probabilidad de evitar el juego de azar, dadas las altas probabilidades que existen de perder dinero. Por el contrario, los jugadores con TJA deberían mostrar el patrón opuesto ya que mantienen la conducta de juego a pesar de las pérdidas. Sin embargo, la evidencia en la literatura de juego a este respecto es inconsistente, en tanto que se han descrito tanto híper como hipo-sensibilidad en jugadores (Loxton, et al., 2008; Navas, Torres, Vilar, Verdejo-García, Catena, y Perales, 2015), sin olvidar además que también existen hallazgos negativos (Brunborg, Johnsen, Mentzoni, Molde, y Pallesen, 2011; Leiserson y Phil, 2007; O´Connor, Stewart, y Watt, 2009).

Una alta sensibilidad al castigo en jugadores con TJA podría explicarse teniendo en cuenta que este rasgo está íntimamente vinculado al neuroticismo y la ansiedad (Corr, 2004; Torrubia et al., 2001). Existe la posibilidad de que las personas hipersensibles al castigo podrían utilizar el juego de azar como una estrategia de afrontamiento de estados afectivos negativos (Wardell, Quilty, Hendershot, y Bagby, 2015; Weatherly y Miller, 2013). Este hecho entra en consonancia con la propuesta de que existe un subtipo de jugadores con TJA que se involucran en actividades de juego principalmente motivados para escapar de estados afectivos negativos (Blaszczynski, y Nower, 2002). Complementariamente, se ha sugerido que este tipo de jugadores prefieren modalidades de juego que favorecen estados disociativos que producen el alivio momentáneo del afecto negativo, como es el caso de las máquinas tragaperras (Balodis et al., 2014; Fang y Mowen, 2009; Thomas, Allen, y Phillips, 2009). De nuevo, a este respecto, para entender mejor el papel específico de este rasgo en el TJA puede ser necesario tener en cuenta las preferencias personales de los jugadores sobre el tipo de juego de azar que practican (Goudriaan et al., 2004; van Holst et al., 2010). Por otro lado, esta cuestión no invalida la potencial existencia de otra vía para el desarrollo del TJA. Es decir, puede existir un subtipo de jugador diferente que muestre

una respuesta reducida a estímulos aversivos. Estos jugadores podrían tener dificultades para ajustar adecuadamente la conducta en función de las consecuencias negativas que produce, llevándoles así a perseverar en la conducta de juego.

4.2. Falta de autocontrol

La falta de autocontrol puede conceptualizarse de muy diversas maneras. Desde una perspectiva de neurociencia cognitiva, se operativiza como un capacidad de *control cognitivo* reducida, lo que implica alteraciones en los mecanismos de control *top-down* para abordar demandas contextuales (i.e. *desinhibición;* Dalley, Everitt, y Robbins, 2011). El control cognitivo implica diversos subprocesos como la *inhibición de respuesta*, (la habilidad de suprimir una respuesta motora automática), la *monitorización del conflicto*, (la habilidad de contener la interferencia de información irrelevante), y el *control de impulsos* (la habilidad para controlar impulsos no deseados). Todas ellas predisponen a la conducta impulsiva.

En este sentido, el termino impulsividad se considera como la expresión conductual de un control cognitivo disminuido y así se iguala habitualmente al termino desinhibición (e.g. Bari y Robins, 2013). Sin embargo, la impulsividad, que es ampliamente definida como la tendencia a actuar sin previsión (Dalley et al., 2011), implica matices que son necesarios tener en cuenta. Una cuestión de enorme relevancia es que la impulsividad es multidimensional. Por ejemplo, estudios recientes de meta-análisis plantean que existen diferentes dominios de impulsividad, es decir: (a) la impulsividad en la acción, (b) la impulsividad en la elección, y (c) la impulsividad rasgo (McKillop, Weafer, Gray, Oshri, Palmer, y de Wit, 2016; para diferentes aproximación de clasificación ver por ejemplo Sharma, Markon, y Clark, 2014). La primera de ellas se refiere a una capacidad de inhibición de respuesta disminuida, la segunda representa la tendencia a preferir sistemáticamente recompensas inmediatas pequeñas en vez de recompensas demoradas en el tiempo de mayor magnitud y la tercera hace referencia a la tendencia disposicional a actuar de manera apresurada (McKillop et al., 2014).

La evidencia sobre la existencia de alteraciones en la inhibición de respuesta (o impulsividad en la acción) en el TJA no es del todo contundente, es decir, existen diversos hallazgos negativos a este respecto (e.g. Kertzman, Lowengrub, Aizer, Nahum, Kotler, y Dannon, 2006; Ledgerwood et al., 2012; Torres et al., 2013b, ver también Verdejo-García y Manning, 2015, para una revisión). En contraposición, el control de impulsos, que estaría más relacionado con la impulsividad en la elección y la impulsividad rasgo, se ha identificado como

un sello distintivo de los trastornos adictivos (Bechara, 2005; Goudriann et al., 2004; Leeman y Potenza, 2012; van Holst et al., 2010; Verdejo-García, Lawrence, y Clark, 2008). Así, existe amplia evidencia de que en pacientes con TJA el valor de la recompensa decae de manera abrupta con el paso del tiempo (Dixon, Marley, y Jacobs, 2003; MacKillop, Anderson, Castelda, Mattson, y Donovick, 2006; Miedl, Peters, y Buchel, 2012), y de que éstos muestran mayor impulsividad rasgo en pruebas de autoinfome (e.g. Canale, Vieno, Bowden-Jones y Billieux, 2016).

En relación a la impulsividad rasgo, cabe señalar que existe una amplia variedad de modelos que proponen también varias dimensiones que son incluso cualitativamente diferentes (e.g., Barrat, 1965; Eysenck y Eysenck, 1978; Whiteside y Lynam, 2001; Zuckerman, Kuhlman, Joireman, Teta, Kraft, 1993). Por este motivo, existe un cuadro complejo sobre su papel específico en el juego de azar (MacKillop et al., 2006). En la presente tesis nos centraremos en el modelo de impulsividad UPPS-P (Cyders y Smith, 2008; basado en el modelo UPPS de Whiteside, y Lynam´s) ya que es una propuesta inclusiva que propone diferentes rasgos de impulsividad cognitivos y afectivos, ha sido identificado como un modelo de enorme trascendencia para el estudio del TJA (Canale et al., 2016) y cuenta, además, con una considerable cantidad de investigación que apuntala las bases neuropsicológicas de algunas de sus dimensiones (ver para una revisión Kayardi, Coskunpinar y Cyders, 2012).

La *falta de premeditación* (i.e. la tendencia a actuar sin considerar potenciales consecuencias) y la *falta de perseverancia* (i.e. dificultad para mantener la atención en tareas demandantes o aburridas) representan las dimensiones de impulsividad cognitiva del modelo. Más específicamente reflejan un componente de problemas de planificación/escrupulosidad que se relaciona con dificultades en la toma de decisiones y en procesos atencionales, respectivamente (Kayardi et al., 2012). Hay evidencia de que ambas están aumentadas en jugadores con TJA (e.g. Michalczuk, Bowden-Jones, Verdejo-García y Clark, 2011), aunque también es cierto que hay diversos hallazgos negativos (e.g. Billieux, Lagrange, Van der Linden, Lançon, Adida, & Jeanningros, 2012). Éstos podrían estar relacionados con confusores potenciales como, por ejemplo, déficits amplios en el funcionamiento ejecutivo en algunas poblaciones de jugadores (Bagby, Vachon, Bulmash, Toneatto, Quilty, y Costa, 2007; Bergen, Newby-Clark, y Brown, 2012).

Por su parte, las dimensiones afectivas de impulsividad engloban, por un lado, la *búsqueda de sensaciones* (i.e. la tendencia a realizar actividades novedosas y excitantes), y por el otro, *la urgencia positiva y negativa* (i.e. la propensión a perder el control de la conducta bajo el influjo de estados afectivos positivos y negativos). La primera de ellas se ha relacionado con el inicio temprano en actividades de juego (Navas et al., 2015) y la frecuencia del mismo (Smith, Fischer, Cyders, Annus, Spillane, y McCarthy, 2007) en muestras comunitarias de jugadores. No obstante, los hallazgos sobre su implicación en el TJA son inconsistentes (MacLaren et al., 2011). Este hecho podría deberse a diferencias en esta dimensión relacionadas con preferencias individuales por ciertas modalidades de juego. Es decir, hay estudios que han encontrado mayor búsqueda de sensaciones en jugadores con preferencia por juegos estratégicos o de habilidad en contraposición a juegos de puro azar (e.g. Barrault y Varescon, 2013).

Por el contrario, tal y como destacan Michalczuk y colaboradores (2011) la urgencia es profundamente relevante para el TJA dado que estados emocionales intensos promueven episodios de juego, especialmente en jugadores con TJA. El análisis de la urgencia constituye uno de los ejes de la presente tesis, y su implicación en el juego de azar se expondrá en la siguiente sección en mayor profundidad. La relevancia de estas dimensiones de impulsividad afectiva para esta tesis tiene que ver también con que se puede localizar en la frontera donde el afecto interfiere en la capacidad de autocontrol.

5. Una propuesta teórica sobre la relevancia del afecto en el trastorno por juego de azar

En 2010, Cheetham y colegas revisitaron algunos de los postulados básicos de los modelos de adicción y los re-enmarcaron dentro de un modelo de adicción centrado en el afecto. Es más, dichos autores conceptualizaron los trastornos relacionados con sustancias como trastornos del afecto. En este trabajo se recopiló exhaustivamente evidencia sobre el rol que tienen los problemas en la experiencia de afectos positivos y negativos en la vulnerabilidad, desarrollo y mantenimiento de los trastornos adictivos relacionados con sustancias. Más allá de los procesos afectivos mencionados anteriormente, también destacaron la importancia en la adicción de trastornos afectivos, tanto premórbidos como comórbidos, y la importancia de la sintomatología afectiva negativa del síndrome de abstinencia y de la experiencia de *craving*. Es importante señalar que existe evidencia convincente de que estos procesos están también involucrados en el

TJA (Blaszczynski, y Nower, 2002). No obstante, y en relación íntima con esta tesis, Cheetham et al., resaltaron de manera especial cómo el afecto positivo y negativo tienen un impacto en la capacidad de autocontrol. En este sentido, colocaron a la urgencia positiva y negativa como claros indicadores de esta interferencia afectiva en los trastornos adictivos.

Ambas urgencias han mostrado el patrón más consistente de hallazgos de entre todas las dimensiones de impulsividad del modelo UPPS-P en distinguir entre jugadores con TJA y controles (Billieux et al., 2012; Canale et al., 2016; Clark et al., 2012). Sin embargo, se ha propuesto que la urgencia negativa podría ser un marcador más claro del TJA. Por ejemplo, la urgencia negativa arroja los mayores tamaños de efecto en comparaciones casos-controles y está especialmente relacionada con la severidad del TJA (McLaren et al., 2011; Michalczuk et al., 2011; Torres et al., 2013b).

La urgencia negativa puede ser producto de una excesiva reactividad afectiva, de dificultades en la capacidad cognitiva de control, es decir, en su regulación, o de ambas (ver también, Lannoy, Billieux y Maurage, 2014; Dir, Karyadi y Cyders, 2013). Hasta donde llega nuestro conocimiento, antes del 2014, solo existía un artículo de neuroimagen que había estudiado directamente la urgencia negativa en el TJA. Clark y colaboradores (2012) encontraron una asociación entre esta dimensión y una menor disponibilidad de receptores de dopamina en el estriado de jugadores con TJA. En otras poblaciones, la urgencia negativa se ha relacionado con la alteración funcional de estructuras límbicas (e.g. amígdala) y frontales (e.g. cortex prefrontal ventromedial, cortex cingulado anterior) (Albein-Urios et al., 2013; Chester, Lynam, Milich, Powell, Andersen, y DeWall, 2016; Cyders, Dzemidzic, Eiler, Coskunpinar, Karyadi, y Kareken, 2014a y b). Teniendo en cuenta la potencial relevancia de esta dimensión en el TJA, resulta sorprendente la escasez de estudios de neuroimagen dirigidos a profundizar en sus bases cerebrales.

En otro orden de cosas, la relevancia para esta tesis del trabajo de Cheetham et al., también recae en que pone de relieve la transcendencia de un área afectiva poco investigada en el TJA, es decir, la regulación de emociones *per se*. Una aproximación ampliamente extendida para investigar la desregulación emocional es el estudio del uso disposicional de estrategias de regulación emocional. Éstas son mecanismos de regulación explícita o *model-based* dirigidos a modular de manera intencional la experiencia emocional y su expresión (Gross, 2014). Hasta donde llega nuestro conocimiento, el único estudio dirigido a tal fin antes de 2014 en TJA es el

de Williams, Grisham, Erskine, y Cassedy (2012). En éste estudio se utilizó el *Cuestionario de Regulación Emocional* (ERQ, por sus siglas en inglés; Gross y John, 2003); un instrumento basado en la teoría de Gross, que evalúa dos tipos de estrategias de regulación emocional: *reappraisal* y *supresión emocional* (i.e. la inhibición deliberada del componente expresivo de la emoción). Los resultados mostraron que los jugadores con TJA tenían una menor tendencia, en comparación a controles sanos, a utilizar *reappraisal* al abordar experiencias emocionales es sus vidas cotidianas. Teniendo en cuenta que esta estrategia se ha asociado a un mayor ajuste social y bienestar emocional (Aldao, Nolen-Hoeksema, y Schweizer, 2010; Gross y John, 2003), los jugadores con TJA podrían desplegar estrategias menos adaptativas para regular sus emociones. Aunque existe una necesidad de replicar estos hallazgos, entran en consonancia con los de otros estudios que muestran cómo la desregulación emocional desempeña un rol clave en problemas psicopatológicos concomitantes y conductas de riesgo en jugadores problemáticos o recreativos (Estévez, Herrero-Fernández, Sarabia, y Jauregui, 2014; Schreiber, Grant, y Odlaug, 2012).

Teniendo en cuenta que hay una escasez de estudios dirigidos específicamente a examinar este tema en la investigación en juego de azar, diversas cuestiones relevantes sobre la regulación de emociones en TJA están aún sin resolver. Por ejemplo, puede ser útil el estudio de otro tipo de estrategias más allá del *reappraisal* y de la supresión emocional que los jugadores podrían implementar para abordar situaciones emocionales. Existen otras propuestas de estrategias de regulación emocional que podrían ser informativas. Por ejemplo Garnefski y Kraaij (2007) plantean la existencia de diferentes tipos de *reappraisal* (e.g. *poner en perspectiva*; relativizar la importancia del suceso emocional) e incluyen otras estrategias no adaptativas más allá de la supresión (e.g. *rumiación*; pensar obsesivamente en un suceso emocional) que son comunes en psicopatología afectiva (Aldao et al., 2010).

Por otro lado, dado que es más probable que el juego de azar produzca pérdidas que ganancias cuando se apuesta de manera regular, el estudio de las emociones negativas producidas por las pérdidas monetarias podrían merecer especial atención. Describir los procesos que los jugadores pueden desplegar para ajustar el impacto emocional de las pérdidas puede ser clave para entender el TJA. No obstante, hasta donde sabemos, no hay estudios que hayan examinado específicamente la regulación de estas emociones.

A este respecto, el estudio de las distorsiones cognitivas relacionadas con el juego de azar puede ayudar a entender la importancia de la regulación de las emociones elicitadas por los

resultados del juego, es decir, tanto de las ganancias como las pérdidas monetarias. Estas distorsiones hacen referencia de manera amplia a creencias y percepciones erróneas sobre el funcionamiento del azar y llevan a los jugadores a sobreestimar sus probabilidades de ganar, o lo que viene a ser lo mismo, a infravalorar sus probabilidades de perder (Clark, 2010). Hay diversos tipos de distorsiones identificadas en jugadores con TJA (ver Goodie y Fortune, 2013 y Fortune y Goodie, 2012, para una revisión comprehensiva) que podrían estar involucradas en reducir la experiencia emocional producida por las pérdidas monetarias y/o en aumentar aquellas producidas por las ganancias. Entre ellas pueden destacar específicamente aquellas creencias erróneas sobre la estructura causal entre conductas y señales ambientales con respecto a los resultados de juego. Algunos ejemplos de estas distorsiones son la *ilusión de control* y *la ilusión de predictibilidad*, es decir, la percepción de habilidad para controlar y predecir los resultados del juego; y el *sesgo interpretativo* que consiste en la atribución interna o externa de los resultados del juego dependiendo de su valencia, es decir, las ganancias se atribuyen a la habilidad y las pérdidas, por ejemplo, a la mala suerte (Raylu y Oei, 2004). Así, existe la posibilidad de que las distorsiones cognitivas relacionadas con el juego sean un mecanismo de autoengaño, protector del ego, que contribuye al mantenimiento de la conducta de juego a través del ajuste de las emociones producidas por los resultados del mismo. Esta idea estaría en consonancia con los modelos de razonamiento motivado que proponen que la motivación moldea el razonamiento por sesgos personales que confirman expectativas preexistentes y deseadas (Kunda, 1990).

En resumen, nuestra propuesta es que la regulación emocional juega dos papeles importantes en el TJA. Por una parte, la alteración de mecanismos *model-free* llevaría a problemas generalizados de desregulación emocional, y se reflejarían en un incremento de la urgencia negativa (Navas, Billieux, Verdejo-García y Perales, 2018), con todo lo que ello conlleva. Por otro lado, el uso motivado de ciertas estrategias de regulación emocional *model-based* podría estar relacionado con el mantenimiento de distorsiones cognitivas relativas a los resultados de juego. A lo largo de esta tesis describiremos ampliamente la relevancia de estos mecanismos en las manifestaciones clínicas del TJA.

6. Fuentes de heterogeneidad en el trastorno por juego de azar

Los modelos clásicos de juego de azar reconocen la naturaleza heterogénea del TJA. Por ejemplo, el influente *Pathways Model* (Blaszczynski y Nower, 2002) propone la existencia de tres tipos de jugadores basándose en su perfil psicobiológico: (a) *los jugadores conductualmente condicionados* son aquellos que caen en la trampa de los programas de reforzamiento de razón aleatoria que gobiernan el juego, pero que no presentan vulnerabilidades psicopatológicas o neurobiológicas premórbidas; (b) *los jugadores emocionalmente vulnerables,* son aquellos que tienen una historia previa de trastornos afectivos o problemas específicos para afrontar estados negativos afectivos, y (c) los *jugadores impulsivos-antisociales*, es decir, jugadores con tendencias impulsivas, incluyendo conductas antisociales y otras conductas desadaptativas. Es importante resaltar que para todos ellos la plantilla común para su progresivo problema con el juego es la sensibilidad a las propiedades reforzantes de las actividades de juego. Complementariamente, sus diferencias se basan en la combinación entre tal sensibilidad con diversos procesos afectivos.

Más allá de las especificidades y matices que deberían hacerse para un mejor esboce de este modelo, es importante señalar, para los fines de esta tesis, que destaca que alteraciones en el procesamiento afectivo es una fuente importante de variabilidad en el TJA. En este sentido, a lo largo de la introducción se han expuesto diferentes factores que pueden contribuir a dicha variabilidad. Es decir, (a) la sensibilidad alterada a los efectos reforzantes del juego (e.g. ganancias monetarias; efectos ansiolíticos), (b) las diferentes dimensiones de impulsividad, y (c) los procesos de desregulación emocional. Éstos de una manera u otra contribuyen al inicio temprano de actividades de juego, a una progresiva implicación en el mismo, a una gradual pérdida de control, y/o al potencial agravamiento del trastorno y problemas relacionados. En este sentido, además, una mayor fuerza de las distorsiones cognitivas relacionadas con el juego contribuye no solo al mantenimiento del juego sino también a su severidad (Myrseth, Brunborg, y Eidem, 2010; Toneatto, Blitz-Miller, Calderwood, Dragonetti, y Tsanos, 1997).

Sin embargo, su importancia en la heterogeneidad del TJA no termina aquí: algunos de estos factores interaccionan con las características propias de un determinado juego y podrían moldear (o ser moldeados por) las preferencias individuales por diferentes modalidad de juego. Este hecho se ilustra por algunos de los hallazgos mencionados a lo largo de la introducción sobre diferencias entre jugadores con preferencias por juegos de habilidad o estrategia y jugadores con preferencias por juegos de puro azar. Estos jugadores podrían diferir tanto en su

motivación para jugar (e.g. jugar para afrontar estamos afectivos negativos) como en su sensibilidad a la recompensa y en diversas dimensiones de la impulsividad rasgo (e.g. búsqueda de sensaciones). Además, diversos estudios han mostrado también que la fuerza de las distorsiones cognitivas relacionas con el juego son mayores en el primer grupo que en el segundo (Myrseth et al., 2010).

Hay que tener en cuenta además que algunas de estas variables también estas asociadas a factores demográficos. De hecho, un perfil de jugadores jóvenes con preferencias por juegos de habilidad está creciendo actualmente (e.g. Griffiths et al., 2009). Estos jugadores se caracterizan por tener una educación al menos de grado superior, ser altamente sensibles a las recompensas y tener altas distorsiones cognitivas (Myrseth et al., 2010). Esta cuestión podría explicar algunos hallazgos actuales que desafían el perfil clásico de jugador, caracterizado, entre otras cuestiones, por amplios déficits en el funcionamiento ejecutivo (incluyendo la memoria de trabajo, la flexibilidad y la planificación) (Verdejo-García y Manning, 2015). En este sentido, existe evidencia sobre la preservación de diferentes facetas del funcionamiento ejecutivo, al menos en diversas poblaciones de jugadores (ver Verdejo-García y Manning, 2015 para una revisión). Esta idea entraría en consonancia con hallazgos recientes de que los jugadores con distorsiones cognitivas más fuertes ejecutan tareas de aprendizaje al mismo nivel que controles sanos igualados en características demográficas y cociente intelectual (i.e. discriminación precisa de contingencias; Perales, Navas, Ruiz de Lara, Maldonado, y Catena, 2017). De esta manera, existe la posibilidad de que algunas distorsiones cognitivas relejen un funcionamiento cognitivo preservado en vez de uno disfuncional.

II. JUSTIFICACIÓN, OBJETIVOS E HIPÓTESIS

La presente tesis se centrará en el estudio de procesos de generación (capturados por la sensibilidad a la recompensa y al castigo) y regulación afectiva (incluyendo diversas facetas de impulsividad y la regulación emocional) que subyacen a la vulnerabilidad, desarrollo y mantenimiento del trastorno del juego de azar, así como a la heterogeneidad que existe en el mismo. A lo largo de los capítulos que conforman esta tesis, se estudia sus potenciales asociaciones con manifestaciones características del juego, esto es, las distorsiones cognitivas relacionadas con el funcionamiento del azar y a la sobrestimación de la capacidad personal para controlar y predecir los resultados del juego, diferencias individuales en preferencias por modalidades de juego, y la severidad del TJA y sus consecuencias clínicas. De esta manera, se espera contribuir a una mayor individualización de las intervenciones clínicas.

En el Capítulo 1 se describe un estudio que examina la potencial asociación de la sensibilidad a la recompensa y al castigo, la impulsividad en la elección, la impulsividad rasgo y las distorsiones cognitivas relacionadas con el juego, con la modalidad preferida de juego de azar y con el estatus clínico de los participantes de una muestra de jugadores regulares (i.e. jugadores con juego recreativo o problemático) y de jugadores con TJA. El objetivo de este capítulo es esclarecer cuáles de estos procesos están relacionados con las preferencias por ciertos juegos, con la severidad del mismo o con ambas. Dada la gran cantidad de hipótesis que se pueden hacer a este respecto, se han resumido todas ellas en un documento anexo al Capítulo 1.

En los estudios de los Capítulos 2 y 3, se examina la supuesta naturaleza afectiva de las distorsiones cognitivas relacionadas con el juego. En el primero, se analiza su asociación de las distorsiones cognitiva con la impulsividad rasgo –en una muestra ampliamente solapada con la del estudio del Capítulo 1– en un intento de replicar hallazgos previos sobre su vínculo específico con las dimensiones afectivas del Modelo UPPS-P de impulsividad (i.e. búsqueda de sensaciones y urgencias negativa y positiva) en contraposición con las dimensiones cognitivas del mismo. Por otro lado, en el estudio del Capítulo 3 se investiga la potencial conexión de estas distorsiones con las estrategias cognitivas de regulación de emociones negativas postuladas por el modelo de Garnefski y Kraaij (2005), en una muestra de pacientes con TJA comparados con otra de controles sanos. Nuestras hipótesis son que las distorsiones cognitivas relacionadas con el juego estarán asociadas a estrategias que son usualmente reconocidas como formas efectivas y adaptativas de regulación emocional. Si esto fuera cierto, estas distorsiones podrían servir a los jugadores como un mecanismo para lidiar

con el impacto de emociones negativas, incluyendo potencialmente también aquellas producidas por las pérdidas monetarias, así como para potenciar el impacto reforzante de las ganancias u otros aspectos subjetivamente reforzantes del juego.

El último objetivo de la tesis es analizar específicamente procesos de regulación emocional en el TJA. En el estudio del Capítulo 3, comparamos a pacientes y controles en su uso disposicional de las estrategias de regulación emocional comentadas anteriormente, para describir las estrategias que los jugadores podrían implementar para afrontar sucesos emocionales. En el Capítulo 4 se añaden dos estudios complementarios. En el primero se continúa explorando el uso estable de estrategias de regulación emocional en la vida cotidiana de los jugadores, específicamente el uso de *reappraisal* cognitivo y de supresión emocional (definidos según el modelo de Gross, 1998). En el segundo se investiga la activación cerebral durante el *reappraisal* de emociones negativas en una tarea de laboratorio mediante resonancia magnética funcional. Finalmente, en ambos estudios se examinan sus asociaciones con la urgencia negativa. Se espera encontrar que los jugadores en comparación con los controles muestren una mayor tendencia a utilizar estrategias de regulación emocional que se hayan vinculado con problemas emocionales, como la catastrofización o la supresión emocional, así como una mayor activación de estructuras cerebrales de control cognitivo para regular emociones negativas en la tarea de *reappraisal*. Asimismo, los jugadores con mayor urgencia negativa mostrarán peor regulación emocional disposicional, mayor dificultad para regular emociones en vivo, y una mayor activación cerebral durante tales intentos en zonas de control cognitivo en comparación con los controles.

III. MEMORIA DE TRABAJOS

CAPÍTULO 1:
Affective processes and gambling-related cognitive distortions associated with gambling preferences and clinical status

The content of this chapter has been published as Navas, J. F., Billieux, J., Perandrés-Gómez, A., López-Torrecillas, F., Cándido, A., & Perales, J. C. (2017). Impulsivity traits and gambling cognitions associated with gambling preferences and clinical status. *International Gambling Studies, 17*(1), 102–124.

Affective processes and gambling-related cognitive distortions associated with gambling preferences and clinical status

Impulsivity (and related traits reward/punishment sensitivity and tolerance to delayed rewards) and gambling cognitions have been linked to gambling. However, their independent associations with gambling preferences and clinical status have never been dissociated. The current study applied a data-driven strategy to identify gambling preferences, based on gambling frequency in several modalities. The two resulting factors were used to classify patients with patients with gambling disorders (PGD) and regular gamblers (RG) into Type I (preferring cards, casino games, and skill-based bets) and Type II (preferring slot machines, lotteries/pools, and bingo). Participants were assessed in impulsivity, delay discounting, reward/punishment sensitivity, gambling-related cognitions, gambling severity, gambling frequency, and average amount gambled per episode. PGD scored higher than RG in positive and negative urgency, delay discounting, reward sensitivity, and intensity of gambling-related cognitions, but less in lack of perseverance. Additionally, Type II gamblers had greater difficulties delaying gratification, whereas Type I gamblers showed higher cognitive distortion and reward sensitivity levels. In practical terms, the finding that some characteristics are equally pervasive in disordered gamblers independently of their preferences (affect-driven impulsivity), whereas others (distorted cognitions, reward sensitivity, delay discounting) are more prominent in one type or the other, provides a basis to establish targets' priority in therapy.

Introduction

Gambling disorder (GD) shares behavior and psychobiological features with substance use disorders (American Psychiatric Association, 2013; Frascella, Potenza, Brown, & Childress, 2010). However, research has also shown that GD is characterized by unique psychological and neurobiological components, such as distinctly altered dopamine release (Boileau et al., 2014; Joutsa et al., 2012), gambling-related cognitive distortions (Cunningham, Hodgins, & Toneatto, 2014; Raylu & Oei, 2004) and loss-chasing behaviors (Campbell-Meiklejohn, Woolrich, Passingham, & Rogers, 2008).

Substantial efforts have been made to explore individual differences in patients with gambling disorder (PGD; MacLaren, Fugelsang, Harrigan, & Dixon, 2011). Existing studies have revealed a number of traits as clinically relevant to characterize gamblers. Among these, impulsive personality traits, sensitivity to reward and punishment, and tolerance to delayed rewards (i.e. impulsive choice) are likely to be the most relevant (e.g. Billieux et al., 2012a; Blain, Gill, & Teese, 2015; Cyders & Smith, 2008; MacLaren et al., 2011; Michalczuk, Bowden-Jones, Verdejo-García, & Clark, 2011). The relationship between these variables and problematic gambling is consistent with their influence on self-regulation-related processes (Bickel, Koffarnus, Moody, & Wilson, 2014; Goodwin, Browne, Rockloff, & Loxton, 2016).

With regard to specific gambling-related traits, a parallel line of research has demonstrated that gambling-related cognitions (beliefs about gambling settings, behaviors and outcomes) are important predictors of disordered gambling and are related to prognosis (Goodie & Fortune, 2013).

An alternative approach to the study of individual differences among gamblers has been to subtype regular gamblers (RG; in this chapter refers to gamblers who not accomplish criteria for the diagnosis of gambling disorder) or PGD on the basis of their preference for different gambling modalities (Milosevic & Ledgerwood, 2010). However, only a few studies (Fang & Mowen, 2009; Moragas et al., 2015; Myrseth, Brunborg, & Eidem, 2010; Toneatto, Blitz-Miller, Calderwood, Dragonetti, & Tsanos, 1997) have combined both approaches; namely, testing whether traits with prognostic or diagnostic clinical value are also related to gambling preferences. Moreover, none of these studies have simultaneously examined PGD and RG.

Trait-based Individual Differences in Gamblers

Impulsivity. Recent multimodal factor analyses have identified at least three separable impulsivity dimensions: one resulting from the more or less successful operation of the deliberative/executive system; a second reflecting the activity levels of reward-sensitive motivational systems and a third reflecting the level of effectiveness of strategies used to deal with negative affect (Sharma, Markon, & Clark, 2014).

Although no single psychometric instrument has been yet developed to assess impulsivity following this factoring, the most frequently referenced questionnaire (the UPPS-P; an acronym for negative urgency, premeditation, perseverance and sensation seeking, with the later addition of positive urgency; Whiteside & Lynam, 2001) is mostly consistent with it (Cyders & Smith, 2007). Positive and negative urgency measure proneness to rash action under the influence of intense negative and positive affect, respectively; sensation seeking measures the tendency to engage in novel and arousing activities; lack of premeditation involves making decisions without consideration of their potential consequences; and lack of perseverance assesses the difficulty to stick with long, boring or cognitively demanding tasks.

In the realm of gambling research, positive urgency, negative urgency and lack of pre-meditation have repeatedly been associated with problematic gambling, with some evidence that negative urgency may have the strongest effect size when comparing PGD against controls (Billieux et al., 2012a; Blain et al., 2015; MacLaren et al., 2011; Michalczuk et al., 2011). Differences in lack of perseverance seem to be less prominent (Bagby et al., 2007; Bergen, Newby-Clark, & Brown, 2012). And, although only inconsistently linked to problem gambling, sensation seeking has been reported to be associated with gambling frequency and game preferences (Bonnaire, Bungener, & Varescon, 2006; Smith et al., 2007).

Reward and punishment sensitivity. Reward and punishment sensitivity measures were developed to assess the level of activity of the two components of Gray's psychobiological model of personality: the Behavioral Activation System (BAS) and the Behavioral Inhibition System (BIS). BAS hyperactivity has been linked to impulsivity and extraversion, whereas BIS hyperactivity has been linked to neuroticism and introversion (Aluja & Blanch, 2011; Gray, 1994). As noted earlier, impulsive behavior can result from over-activated affective systems, so there is some overlap between punishment and reward sensitivity and certain aspects of impulsivity (Lannoy, Billieux, & Maurage, 2014). Still, the importance of these systems goes beyond their role in impulsivity, constituting one of the main foundations of personality (Carver & White, 1994; Corr, 2016). Indeed, evidence shows that punishment and reward sensitivity have a significant impact on a number of externalizing

behaviors, above and beyond impulsive personality traits (Carlson, Pritchard, & Dominelli, 2013).

With regard to gambling, reward sensitivity predicts gambling onset and signals problematic gambling (see MacLaren et al., 2011 for a review). But, complementarily, the possibility that gambling might compensate reduced effectiveness of natural rewards has also been suggested, on the basis of reports of diminished reward sensitivity in PGD (Reuter et al., 2005; Sescousse, Barbalat, Domenech, & Dreher, 2013).

Punishment sensitivity has received less attention but, again, its relationship with gambling does not seem straightforward. On the one hand, in community samples, individuals with low punishment sensitivity are more likely to gamble (Navas et al., 2015), and, in experimental tasks, pathological gamblers have been observed to be less sensitive than controls to punitive feedback (van Holst, van den Brink, Veltman, & Goudriaan, 2010). On the other hand, in some gamblers, heightened punishment sensitivity raises the risk of problem gambling, via the negative reinforcement effect that gambling activities might exert (Balodis, Thomas, & Moore, 2014; Wardell, Quilty, Hendershot, & Bagby, 2015).

Tolerance to reward delay. Impulsivity is also closely related to the ability to sacrifice immediate gratification for the sake of long-term goals (Rachlin, 2009). Gambling-related research has consistently found PGD to temporally discount the value of rewards more rapidly than controls (Albein-Urios, Martinez-Gonzalez, Lozano-Rojas, & Verdejo-García, 2014; Dixon, Marley, & Jacobs, 2003; MacKillop, Anderson, Castelda, Mattson, & Donovick, 2006; Miedl, Peters, & Büchel, 2012; Petry, 2003), and has identified delay discounting as an index of GD severity (Alessi & Petry, 2003). Complementarily, delay discounting measures are related to other decision-making tasks in which participants are asked to integrate rewards and punishments in the domain of time, and in which PGD have also been found to perform abnormally (e.g. set-shifting tasks; Grant, Odlaug, Chamberlain, & Schreiber, 2012).

Gambling-related cognitions. Most research on gambling-related cognitions has focused on three related phenomena. First, most gamblers are prone to perceive patterns or streaks in random series of gambling outcomes (Jessup & O'Doherty, 2011; Ladouceur, Paquet, & Dubé, 1996). This happens, for instance, in the gambler's fallacy (the belief that a series of losses is bound to be followed by a win) and the hot-hand fallacy (the belief that a coincidental series of wins will extend in time; Ayton & Fischer, 2004; Wilke, Scheibehenne, Gaissmaier, McCanney, & Barrett, 2014). Second, some gamblers also tend to perceive

causal connections in coincidental co-occurrences of environmental cues and gambling outcomes (e.g. Joukhador, Blaszczynski, & Maccallum, 2004). Third, some gamblers overestimate their degree of personal control over gambling outcomes (e.g. Coventry & Norman, 1998; Ladouceur, Mayrand, Dussault, Letarte, & Tremblay, 1984).

The most pervasively used tool to assess cognitive distortions and beliefs in relation to gambling is the Gambling Related Cognitions Scale (GRCS; Raylu & Oei, 2004). This questionnaire assesses five gambling-related cognitive domains. Inability to stop (ITS, e.g. 'I'm not strong enough to stop gambling') and gambling expectations (GE, e.g. 'Gambling makes things seem better') are beliefs of lacking the ability or capacity to control gambling impulses, and overvaluing the joy, reward or relief that can be obtained from gambling, respectively. Illusion of control (IC, e.g. 'Praying helps me win'), predictive control (PC, e.g. 'When I win once, I will definitely win again') and interpretative biases (IB, e.g. 'Relating my losses to bad luck and bad circumstances makes me continue gambling'), on the other hand, are cognitive distortions involving causal attribution processes, and are categorized together as gambling-related cognitive biases.

Preference-based Individual Differences in Gamblers

Most clinicians treating PGD report differences between patients with a predilection for different gambling types, and stress the importance of such differences in treatment tailoring (Lobo et al., 2014). Additionally, some of the above-mentioned inconsistences in associations between psychological traits and clinically relevant gambling features could be due to the existence of gambler subtypes.

In spite of this, the psychological profiles associated with different gambling preferences have been the focus of limited studies to date. For example, Bonnaire et al. (2006) found pathological gamblers playing games of chance in cafés (e.g. lotteries, scratchcards, off-course betting) to have lower sensation-seeking scores than pathological horse-track betters. In a larger study with regular, mostly non-pathological gamblers, Fang and Mowen (2009) observed that escape motives positively correlated with slot-machine playing, but did negatively with playing card games, whereas self-esteem and competitiveness correlated negatively with playing slot machines, and positively with playing card games and sports betting. This study concurs with studies with homogeneous samples (casino betters, Anderson & Brown, 1984; horse ride betters, Coventry & Norman, 1997; poker machine gamblers, Sharpe, Tarrier, Schotte, & Spence, 1995; electronic gaming machine gamblers, MacLaren, Ellery, & Knoll, 2015) in highlighting the differential role of

processes related to reward versus punishment sensitivity in different gambling modalities (Cocco, Sharpe, & Blaszczynski, 1995).

A second approach has been to categorize games based on an a priori criterion, and then classify gamblers accordingly. Following this rationale, Moragas et al. (2015) found higher of novelty seeking and lower levels of agreeableness in strategic gamblers, compared to non-strategic gamblers, and Toneatto et al. (1997) reported that cognitive distortions are considerably stronger in gamblers characterized by a predilection for skill-based games in comparison to gamblers preferring chance games. Such differences have been corroborated by Myrseth et al. (2010), who emphasized illusion of control being more pervasive in PGD and RG preferring skill-based games. Therefore, the possibility exists that gambling preferences and clinical status contribute not only to the intensity, but also to differential profiles in terms of cognitive distortions.

Current Study

The aim of the present study is to explore whether treatment-seeking PGD and RG, further classified on the basis of their gambling preferences, differed in terms of impulsivity, reward/punishment sensitivity, tolerance to reward delay, and gambling cognitions. This approach is novel in two senses. First, our sample was composed of PGD and RG, so that the effect of clinical status can be dissociated from the differences depending on gambling preferences. Second, in order to categorize gamblers on the basis of their preferences, we adopted a data-driven method. A principal-component factor analysis (PCA) was used to identify covariations in participation patterns in several games, and participants were later classified according to their favorite activity. In line with previous literature, we expect this approach to succeed in differentiating at least between two broad categories of games. In previous studies, these two types have been labeled as skill-based and chance-based. However, to our knowledge, no previous attempts have been made to investigate whether these two categories are supported by actual gambling participation data.

In order to avoid speculating about the reasons why participation scores for some games tend to correlate between themselves, but not with others, here we will use the neutral labels Type I (preferring card, casino-games and skill-based bets) and Type II (preferring slots, lotteries and bingo) to refer to gambler subtypes. Type I-PGD, Type I-RG, Type II-PGD and Type II-RG completed the brief UPPS-P Impulsive Behavior Scale (Billieux et al., 2012b), the Now-or-Later test for delay discounting (NoL; Kirby, Petry, & Bickel, 1999), the SPSRQ (Sensitivity to Punishment and Sensitivity to Reward Questionnaire; Aluja & Blanch,

2011) and the GRCS questionnaire (Gambling-Related Cognitions Scale; Raylu & Oei, 2004).

Our hypotheses referring to the effect of preferences are based on the available literature. As noted above, previous results come from homogeneous samples, one-to-one comparisons between different games, or comparisons between skill and chance games (not perfectly overlapping with our classification). On the whole, we expect PGD to clearly differ from RG in specific variables previously associated with problem gambling (UPPS-P, delay discounting and GRCS), except those related to affective feedback sensitivity (SPSRQ). Additionally, we expect Type I gamblers to score higher in sensation seeking and reward sensitivity. Punishment sensitivity, on the other hand, has been proposed to underlie problem gambling in emotionally vulnerable patients, via escape motives, mostly in slot machine gamblers (categorized here as Type II; Balodis et al., 2014).

With regard to cognitions (GRCS), as described earlier, causal attribution processes have consistently been shown to play a larger role in gamblers with a preference for skill-based games (most of which are labeled here as Type I). Gambling expectancies, however, include both the prospect that gambling will be enjoyable and the prospect that it will curb negative affect. Thus, we expect to find higher expectancy scores in PGD than RG, whereas no difference is expected regarding gambling preferences. Finally, no a priori hypotheses were formulated regarding potential differences between gambler types in feelings of inability to stop, as long as clinical status is controlled for. A comprehensive list of hypotheses and their origin in the available literature can be found in Table A1 (Appendix).

Method

Participants and Ethical Considerations

Seventy-one patients with gambling disorder (PGD) and 74 regular gamblers (RG) were enrolled in the current study. PGD were diagnosed by the professional therapist at their treatment center (AGRAJER – Granada Association of Rehabilitated patients with Gambling disorder, APLIJER – Linares Provincial Association of Gamblers in Rehabilitation, and ALUJER – Jaén Association of Rehabilitated patients with Gambling disorder [Andalusia, Spain]). RG were recruited from PGD' and researchers' acquaintances, and by posting notices on the University of Granada's social networks.

The only inclusion criterion for PGD was being in treatment for GD (pathological gambling, diagnosed according to DSM-IV criteria). For RG, the inclusion criteria were

participating in any gambling modality at least once a week, and a severity score in the South Oaks Gambling Screen (SOGS) below the threshold to be at risk of gambling disorder (<5). Exclusion criteria, for both groups, were any history of neurological disease or brain trauma causing unconsciousness for 10' or longer (as informed by the participant), and any current mental disorder. GD diagnosis and potential psychiatric comorbidities were assessed by therapists in the case of PGD, and by a psychologist with clinical experience (first author) in RG.

Frequencies of participation in different gambling modalities were assessed with the Spanish SOGS. Participants were also allowed to freely report their favorite game. Those who reported more than one game were asked to list them in order of preference. Participants whose favorite game was not listed in SOGS (i.e. sport bets other than horse-race and traditional sports betting; n=11) were excluded from further analyses.

All participants were informed about the aims and features of the study, and gave informed consent. The study was approved by the Ethics Committee of the University of Granada as part of the PSI2013-45055-P research project, and was in accordance with the 1964 Helsinki Declaration and its later amendments.

Instruments

South Oaks gambling Screen (SOGS, Spanish version; Echeburúa, Báez, Fernández-Montalvo, & Páez, 1994). In order to estimate gambling severity and participation frequencies in different games, we used the Spanish SOGS. To date, this is the only validated instrument for the assessment of gambling severity in Spanish; it has been widely used and has good psychometric properties.

***Gambling behavior parameters*.** Participants were asked to report their gambling preferences, how many times a week they usually gambled (in the present moment, for RG, and in the period preceding abstinence, for PGD) and how much money they spent on gambling, on average, during a typical gambling episode.

Brief UPPS-P impulsivity scale (Spanish version; Cándido, Orduña, Perales, Verdejo-García, & Billieux, 2012). The brief Spanish UPPS-P scale contains 20 items and allows for a multidimensional assessment of impulsivity: positive urgency (e.g. 'I tend to lose control when I am in a great mood'), negative urgency (e.g. 'When I am upset I often act without thinking'), (lack of) premeditation (e.g. 'My thinking is usually careful and purposeful'), (lack of) perseverance (e.g. 'Once I get going on something I hate to stop'), and

sensation seeking (e.g. 'I quite enjoy taking risks'; see Cándido et al., 2012, for psychometric properties).

Now-or-later (NoL; Kirby, Petry, & Bickel, 1999). This 27-item monetary-choice questionnaire asks for individual preferences between smaller, immediate rewards and larger, delayed rewards. In each item, the participant was asked to imagine being offered two rewards with different values and delays, and to indicate which one she/he would prefer to receive. No real rewards were administered. The main measure from this questionnaire was the number of items in which the participant chose the immediate reward, an atheoretical index that has been shown to highly correlate (r= 0.97) with the logarithm of k, the hyperbolic discounting rate parameter (Myerson, Baumann, & Green, 2014). Henceforth we will refer to this score as *delay discounting*.

Shortened Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ, Spanish version; Aluja & Blanch, 2011). This questionnaire contains 20 yes/no items, and has been shown to have robust psychometric properties. Ten items are worded to measure reward sensitivity (e.g. 'Do you often do things to be praised?') and the other 10 to measure punishment sensitivity (e.g. 'Compared to the people you know, do you think you are afraid of many things?').

Gambling Related Cognitions Scale (GRCS, Raylu & Oei, 2004*).* As described above, this 23-item questionnaire assesses 5 gambling-related cognitive domains: *inability to stop* (IS), *gambling expectations* (GE), *illusion of control* (IC), *predictive control* (PC), and *interpretative biases* (IB). PGD were instructed to answer the questionnaire with regard to the time when they used to gamble (prior to therapy onset). The results of validating the Spanish GRCS (showing intra-class correlation coefficients, ICC= .77 [GE], .68 [IC], .84 [PC], .92 [ITS], and .89 [IB]) have been reported in Del Prete et al., (2017; see Chapter 2).

Procedure

For PGD, all assessments were individual and face to face. After welcoming the participant and obtaining his/her consent, the assessment started. For PGD, the assessments were part of a larger protocol aimed at carrying out a detailed evaluation of behavior and neurobiological correlates of gambling. The whole protocol was divided in two sessions, and all the instruments mentioned here were administered during the first session, lasting for approximately three hours. In all cases, assessments were carried out by trained psychologists with extensive experience in clinical evaluations.

RG were either individually assessed, or asked to provide consent and fill the questionnaires online. As evaluations for participants filling the questionnaires online (n=35) were not carried out under supervision, there was no way to ensure that participants answered every item in the questionnaires. This led to limited data missing. The assessment session lasted approximately 45 minutes.

Statistical Analyses

SOGS participation frequency scores were submitted to a PCA (Oblimin-rotated). The resulting factors were used to classify participants as Type I or Type II gamblers, in accordance to their declared preference for games more heavily loaded by one factor (including cards, skills-based games, casino games) or the other (slots, lottery/pools, bingo). The factorial combination of preference and clinical status resulted in four subgroups of Type I PGD, Type II PGD, Type I RG, and Type II RG.

In order to identify potential sociodemographic confounders, clinical status group (henceforth, *group*: PGD, RG) x *preference* (Type I, Type II) analyses of variance (ANOVAs) were performed on age and years of education, and χ^2 tests on sex.

SOGS severity and gambling involvement, UPPS-P dimensions, delay discounting, sensitivity to punishment and reward, and gambling-related cognitions were submitted to four group x preference multivariate analysis of covariance (MANCOVA; one for SOGS and gambling involvement, one for impulsivity and delay discounting, another one for sensitivity to punishment and reward, and a fourth one for gambling cognitions). Potential confounders identified in preliminary analyses were entered the design as continuous covariates. Omnibus MANCOVA and variable-by-variable between-group effects (but not the effects of covariates) are reported.

Additionally, the origin of main effects was explored using Bonferroni-corrected pairwise comparisons (restricted ANCOVAs) for each possible pair of subgroups. For the sake of conciseness, the results of these pairwise comparisons are reported in supplementary materials.

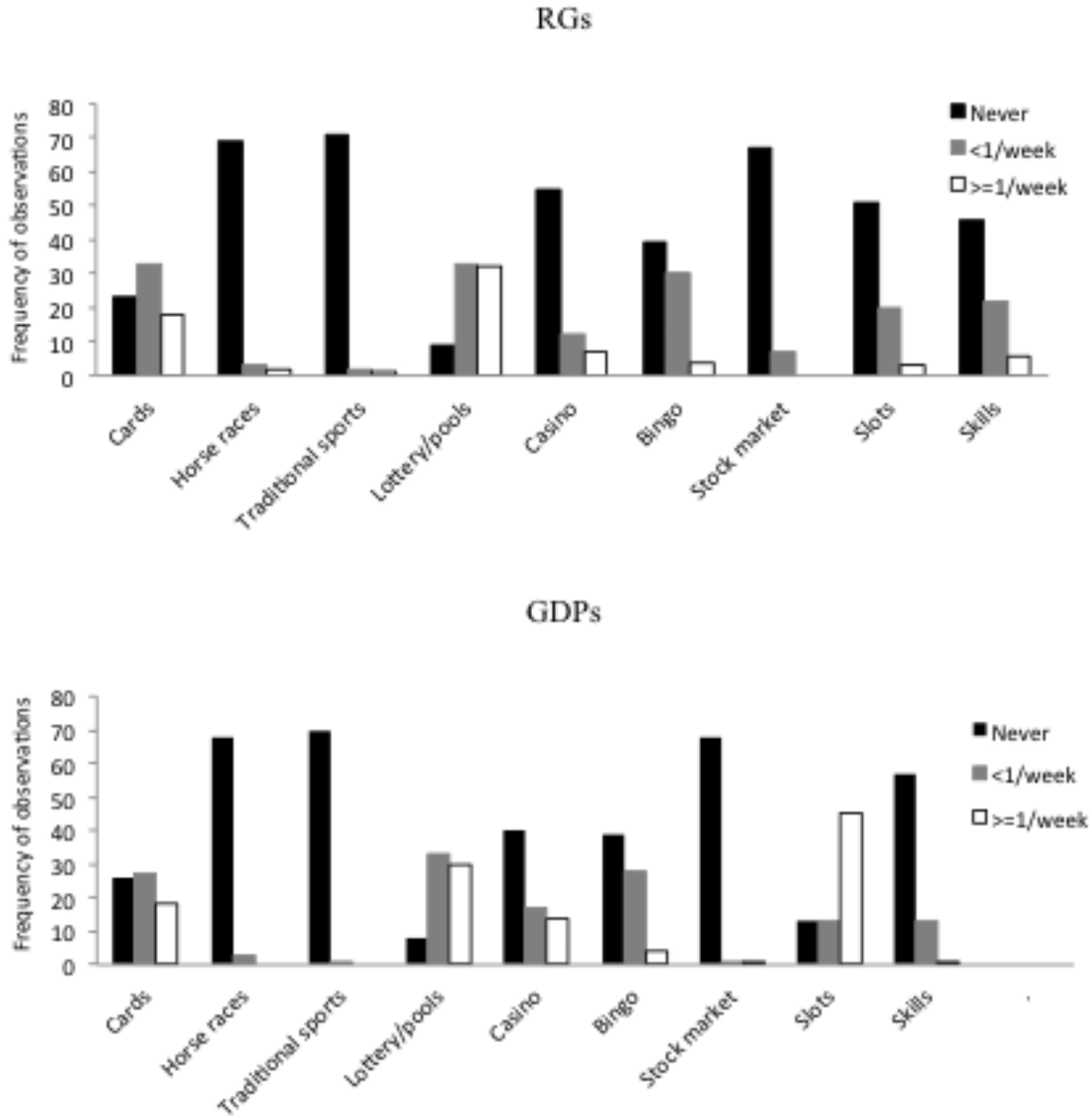
Results

Gambler Subtyping

***Factor analysis of participation in game modalities*.** Figure 1 summarizes gambling frequency for PGD and RG in the modalities under scru-tiny in the Spanish SOGS. Factor analysis was performed on the whole sample of PGD and RG. This strategy is congruent with

the one followed by previous studies validating instruments intended to be relevant in both pathological and non-pathological samples (for example, French, Japanese and Turkish validations of the GRCS scale; Arcan & Karanci, 2015; Grall-Bronnec et al., 2012; Yokomitsu, Takahashi, Kanazawa, & Sakano, 2015). Still, as described below, extra measures were taken to ensure that factor composition was not affected by the dual origin of our sample.

Figure 1. Frequency of observations (total number of responses) in each participation frequency category (never, less than once a week, once a week or more) for gambling modalities, as registered by the Spanish version of SOGS. Upper panel: regular gamblers (RG). Lower panel: patients with gambling disorder (PGD).



Distribution of frequencies was similar across groups for all games, except slot machines, which was strongly over-represented in PGD. In addition, some activities were very infrequent in both groups. To ensure factorizability, we took into account only those activities reaching at least a 5% occasional participation rate (at least <1/week) in the two groups. Consequently, horse-track bets (6.8 and 4.2% for RG and PGD, respectively), traditional sports betting (4.1 and 1.4%), and investing in the stock market (2.8 and 9.5%) were not further considered.

Participation frequency scores in lottery/pools, cards, slot machines, casino games, skill-based games, and bingo were submitted to a principal components factor analysis. (*Pools* here refer to *football pools*, a State-operated form of betting on football results with small amounts of money [€0.75 per 14-match bet] and delayed feedback, for which tickets are sold by licensed lottery agents). The two components resulting from this analysis (Table 1, left panel) accounted for 50.895% variance. Eigenvalues were 1.720 and 1.334 for factors 1 and 2.

Table 1. Results of factoring frequency of participation scores in the different SOGS gambling modalities. Left panel: factor analysis on raw scores. Right panel: factor analysis on residuals resulting from controlling for clinical status.

	Raw scores		**Residuals**	
	1	**2**	**1**	**2**
Cards	.69	-.13	.68	-.08
Lottery/pools	-.33	.62	-.36	.65
Casino games	.63	.23	.66	.08
Bingo	.43	.64	.39	.68
Slot machines	-.03	.66	-.01	.68
Skill-based	.75	-.14	.76	-.01

In order to control for the possibility that correlations between modalities are partially explained by the clinical status of participants, participation scores were regressed over group, and standardized residuals were kept for factor analysis. This yielded almost identical results (Table 1; right panel; 1.76 and 1.36 eingenvalues, and 51.92% explained variance).

Participants' classification based on gambling preferences. As noted earlier, all gamblers were asked to freely report their preferred game. Figure 2 displays cumulated frequency of responses (please note that labels are not exactly the same as in Figure 1, given that, in this case, participants' responses are not referred to any predefined categories).

Gambling preferences differed between PGD and RG, with slot machines favoured among the former, and lotteries/pools among the latter.

These results were used to classify gamblers in two categories. Domino, card games (including poker and blackjack), and roulette players were categorized as Type I, whereas lottery/pools, slot machine, and bingo gamblers were categorized as Type II, on the basis of factor 1 and factor 2 games, as identified by the factor analysis. The final sample consisted of 31 Type I RG, 43 Type II RG, 24 Type I PGD, and 47 Type II PGD (a χ^2 test on these numbers revealed no significant association between preference and group in the total sample, p=.32).

Data in Figure 2 suggest that preferences are more discriminative than participation scores. Our decision to classify gamblers on the basis of preferences, instead of participation scores was based partially on this, but much more strongly on methodological reasons. First, frequency of participation is only an indirect proxy to other gambling measures (there are games that can be played many times without incurring severe losses, whereas others can imply large losses with low playing frequency). In other words, the game with highest frequency is not necessarily the most personally salient or significant. Second, an alternative measure based on estimated factor values would imply dichotomizing a continuous measure (e.g. median-split of the differences between Factor 1 and Factor 2 estimates for each participant). Expressed preferences override these potential problems, although they present some problems of their own (see Limitations section). In view of that, additional analyses were performed to ensure that preferences relate to participation frequencies and portray real behavioral meaning (supplementary materials).

Sociodemographic Variables

Descriptive data for the four group x preference conditions are displayed in Table 2 (rows 1-3). Some data were missing regarding gender (n=1), age (n=2), and years of education (n=4). The two-factor group x preference ANOVA on age yielded an effect of preference, $F(1, 139)=53.69$, $MSE=103.64$, $p<.001$, $\eta^2_p=.28$. The effects of group and group x preference were not significant (min. p=.358). A similar analysis on years of education yielded a significant effect of group, $F(1, 137)=10.38$, $MSE=24.37$, $p=.002$, $\eta^2_p=.07$, but no effect of preference, or group x preference (min. p=.207). Finally, regarding sex, χ^2 tests revealed that the proportion of women was larger in the RG subgroups than in the PGD subgroups: $\chi^2(1)=10.87$, p=.001. In view of these results, multivariate analyses on gambling involvement and severity, impulsivity, delay discounting, reward and punishment sensitivity,

and gambling-related cognitions were performed while controlling age, sex, and education level.

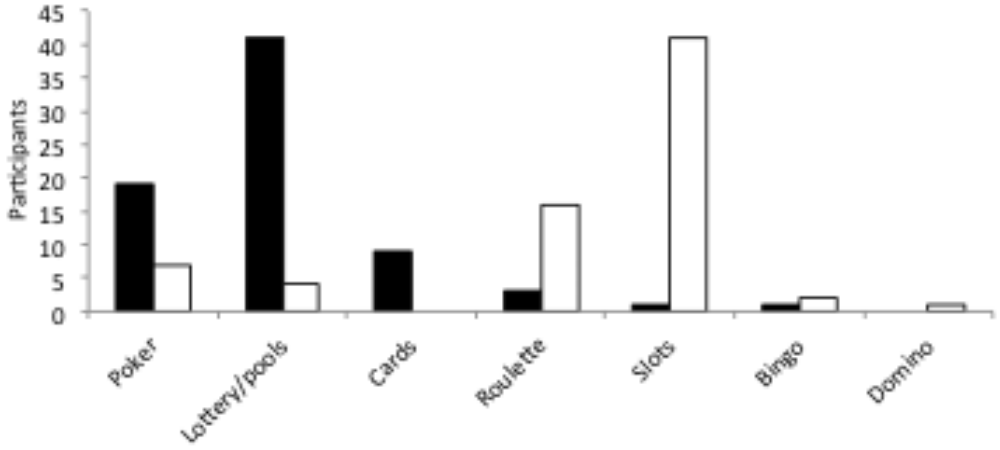
Gambling Severity and Involvement

Table 2 (rows 4-6) displays mean (SD) values for SOGS severity, weekly gambling frequency, and average amount gambled per episode across conditions.

Multivariate effects were found for group and preference, Wilks' λ=.24, p<.001, η^2_p=.76, and Wilks' λ=.93, p=.026, η^2_p=.07, respectively. Table 3 (rows 1-3) displays results of variable-by-variable between-participant effects, revealing that the multivariate effect of preference originated in frequency scores (Type I>Type II).

Impulsivity and Delay Discounting

Figure 2. Number of individuals with predilections for different game types (as freely reported), in patients with gambling disorder (PGD) and regular gambler (RG).



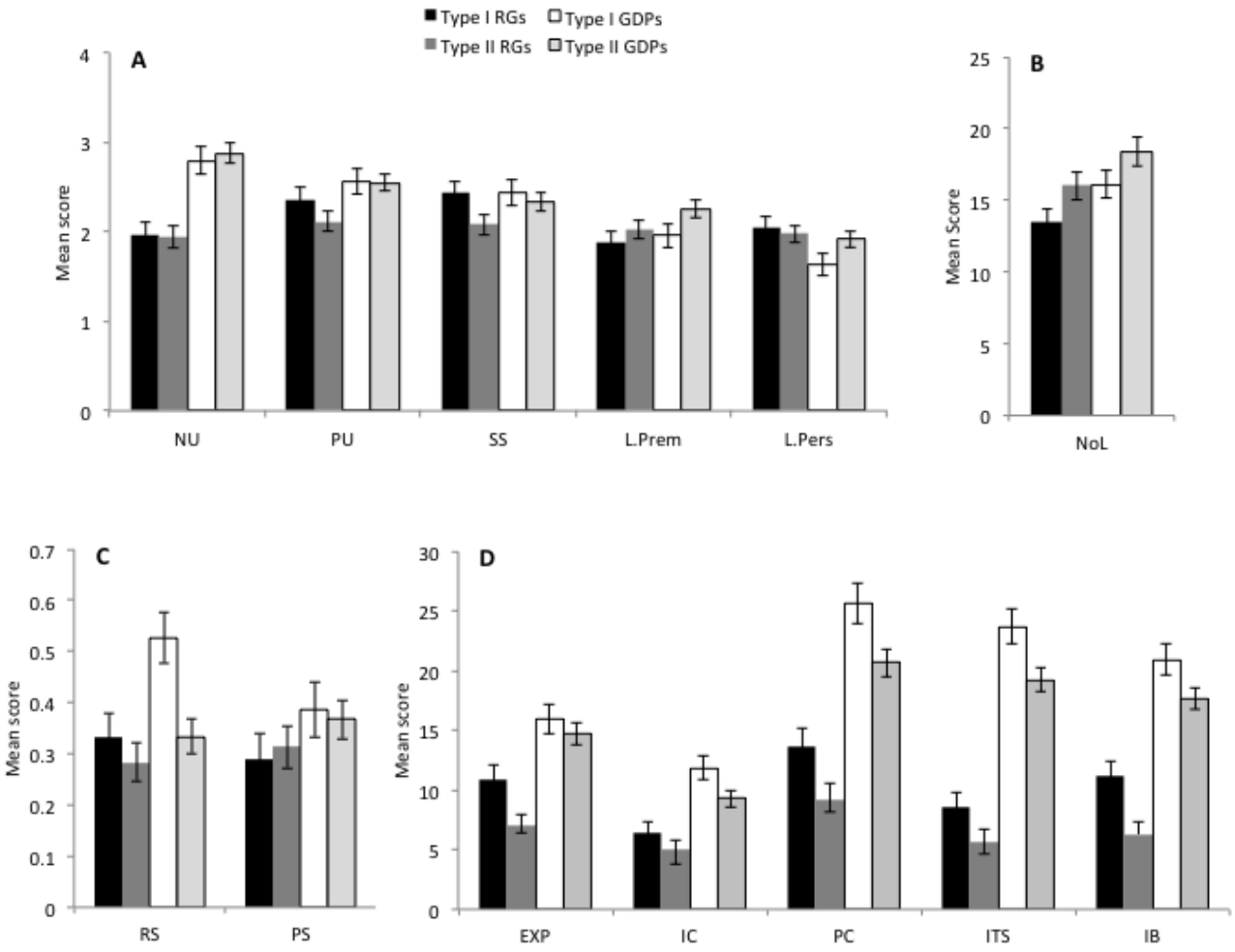
Note: Black bars represent RG group.

Table 2. Mean (SD) for age, years of education, SOGS severity, weekly gambling frequency, and average spending per gambling episode, and total number of males (percentage), across the four subgroups in the study.

	Subgroup (Preference/Group)			
	Type I RG	**Type II RG**	**Type I PGD**	**Type II PGD**
Age	28.68 (9.59)	39.95 (11.08)	27.54 (8.31)	42.06 (10.58)
Years of education	16.23 (3.07)	14.28 (4.88)	12.38 (2.96)	12.60 (6.49)
Sex (male)	26 (83%)	32 (74%)	24 (100%)	45 (96%)
SOGS Severity	1.93 (1.39)	0.95 (1.03)	10.54 (2.36)	10.02 (3.27)
Frequency	4.56 (4.60)	1.71 (1.76)	4.92 (2.82)	4.45 (3.48)
€/ Episode	54.11 (121.94)	6.91 (11.58)	152. 42 (202.36)	151.42 (157.23)

Figure 3 (A, B) displays covariate-corrected mean (SE) UPPS-P and delay discounting scores for the two groups and the two gambling modalities. Some data were missing regarding impulsivity (n=1) and delay discounting (n=4). A multivariate significant effect of group was found in both variables, Wilks' λ=.69, p<.001, η^2_p =.31. Neither the effect of preference (p=.109) nor the interaction were significant (p=.619).

Figure 3. Corrected mean impulsivity, delay discounting, reward and punishment sensitivity and intensity of gambling-related cognitions scores across Type I/Type II Preference conditions and Group (patients with gambling disorder [PGD] vs. regular gamblers [RG]).



Note: NU= negative urgency; PU= positive urgency; SS= sensation seeking; LPrem= lack of premeditation: LPers= lack of perseverance; NoL= now-or-later; RS= reward sensitivity; PS= punishment sensitivity; EXP= expectations; IC= illusion of control; PC= predictive control; ITS= inability to stop; IB= interpretative bias.

Table 3 (rows 4-9) displays variable-by-variable between-participants effects. Positive and negative urgency, and delay discounting scores were higher for PGD than for RG. Lack of perseverance, on the contrary, was slightly higher for RG. Despite the fact that preference did not reach significance in the general MANCOVA, the test on delay discounting revealed more impulsive choices in Type II gamblers.

Sensitivity to Punishment and Reward

Figure 3 (C) shows covariate-corrected mean (SE) sensitivity to reward and sensitivity to punishment scores in the SPSRQ questionnaire. SPSRQ data were missing for 3 participants. Significant multivariate effects of group, Wilks' λ=.93, p=.008, η^2_p =.07, and preference, Wilks' λ=.95, p=.042, η^2_p=.05, were found. The interaction between the two was not significant (p=.197).

Table 3 (rows 10-11) displays between-participants effects. Reward sensitivity reflected the effects of group and preference, whereas PS did not reveal any significant influence of either group or preference.

Table 3. Results for group, preference, and group x preference effects on SOGS clinical measures, impulsivity, delay discounting, reward and punishment sensitivity and intensity of gambling-related cognitions with age, gender, and education years as covariates.

	Group			**Preference**			**Interaction**		
	F	***p***	η^2_p	***F***	***p***	η^2_p	***F***	***p***	η^2_p
SOGS Severity	405.36	**<.001**	.76	0.39	.534	.00	0.48	.492	.00
Frequency	4.37	**.038**	.03	8.85	**.003**	.06	5.44	**.021**	.04
€/Episode	17.26	**<.001**	.12	0.92	.340	.01	0.84	.361	.01
Negative urgency	43.12	**<.001**	.25	0.04	.843	.00	0.23	.632	.00
Positive urgency	7.30	**.008**	.05	0.87	.353	.01	1.37	.244	.01
Sensation seeking	1.11	.294	.01	2.30	.132	.02	1.25	.265	.01
Lack of premeditation	1.76	.187	.01	2.73	.101	.02	0.73	.395	.01
Lack of perseverance	4.03	**.047**	.03	0.68	.412	.01	2.98	.087	.02
NoL choices	6.77	**.010**	.05	4.95	**.028**	.04	0.07	.797	.00
RS	8.64	**.004**	.06	6.39	**.013**	.05	3.27	.073	.02
PS	2.71	.102	.02	0.00	.971	.00	0.24	.623	.00
Expectations	36.42	**<.001**	.21	4.52	**.035**	.03	1.66	.200	.01
Illusion of control	34.07	**<.001**	.20	4.45	**.037**	.03	0.62	.434	.01
Predictive control	67.64	**<.001**	.34	8.18	**.005**	.06	0.04	.845	.00
Inability to stop	144.11	**<.001**	.51	7.13	**.009**	.05	0.46	.499	.00
Interpretative bias	93.66	**<.001**	.41	10.60	**.001**	.07	0.66	.419	.01

Abbreviations: Nol= Now-or-later; RS=Reward sensitivity; PS=Punishment sensitivity

Discussion

The current study classified patients with gambling disorders (PGD) and regular gamblers (RG) according to the modality of their preferred gambling activity. Participants were then assessed in impulsivity, delay discounting, punishment and reward sensitivity, and gambling-related cognitions, with the aim of disentangling the impact of clinical status and gambling preferences on these variables. To our knowledge, this is the first time PGD and RG have been examined in a single study, using the same set of variables.

The PCA on gambling activities successfully identified two factors contributing to participation scores. These two factors were subsequently used to classify participants' reported preferences in Type I (card games, casino games and skill-based bets) and Type II (lotteries/pools, slot machines and bingo). This distinction shows partial overlapping but not full correspondence with the one between strategic and non-strategic games (Grant et al., 2012; Odlaug, Marsh, Kim, & Grant, 2011). Actually, complementary analyses showed that a game customarily classified as chance-based (i.e. roulette) behaviorly and subjectively aligns not only with other casino games, but also with card games and skill-based bets, but diverge from slot machine gambling. This preliminary result, made possible by letting participants freely report their preferred game, somewhat questions the strategic/non-strategic dichotomy/

As expected, there were group differences in urgencies and delay discounting (with higher scores in PGD). Neither sensation seeking nor lack of premeditation yielded significant differences between RG and PGD. Finally, PGD presented lower scores in lack of perseverance. This counter-intuitive difference, and the lack of differences in lack of premeditation, contradicts our hypotheses. On the other hand, Type II gamblers discounted rewards more rapidly than Type I gamblers, but the two did not differ between them in any UPPS-P dimension, including sensation seeking (for which higher scores were expected in Type I gamblers) and lack of premeditation (for which higher scores were expected in Type II gamblers).

In a recent report, urgency has been observed to influence GD symptoms via altered deci-sion-making (Canale, Vieno, Griffiths, Rubaltelli, & Santinello, 2015), and more specifically via diminished reward delay tolerance. Our results, however, seem to show that negative urgency relates to clinical status in a less restricted way. Confirming previous reports, among impulsivity-related dimensions, negative urgency emerges as the clearest marker of gambling disorder (Billieux et al., 2012a; Blain et al., 2015; Cyders & Smith, 2008). Elevated negative urgency stands out as a hallmark of addictive and self-control

disorders (Dir, Karyadi, & Cyders, 2013) and seems to be connected with addictive behaviors via abnormal emotion regulation and dysfunctional coping skills (Adams, Kaiser, Lynam, Charnigo, & Milich, 2012). Importantly, negative urgency seems to be particularly relevant in gambling disorder (Torres et al., 2013), and, following the observed results, arises as a common feature associated with clinical status, regardless of gambling preferences. Accordingly, negative urgency stands as a core treatment target. This is potentially addressable by incorporating emotion regulation strategies into cognitive-behavior packages designed to manage negative emotions that are not necessarily triggered by gambling stimuli.

Gambling preferences were found to be unrelated to lack of premeditation, but were associated with delay discounting. This result suggests the specific vulnerability of Type II gamblers (most of whom are slot machine gamblers in the PGD sample) to executive function-based decision-making anomalies, which replicates the results previously reported by Goudriaan, Oosterlaan, de Beurs, and van den Brink (2005). Importantly, that effect seems independent of socio-demographic factors.

Regarding affective feedback-driven motivation, results did not replicate any of the previous (inconsistent) results regarding gambling severity on punishment sensitivity, in any direction. PGD were not more sensitive to punishment than RG (in contrast to the findings by Álvarez-Moya et al., 2007, and related results by Forbush et al., 2008; Loxton, Nguyen, Casey, & Dawe, 2008; and Nordin & Nylander, 2007). Contrary to our hypothesis, Type II gamblers did not display higher punishment sensitivity than Type I gamblers. In combination with previous results, that lack of effect in all likelihood indicates that PGD samples consist of mixtures of individuals with more or less avoidant/escapist tendencies, but such variability is not necessarily connected to the modality of games they prefer. Neither PGD nor RG showed the difference between Type I and Type II gamblers that would be expected on the basis of Fang and Mowen's (2009) and Balodis et al.'s (2014) results (see supplementary materials for detailed analyses). That opens the hypothesis that Type II gamblers do not necessarily present higher levels of anxiety or neuroticism, but are instead more sensitive to the 'anxiolytic' properties of gambling. The existence of a specific path to addiction vulnerability attributable to the sedative effect of the potentially addictive agent, rather than to previous neuroticism per se, has also been proposed for alcohol abuse (Hendler, Ramchandani, Gilman, & Hommer, 2013).

On the other hand, results were consistent with the hypotheses formulated regarding reward sensitivity. As expected (on the basis of Balodis et al., 2014; Barrault & Varescon,

2013; and Sharpe et al., 1995), collapsing PGD and RG, Type I gamblers were more reward-sensitive than Type II gamblers (in supplementary materials, we briefly discuss how well this global preference effect replicates across clinical status levels). Complementarily, gambling expectancies, as measured by the GRCS, were also elevated in Type I gamblers, which suggests that gambling expectancies substantiate gambling behavior reinforcement, and such reinforcement processes seem to play a more important role in Type I than in Type II gamblers.

Finally, with regard to gambling cognitions, our results mostly confirmed previous reports of stronger cognitive biases in PGD than in non-problem gamblers or healthy controls (Goodie & Fortune, 2013; Jacobsen, Knudsen, Krogh, Pallesen, & Molde, 2007), and are consistent with the higher pervasiveness of biases in strategic gamblers (Myrseth et al., 2010; Toneatto et al., 1997). Among the cognitions under scrutiny, interpretative bias – the tendency to attribute losses to external factors and wins to internal ones, once a gambling episode has finished – showed the strongest difference between preference groups. This effect suggests that cognitive differences appear not only in PGD, but also in regular gamblers. In other words, preference for certain games seems to have an intrinsic link to gambling-related cognitions. Still, the possibility exists that a stronger perception of one's skills is not necessarily distorted. Poker, for example, has an objective skill element, and some other games, though not having a skill element, contain probabilistic or frequency information that can quite accurately be captured by players. Supporting this, some recent evidence (Perales, Navas, Ruiz de Lara, Maldonado, & Catena, 2017) shows that PGD with higher GRCS scores are better at discriminating null from positive contingencies in an instrumental learning task. These results resonate with evidence showing that some PGD are very accurate at capturing statistical information from gambling devices, and that accuracy could contribute to a false sense of mastery (King, Delfabbro, & Griffiths, 2010). In other words, it could be that although both RG and PGD Type I gamblers have an elevated concept of their skills, in PGD, such beliefs – distorted or not in terms of statistical accuracy – are useless to avoid loss accrual and could contribute to the maintenance or aggravation of the disorder.

This is a significant advance in the direction signalled by Fortune and Goodie (2012), according to whom 'there is little consensus on whether distortions might be fruitfully considered separately for the various gambling modalities that lead to pathology, or whether it is more useful to collapse across modalities' (p. 307). According to our results, cognitive

distortions influence both clinical status and gambling preference. So, engaging the right distortions could help prevent and treat problem gambling in general (Ladouceur et al., 2001, 2003; Spurrier & Blaszczynski, 2014), although such interventions will probably have a larger effect in Type I gamblers.

Limitations and Strengths

In the present study we found PGD to differ from RG in a number of traits that had previously been identified as contributing to gambling disorder. Among these, delay discounting, reward sensitivity and gambling-related cognitive distortions also discriminated between gambler subtypes.

The interpretation of results from this study is, however, affected by several limitations. First, its cross-sectional nature precludes causal statements about the correlations found, so that gambling preferences and clinical status could be either causes or consequences of other individual differences. Second, participant selection methods do not ensure representativeness. PGD were selected from a small set of treatment facilities, all of which are federated and have common recruitment and therapy resources, so that we could be targeting a socially distinctive subgroup of PGD. Similarly, RG were recruited via social networks, and again the risk exists that our sample is more socially homogeneous than the whole population. Third, although the sample is large enough to make cross-modality and cross-group comparisons, power is reduced for the analysis of group x modality interactions. Although the direction of modality effects for main dependent variables was the same across PGD and RG, the possibility exists that differences in effects size could emerge with larger samples. Eventually, assessments are limited by the availability of only one validated instrument in Spanish that allows for measurement of frequency of participation in different game types.

To conclude, the main strength of this study is the fact that, to our knowledge, it is the first to simultaneously consider carefully characterized PGD and RG, while exploring individual differences in risk factors for disordered gambling associated with gambling preferences. Future research should explore other variables and, particularly, those yielding the most promising ways to tailor treatments to individual features.

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Appendix

Table A1. Hypotheses regarding relationships of gambler subtypes' preferences and gamblers' clinical status with self-regulation and gambling cognitions.

Variables	Hypotheses	Rationale for Hypotheses
UPPS Positive urgency *UPPS Negative urgency*	PGD>RG	Failure of top-down emotion regulation, common to gambler subtypes and other addictive disorders (Clark et al., 2012; Michalczuk et al., 2011; MacLaren et al., 2011)
UPPS Lack of Premeditation	PGD>RG Type II>Type I	Deterioration of executive functions involved in decision making (shortsightedness) found in slot machine gamblers but not in strategic gamblers (Goudriaan et al., 2005; Grant et al., 2012)
UPPS Sensation Seeking	Type I>Type II	Search for stimulation through skill-based and exciting games (Barrault & Varescon, 2013; Moragas et al., 2015; Sharpe et al., 1995).
UPPS Lack of Perseverance	PGD>RG	Less availability of general cognitive resources, less conscientiousness and more sensitivity to ego depletion in PGD and other addictions (Bagby et al., 2007; Bergen, Newby-Clark, & Brown, 2012).
Delay discounting	PGD>RG Type I>Type II	Deterioration of executive functions involved in decision making (shortsightedness) found in slot machine gamblers but not in strategic gamblers (Goudriaan et al., 2005; Grant et al., 2012).
SPSRQ Reward Sensitivity	Type I>Type II	Positive reinforcement, not necessarily problematic, and previous associations with skill-based and exciting games (Balodis et al., 2014; Sharpe et al., 1995).
SPSRQ Punishment Sensitivity	Type I<Type II	Negative reinforcement/coping-based gambling previously associated with non-strategic games (Balodis et al., 2014).
GRCS Predictive Control *GRCS Interpretative Bias* *GRCS Illusion of Control*	PGD>RG Type I>Type II	Illusions linked to beliefs in a hidden causal structure underlying gambling outcomes, either related to one's instrumental or pattern-detection skills (more related to skills-based games; Toneatto et al., 1997; Myrseth et al., 2010).
GRCS Expectations	PGD>RG	Related to both positive and negative reinforcement processes. Unlikely to reflect gambling preferences.
GRCS Perceived inability to stop	PGD>RG	Perceived failure of self-control that can be related to various factors, independent of game preferences.

Note: References regarding rationale for hypotheses are illustrative, not exhaustive. Abbreviations: PGD=patients with gambling disorders group; RG=regular gamblers group.

Supplementary materials.

Post-hoc comparisons in group x preference interactions

The origins of main group, preference, and group x preference effects (as reported in Table 1) were explored using Bonferroni-corrected pairwise comparisons (restricted analyses of covariance) for each possible pair of subgroups. All pairwise comparisons were corrected for potential confounders. Pairwise comparisons were performed regardless of whether the group x preference interaction was significant or not. This was done to test whether or not main preference effects were significantly reproduced across the two clinical status groups.

Gambling Involvement and Severity

Type I regular gamblers (RG) differed from Type I patients with gambling disorder (PGD) in SOGS severity, and from Type II PGD in SOGS severity and amount gambled per episode. Type II RG differed from both PGD subgroups in the three variables (SOGS severity, frequency, and amount gambled per episode). Finally, and most importantly, Type I RG gambled more frequently than Type II RG. In other words, although Type I and Type II PGD are well matched in gambling severity and involvement (and despite the fact that none of the RG group gamblers qualified as potentially pathological gamblers according to their SOGS severity score), Type II RG were significantly less involved in gambling activities than Type I RG, and PGD. In view of that difference, we added gambling frequency as a potential confounder in all further comparisons involving Type II RG.

UPPS-P Impulsivity and Delay Discounting

Bonferroni-corrected pairwise comparisons between the four subgroups (controlling for gambling frequency in comparisons involving Type II RG) in all impulsivity variables revealed the two PGD subgroups to score higher than the two RG subgroups in negative urgency, and Type II PGD to make more impulsive choices than Type I RG. No other differences were significant.

Sensitivity to Punishment and Reward

Bonferroni-corrected pairwise comparisons showed Type I PGD to score higher in RS than Type II PGD and Type II RG, but not Type I RG. No other differences were significant.

Gambling-related Cognitions

Bonferroni-corrected pairwise comparisons revealed differences between Type I and Type II RG in interpretative bias (Type I>Type II RG), between Type I RG and Type I PGD (Type I PGD>Type I RG) in all dimensions, between Type I RG and Type II PGD (Type II PGD>Type I RG) in inability to stop and interpretative bias, between Type II RG and Type I PGD (Type I PGD>Type II RG) in all dimensions, between Type II RG and Type II PGD in all dimensions (Type II PGD>Type II RG), and between Type I PGD and Type II PGD in control illusion (Type I PGD>Type II PGD).

Interpretation of Post-hoc Differences and their Relation to Main Group and Preference Effects

With regard to impulsivity-related measures, there were global group differences in positive and negative urgency, and delay discounting (with higher scores in PGD). Neither sensation seeking nor lack of premeditation yielded significant differences between RG and PGD, and PGD presented lower scores in lack of perseverance. On the other hand, Type II gamblers discounted rewards more rapidly than Type I gamblers, but the two did not differ between them in any UPPS-P dimension, including sensation seeking and lack of premeditation.

Pairwise comparisons confirmed heightened levels of negative urgency in the two PGD subgroups, compared to the two corresponding RG subgroups. In the case of delay discounting, effects of clinical status and preference were significant, but pairwise comparisons yielded a difference only between the two most extreme subgroups (Type I RG and Type II PGD, with higher scores for the latter).

Regarding reward and punishment sensitivity, results did not yield any effect of clinical status in any direction. However, collapsing PGD and RG, Type I gamblers were more reward-sensitive than Type II. This effect was mostly attributable to Type I PGD, with Type I RG not differing from any of the two Type II subgroups. Thus, although we cannot exclude the existence of a trend of Type I RG towards elevated reward sensitivity, that trend became detectable only at problematic levels of gambling.

Finally, in relation to gambling-related cognitions, global analyses showed both group and preference effects, with Type I gamblers and PGD showing stronger biases. Importantly, control illusion, interpretative bias and predictive control showed very similar patterns of differences across the two clinical status groups. The effect of

preference, however, only survived alfa-growth correction for interpretative bias in the RG group, and for the control illusion bias in the PGD group.

Relationships between Self-reported Gambling Preferences and Participation Scores

As noted in the Method section, participants were classified as Type I or Type II on the basis of their self-reported preferences, whereas gambling modalities themselves were defined based on correlations between participation scores. The following analyses were carried out to ensure that preferences are meaningful in terms of actual gambling behavior.

First, we performed a binary logistic regression analysis, using frequency of participation scores as predictors, and Type I/Type II classification group as dependent variable. The resulting model correctly classified 72.7% of Type I gamblers, and 87.6% of Type II gamblers. $\chi^2(6)=73.293$, $p<.001$, Nagelkerke's $R^2=.54$. The games types significantly contributing to that model were card games and casino games (B=-1.875, SE=0.371, p<.001; B=-1.262, SE=0.350, p<.001), increasing the odds of Type I classification, and slot machines (B=1.158, SE=0.333, p<.001), increasing the odds of Type II classification. The independent contribution of lotteries, bingo, and skill-based bets remained non-significant (p=.083; p=.116, and p=.246, respectively).

A complementary multivariate analysis of variance (MANOVA) on the 6 participation frequency scores, with preference group as independent factor, showed a very strong preference multivariate effect (Wilks' λ=.585; $p<.001$, $\eta^2_p=0.42$). On a game-by-game basis, this effect was non-significant for bingo (p=0.521), but significant for cards, lotteries, casino games, slot machines, and skill-based bets (η^2_p =.21, .10, .11, .08, and .11, respectively; $p \leq .001$ in all cases).

These analyses suggest that classification based on preference was strongly related to participation frequency scores, as recorded by the SOGS. It is important to note that casino games comprise both skill- and pure chance-based games, so it is likely that frequency scores for casino games are mixed. However, casino games aligned with card and skill-based bets, and its discriminative value was in the opposite direction of slot machines and lotteries.

Finally, and in order to reinforce this conclusion, we identified those participants who reported their preferred game to be roulette. Following an anonymous reviewer's

advice, we singled these participants out because roulette, despite being the most representative casino game, is a pure chance-based game. In total, there were 18 roulette players in our sample (see Figure 2). For all of them, we computed the standardized participation score in card games, lotteries, casino games, bingo, slot machines, and skill-based bets. Corresponding scores, after discounting the effect of clinical status, were .210, -.212, .953, -.015, -.556, and .345. In other words, roulette players were, obviously, mostly casino players, but were also more likely to simultaneously bet on own skills, and to be card players. Importantly, they were less likely to be slot-machine players. This pattern convincingly supports the inclusion of roulette players as Type I gamblers in further analyses.

CAPÍTULO 2:
Associations between affect-driven impulsivity and gambling-related cognitive distortions in community and clinical samples

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Abnormal cognitions are among the most salient domain-specific features of gambling disorder. The aims of this study were (a) to examine and validate a Spanish version of the Gambling Related Cognitions Scale (GRCS; Raylu & Oei, 2004), and (b) to examine associations between cognitive distortion levels, impulsivity, and gambling behavior.

The present study firstly recruited a convenience sample of 500 adults who had gambled during the previous year. Participants were assessed using the Spanish GRCS (GRCS-S) questionnaire, the UPPS-P impulsivity questionnaire, measures of gambling behavior, and potentially relevant confounders. Robust confirmatory factor analysis (CFA) methods on half the sample were used to select the best models from a hypothesis-driven set. The best solutions were validated on the other half, and resulting factors were later correlated with impulsivity dimensions (in the whole n=500 factor analysis sample) and clinically relevant gambling indices (in a separate convenience sample of 137 disordered and non-disordered gamblers; validity sample).

Our study supports the original five-factor model, suggests an alternative four-factor solution, and confirms the psychometric soundness of the GRCS-S. Importantly, cognitive distortions consistently correlated with affect- or motivation-driven aspects of impulsivity (urgency and sensation seeking), but not with cognitive impulsivity (lack of premeditation and lack of perseverance).

Our findings suggest the GRCS-S is a valid and reliable instrument to identify gambling cognitions in Spanish samples. Our results expand upon previous research signaling specific associations between gambling-related distortions and affect-driven impulsivity in line with models of motivated reasoning.

Introduction

Gambling Disorder (GD) is defined as persistent and recurrent problematic gambling behavior leading to clinically significant impairment or distress (American Psychiatric Association, 2013). In the European Union, for example, problem gambling rates have been found to range from 0.3% to 3.1% (Planzer, Gray, & Shaffer, 2014). In Spain specifically, epidemiological research points to high rates of gambling behavior, and specific culturally bound types of gambling (e.g. state lotteries, pervasive slot machines) are thought to encourage such behaviors (Jiménez-Murcia, Fernández-Aranda, Granero, & Menchón, 2014). Demographic variables (gender, age and education levels), personality traits, schedules of reinforcement, comorbid states (drug and alcohol abuse, obsessive compulsive disorder, personality disorders), and delinquency/illegal acts have been identified as risk factors for problematic gambling (del Pino-Gutiérrez et al., 2016; Johansson, Grant, Kim, Odlaug, & Götestam, 2009; Petry, Stinson, & Grant, 2005). Cognitive-behavioral therapy (CBT) is regarded as being effective at treating GD (Oei, Raylu & Casey 2010; Raylu & Oei, 2010; 2016; Yau & Potenza, 2015), though relapse and dropout rates in such interventions remain high (Aragay et al., 2015). In order to enhance currently available treatment options, a better understanding of the mechanisms underpinning GD is crucial.

Recently, the role of altered gambling cognitions in the etiology and maintenance of GD has received increased interest from researchers and clinicians alike (Raylu & Oei 2002; Fortune & Goodie, 2012; Goodie & Fortune, 2013); although it has also been suggested that the causal link between GD and gambling cognitions could be bidirectional (so that GD, and its accompanying cognitive distortions, can remit spontaneously, or as a consequence of treatments not explicitly targeting such distortions, e.g. Echeburúa, Báez, & Fernández-Montalvo, 1996). Numerous studies have identified common patterns of distorted thinking in individuals with GD, and such patterns have been linked to the frequency of gambling behavior and GD severity (Emond & Marmurek, 2010). For example, the term *the gambler's fallacy* refers to the cognitive distortion that a win will follow a sequence of losses even though outcomes occur independently of each other and are therefore unpredictable (Delfabbro, 2004). Similarly, gamblers may be of the belief that they themselves are able to influence gambling

outcomes through the use of strategies, rituals or lucky charms (Illusion of control; Teed, Finlay, Marmurek, Colwell, & Newby-Clark, 2012). Other cognitive distortions involve the over-interpretation of signals of gambling skills, attributional errors, selective memory and probabilistic bias (Cantinotti, Ladouceur & Jacques, 2004; Goodie, 2005; Ladouceur & Sévigny, 2005).

The Gambling Related Cognitions Scale (GRCS) is an instrument that assesses five domains of gambling-related cognition in clinical and non-clinical gamblers (Raylu & Oei, 2004). These domains consist of cognitions related to: interpretative bias, illusion of control, predictive control, gambling expectancies and perceived inability to stop gambling (see the Measures section for details on the meaning of each domain). The GRCS has been found to be highly reliable (scale Cronbach's α=0.93, domain Cronbach's α=0.77–0.91) and criterion-valid when tested against the South Oaks Gambling Screen (SOGS) (Whelan, Meyers, & Steenbergh, 2007), a widely used instrument for assessing gambling-related behavior (Lesieur & Blume, 1987; Stinchfield, 2002). Validated versions of the GRCS have been developed for Chinese (Oei, Lin, & Raylu, 2007), Japanese (Yokomitsu & Takahashi, 2015), Turkish (Arcan & Karanci, 2015), French (Grall-Bronnec et al., 2012) and Italian samples (Donati et al., 2015; Iliceto et al., 2015).

Gambling cognitions have clinical implications: gamblers who identify and correct their gambling cognitions have greater treatment adherence than gamblers who do not (Ladouceur et al., 2001). Thus, a Spanish validated, self-report questionnaire for the assessment of gambling cognitions is an essential preliminary step for conducting research on gambling cognitions and to determine their role in the efficacy of treatment interventions for GD patients in the Spanish population[1].

Interestingly, impulsive personality traits in problem gamblers have been found to correlate with gambling cognitions and it has been hypothesized that an impulsive decision-making style could increase the acceptance of erroneous beliefs during the execution of gambling behavior (Michalczuk, Bowden-Jones, Verdejo-García, & Clark, 2011). Somewhat counterintuitively, gambling cognitions, and particularly the illusion of control bias, were observed to be more closely linked to affect-driven impulsivity (positive and negative urgency, the tendency to act rashly under the influence of

[1]Preliminary test of a provisional version of the scale suggest that it is also usable, with minor alterations, in other Spanish-speaking communities (Jara-Rizzo, Navas, & Perales, 2016).

emotional states), than to cognitive impulsivity (lack of premeditation and lack of perseverance). In line with this evidence, gambling related cognitions also correlate with anomalies in emotion regulation abilities (Navas, Verdejo-García, López-Gómez, Maldonado, & Perales, 2016), as commonly observed in other putative behavioral addictions (Wolz et al., 2015). This supports the idea that gambling cognitions are self-serving, that is, they help gamblers curb negative affective states generated by aversive events (e.g. losses), and encourage them to keep on gambling, as suggested by motivated reasoning models (Kunda, 1990).

The aims of the current study were: a) to develop a Spanish version of the GRCS (GRCS-S) and examine its validity and reliability in Spanish samples, and, b) to assess associations between cognitive distortion levels, measures of impulsivity, and gambling behavior. In line with previous evidence, we hypothesize cognitive distortions in gamblers to be linked, on the one hand, to problematic aspects of gambling behavior and gambling severity, and, on the other hand, to affect-driven impulsivity traits.

Method

Participants and Procedure

Data were collected between October 2012 and March 2015. A first convenience sample of 500 individuals was selected for factor analyses (henceforth *factor analysis sample*). The only criterion for inclusion in this sample was having gambled at least once during the year before the assessment. Subsequently, using random number generation, this sample was split in two groups of 250 subjects (henceforth *Subsets A* and *B*; see Table 1, upper panel).

For validity analyses, a different convenience sample of 137 participants (henceforth, *validity sample*) was used (Table 1, lower panel). This sample was composed of (a) treatment-seeking gamblers from three outpatient clinics (*Asociación Granadina de Jugadores de Azar en Rehabilitación*, *Asociación Provincial Linarense de Jugadores de Azar en Rehabilitación*, and *Asociación de Ludópatas Jiennenses en Rehabilitación*), in the cities of Granada, Linares, and Jaén (Andalusia, Spain), and (b) non-treatment-seeking gamblers meeting the same inclusion criterion described above. Exclusion criteria for this sample were: (a) having a history of neurological disease or

brain trauma causing unconsciousness for 10' or longer and (b) having been in treatment for a psychiatric disorder other than GD, in the case of GD patients. Time in treatment for GD patients ranged between 1 and 21 months (*Mean*=5.206 months, *SD*=4.963). 52% of these patients had been in treatment for three complete months or less.

Table 1. Participant characteristics

	Factor analysis sample	
	Subsample A	Subsample B
n	250	250
Mean (SD) age	21.56 (7.04)	23.22 (9.63)
% Females	40.5	42.08
	Validity sample	
n	137	
Mean (SD) age	34.96 (0.99)*	
% Females	16.78**	
% of n diagnosed as GD	37.23	
% of n with SOGS >=5	40.88	

* Age information was lost for 4 participants. ** Gender information was lost for 3 participants

Most of the factor analysis (n=500) sample was extracted from the same pool of participants assessed for a study by Navas, Torres, Cándido and Perales (2014). These participants were contacted in the University of Granada facilities, by means of Internet posting, or through people who had already participated in the study (so that most were college students), and took part in-group assessment sessions carried out in several lecture rooms at the University of Granada. Only those who had gambled at least once in the last year were later selected as members of the factor analysis sample. Extra participants were recruited and assessed in the same way until an n=500 sample size was reached. In the group sessions, after being debriefed about aims and procedures (via written and read-aloud instructions), and providing informed consent, they filled out all

the questionnaires described below except the South Oaks Gambling Screen (SOGS, Spanish version; Echeburúa et al., 1994) in random order. Participants in this sample were not paid, although college students taking courses from the Department of Experimental Psychology, University of Granada, at that time obtained course credits for their participation. Each session lasted approximately 30 minutes.

The validity sample (n=137) partially overlaps with the one in Navas et al., (2017), and consisted of both disordered and non-disordered gamblers. Treatment-seeking gamblers in this sample (51 participants) were contacted through their treatment centers. For these gamblers, all assessments were conducted individually and face-to-face. After welcoming the participant and obtaining his/her consent, the assessment began. In these patients, assessments were part of a larger protocol aimed at carrying out a detailed evaluation of behavioral and neurobiological correlates of gambling (see, for example, Navas et al., 2016, and Perales, Navas, Ruiz de Lara, Maldonado, & Catena, 2017). The whole protocol was divided into two sessions, and all the instruments mentioned here were administered during the first session, lasting for approximately 3 hours. Participants were not compensated in this session (although they were paid approximately €10/hour in the second session, with payment being channeled through the treatment center or a responsible relative). The clinical assessment, including GD and potential comorbidities diagnosis, was carried out by a professional therapist in the treatment center. All other assessments were carried out by a trained psychologist with extensive experience in clinical evaluations (third author). Beyond clinical diagnosis, fulfillment of inclusion/exclusion conditions was reported by the participant.

Non-treatment-seeking gamblers in the validity sample (86 participants) were contacted through people who had already participated in the study, by Internet posting or by personal contacts. They were individually assessed, or, alternatively, received the materials via e-mail, and were asked to fill the questionnaires at home, and return them again via e-mail. These off-site participants were informed about the participation conditions (exclusion/inclusion criteria) and debriefed about their task by phone. They were then sent an e-mail with a fact sheet about the study aims and the conditions of consent. After formal consent was obtained, they received a second e-mail with full instructions and the questionnaires. On-site assessments were carried out by the third

author on an individual basis. In this case, the presence of psychiatric comorbidities was assessed by means of a structured interview carried out by the same evaluator. Completion time for the set of questionnaires was approximately 45 minutes.

The study procedures were carried out in accordance with the Declaration of Helsinki. The Ethics Committee of Clinical Research at the University of Granada approved the study as part of the funded PSI2013-45055-P project. All subjects were informed about the study and all provided signed consent.

Measures

***Spanish Gambling Related Cognitions Scale* (GRCS-S).** The original GRCS questionnaire (Raylu & Oei, 2004) assesses five gambling-related cognitive domains through 23 7-point Likert style items. *Inability to stop gambling* (*ISG*, e.g. 'I'm not strong enough to stop gambling') and *gambling expectancies* (*GE*, e.g. 'Gambling makes things seem better'), refer to personal beliefs of lacking the ability or capacity to control gambling impulses, and overvaluing the joy, reward or relief that can be obtained from gambling, respectively. *Illusion of control* (*IC*, e.g. 'Praying helps me win'), *predictive control* (*PC*, e.g. 'Once I have a won, I will definitely win again'), and *interpretative bias* (*IB*, e.g. 'Relating my losses to bad luck and bad circumstances makes me continue gambling') are cognitive distortions involving causal attribution processes.

The English-language GRCS questionnaire was translated into Spanish, and then back-translated into English by a native, English-speaking bilingual translator. Potential discrepancies between the original and back-translated versions of the questionnaire were discussed and eventually polished from the Spanish version by the translator and one of the authors (see supplementary materials, Appendix 1 for the final version).

Brief UPPS-P impulsivity scale (Spanish version; Cándido, Orduña, Perales, Verdejo-García, & Billieux, 2012). This scale contains 20 items (4 items per dimension), and allows for a quick multidimensional assessment of impulsivity: positive urgency (e.g. 'I tend to lose control when I am in a great mood'), negative urgency (e.g. 'When I am upset I often act without thinking'), (lack of) premeditation (e.g. 'My thinking is usually careful and purposeful'), (lack of) perseverance (e.g. 'Once I get going on something I hate to stop'), and sensation seeking (e.g. 'I quite enjoy taking risks ').

MultiCAGE CAD-4 (Pedrero Pérez et al., 2007). This instrument is a quick screening tool to detect alcohol misuse, and illegal drug misuse among other problematic behaviors beyond the scope of this study. Each subscale is consists of four yes/no items, checking for current feelings of craving, others´ complaints about the potential problematic behavior, guilt or shame feelings and/or lack of self-acknowledgment, and self-reported compensatory behaviors. The scales of alcohol and illegal drug misuse have shown appropriate psychometric properties and predictive validity of alcohol and drug abuse. In the present study the illegal drug and alcohol subscales were used as control variables to check for GRCS-S domain-specificity.

South Oaks gambling Screen (SOGS, Spanish version; Echeburúa, Báez, Fernández-Montalvo, & Páez, 1994). This questionnaire is aimed to assess gambling severity, dependence, and debt accrual. It is the most commonly used tool in gambling research, a fact that allows comparisons across studies. The Spanish version used in this study has shown good psychometric properties. It comprises 16 items, 12 of which are worded as yes/no questions, and count for calculating the SOGS dependence, debt, and total severity indices.

Statistical Analysis

Preliminary analyses and selection of estimation method. Preliminary analyses showed that all variables of interest had non-normal distributions in the factor analysis sample, with strong violations of skewness and kurtosis. This fact, along with the use of ordinal measure scales (Muthén & Kaplan, 1985), led us to consider all the variables as discrete, and to use analyses and estimation methods appropriate for them (Babakus, Ferguson, & Joreskog, 1987). Hence, we used a robust method for the estimation of models (DWLS: *Diagonal Weighted Least Square*; Babakus et al., 1987; Schumacker & Beyerlein, 2009). The inputs for DWLS implementation are a polychoric correlation matrix, suitable for ordinal data, and an asymptotic covariance matrix, that the software uses to adjust the estimation in presence of extreme values.

Factor analyses. For testing and comparison purposes, we took four different nested factorial solutions into consideration: (a) The original 5-factor model, composed of Gambling expectancies, Illusion of control, Predictive control, Inability to stop gambling, and Interpretative bias. (b) A 4-factor solution formed by Gambling

expectancies, Inability to stop gambling and Predictive control, plus a fourth factor obtained by merging Illusion of control and Interpretative bias items. (c) A 3-factor solution composed of Gambling expectancies, Inability to stop gambling, and a third factor obtained by merging Illusion of control, Predictive control and Interpretative bias items. (d) And finally, a one-factor solution resulting from loading all the items on a single factor. Model *b* was based on the assumption than Illusion of control and Interpretative bias refer to illusory perceiving a connection between one's behavior and gambling outcomes (either *a priori* or retrospectively). Model *c*, on the other hand, reflects the fact that Illusion of control, predictive control, and the interpretative bias are distortions in the realm of causal and contingency-based cognition (see Perales et al., 2017).

The traditional goodness-of-fit measure, χ^2 assesses the magnitude of discrepancy between the sample and fitted covariance matrices (Hu & Bentler, 1999). However, χ^2 is sensitive to sample size, and tends to reject the model as the sample grows larger (Bentler & Bonnet, 1980; Jöreskog & Sörbom, 1993). Additionally, it does not provide enough information to discriminate between different models applied upon the same dataset. In view of these features, we used several alternative indices (Schermelleh-Engel, Moosbrugger, & Müller, 2003), namely $\Delta\chi^2$, relative χ^2, *RMSEA* (*Root Mean Square Error of Approximation*), *NFI (Normed Fit Index*), *CFI*, (*Comparative Fit Index*) and *ECVI* (*Expected Cross Validation Index*).

The statistic $\Delta\chi^2$, suitable for nested models, is the difference between the χ^2 values of two hierarchical models estimated with the same data. This difference is tested on the χ^2 table with degrees of freedom equal to the difference between the two respective values of degrees of freedom. A non-significant result leads to choosing the most parsimonious model (i.e. the model with fewer factors). Contrarily, when $\Delta\chi^2$ is significant, the best fitted solution is the least parsimonious model (i.e. the model with more factors) (Cheung & Rensvold, 2002; Gallucci & Leone, 2012). Relative χ^2 is the odds between χ^2 and its degrees of freedom, and its acceptance criterion varies among researchers, ranging from a value of less than 2 to a value of less than 5 (Schumacker & Lomax, 2004; Tabachnick & Fidell, 2007; Ullman & Bentler, 2003). RMSEA is a measure of the distance between the perfect model and the estimated model. It is not

affected by sample size and values lower than 0.05 are assumed to imply a good fit (Hu & Bentler, 1995). NFI (Tucker & Lewis, 1973) and CFI (Bentler & Bonett, 1980), compare the model of interest with alternative ones, such as the null or independence model Values higher than 0.95 are acceptable, and those higher than 0.98 are optimal (Bentler, 1990). ECVI is the discrepancy between the covariance matrix in the analyzed sample and the covariance matrix that would be expected in a different sample with the same size (Joreskog & Sorbom, 1993). The model with the smallest ECVI indicates the best fit.

As noted above, for factor analyses, the sample was divided into two subsamples (n=250). The first (Dataset A) was used for model estimation, whereas the second (Dataset B) was used for model replication. Factor intercorrelations were computed using a non-parametric method (Spearman's Rho), separately for the two subsamples. Reliability of the factors was computed using the intraclass correlation coefficient (*ICC*; Gallucci & Leone, 2012), again separately for the two subsamples.

Concurrent and criterion validity. Non-parametric correlational analysis (Spearman's Rho) was used to test GRCS-S convergent validity with SOGS, and specificity, with MultiCAGE alcohol and drug scores (using the n=137 validity sample, and the whole n=500 factor analysis sample, respectively). For criterion validity, a classification tree (Breiman, Friedman, Olshen, & Stone, 1984) was performed, using the variables from the best-fitting GRCS-S model as discriminative factors, and the recommended threshold for clinical significance (SOGS' severity>=5) as criterion of group membership. Non-parametric correlation analyses were used to test GRCS-S/UPPSP links in the factor analysis (n=500) sample. Parametric partial correlation analyses (controlling for clinically-significant gambling) were used to further test and replicate GRCS-S/UPPS links in the validity n=137 sample.

Preliminary and correlation analyses were conducted with Statistical Package for the Social Sciences (SPSS 20) software. Factor analyses were performed using LISREL 8.80 software (Jöreskog & Sörbom, 2006). PRELIS software was used for goodness-of-fit estimation (Jöreskog & Sörbom, 2006).

Results

Factor Analysis

Fit indices for Subset A from the factor analysis sample are shown in Table S1 (left panel). Although all the solutions have good or very good fit indices, the four- and the five-factor solutions stand out as the best models. The comparison indices between these two solutions showed a lower *ECVI* for the four-factor solution (1.65 vs. 1.68, for four- and five-factor solution respectively) and a non-significant $\Delta\chi^2$. In other words, although models *a* (the original one) and *b* (four factors, merging the two biases on own behavior's impact on gambling outcomes) are viable, a parsimony criterion would lead to selecting the latter.

In general, all the results for Subset B (Table S1, right panel) confirmed the ones obtained in Subset A, except for a slightly weaker strength. Again, the four- and five-factor solutions clearly beat the other models. ECVI for the four- and the five-factor solutions were virtually identical (1.86 vs. 1.85) and the $\Delta\chi^2$ value was not significant. The four- and five-factor models thus provide equivalent fits, with the former being preferable in terms of parsimony.

Factor Inter-correlation

Intercorrelation analyses were run on 8 factors (the 5 original ones, plus IC + IB, IC + IB + PC, and the one merging all the items together). All the correlations were significant and above 0.40 for Subset A (Table 2a) and Subset B (Table 2b). Intercorrelations between individual factors are in a range slightly higher than the one reported for the original scale (0.49, -0.62 in Raylu & Oei, 2004). As in the original scale, the highest correlation was observed between PC and IB.

Reliability

Reliability outcomes are presented in Table 3. The overall scale showed an excellent value. For Subset A of the factor analysis sample, values were good for IC + PC + IB, IC + IB, ISG, and PC. Values were acceptable for GE and IB, and just sufficient for IC (for threshold values see George & Mallery, 2007). Reliabilities were very similar for Subset B, although with slightly lower values. These results provide further proof of the goodness of the four-factor solution. Indeed, this solution does not isolate the factor Illusion of Control, which is the only one with low internal consistency in the validation subsample.

Although the size of the validity (n=137) sample was not large enough for factor analysis purposes (see results below for validity analyses), we did compute reliability indices for all factors in this sample. ICC values were .77 (GE), .68 (IC), .84 (PC), .92 (ISG), .89 (IB), .88 (IC+IB), 1.00 (IC+IB+PC), and .95 (full scale). That is, despite the smaller sample size, increasing the range of gambling severity scores (this sample was composed of both GD patients and non-disordered gamblers) slightly improved reliability of the subscales. IC remained, however, on the limit of acceptability.

In previous reports, reliability values (Cronbach's a) were .87 (GE), .87 (IC), .77 (PC), .89 (ISG), .91 (IB), and .93 (full scale), for the original scale, and .73 (GE), .75 (IC), .76 (PC), .84 (ISG), and .79 (IB), averaged across translations (French, Turkish, Japanese, Chinese, and Italian). In terms of both order and magnitude, these reliabilities are well matched by the ones found in our validity sample.

Validity

***Concurrent validity*.** Correlations of GRCS-S factors with SOGS scores (in the validity sample) and MultiCAGE CAD-4 subscores (in the factor analysis sample) are shown in Table 4. As expected, GRCS-S scores strongly correlated with SOGS measures (dependence, debt, and total severity score). ISG was the factor showing the strongest correlation with SOGS scores, followed by the factors including IB (either isolated or in combination with IC and PC), and by PC, GE and IC. Interestingly, GRCS-S factors did not significantly correlate either with alcohol- or illegal drug-related problems, which unveils a very strong specificity of the measured cognitions with regard to potentially problematic aspects of gambling.

***Criterion validity*.** Using the recommended threshold (Lesieur & Blume, 1987), the 137-participant validity subsample was divided into two groups of problematic (SOGS≥5, n=51) and non-problematic (SOGS<5, n=86) gamblers[2]. A classification tree (Breiman, Friedman, Olshen, & Stone, 1984) was performed, using the variables from the four-factor model to discriminate between groups. Results yielded a three-node tree wherein three of the four factors (i.e. ISG, IC + IB, and GE) correctly categorized 95.3% of non-problematic and 84.3% of problematic gamblers (total %=91.2%). After the third node, PC did not improve the percentage of correct categorization. The *I* effect size index (the improvement in classification capacity beyond chance; Henson, Natesan, &

Axelson, 2014) yielded a value of 0.82 (customarily interpreted as very good; Hess, Olejnik, & Huberty, 2001).

Table 2a. Factor inter-correlation for subset A from the factor analysis sample

	GE	IC	PC	ISG	IB	IC+IB	IC+PC+IB	TOT
GE	1							
IC	.57	1						
PC	.69	.64	1					
ISG	.70	.65	.64	1				
IB	.75	.60	.79	.67	1			
IC+IB	.75	.87	.80	.74	.92	1		
IC+PC+IB	.76	.82	.92	.73	.91	.97	1	
TOT	.88	.79	.88	.84	.90	.95	.97	1

Table 2b. Factor inter-correlation for subset B from the factor analysis sample.

	GE	IC	PC	ISG	IB	IC+IB	IC+PC+IB	TOT
GE	1							
IC	.54	1						
PC	.60	.60	1					
ISG	.64	.56	.48	1				
IB	.67	.55	.76	.58	1			
IC+IB	.70	.84	.78	.64	.92	1		
IC+PC+IB	.70	.79	.91	.61	.91	.97	1	
TOT	.85	.77	.85	.76	.88	.94	.96	1

Abbreviations: GE= Gambling expectancies, IC= Illusion of control, PC= Predictive control, ISG= Inability to stop gambling, IB= Interpretative bias, TOT= Total

Correlations between Impulsivity Traits and Gambling Cognitions

As shown in Table 5, all GRCS-S scores significantly correlated with positive and negative urgency, and GE, PC and all factors including IB correlated with sensation seeking. Most interestingly, none of the GRCS-S scores correlated with cognitive impulsivity traits (lack of premeditation and lack of perseverance).

Table 3. Reliability of all the factors in both data subsets from the factor analysis sample.

	ICC Subset A (n=250)	ICC Subset B (n=250)	Number of items on the factor	Items that load on the factor
GE	.80	.72	4	1-6-11-16
IC	.72	.64	4	3-8-13-18
PC	.80	.78	6	4-9-14-19-22-23
ISG	.85	.79	5	2-7-12-17-21
IB	.78	.75	4	5-10-15-20
IC + IB	.83	.80	8	3-8-13-18 + 5-10-15-20
IC+PC+IB	.90	.88	14	3-8-13-18 + 4-9-14-19-22-23 + 5-10-15-20
One-factor	.94	.92	23	All

Abbreviations: ICC= Intraclass Correlation Coefficient, GE= Gambling expectancies, IC= Illusion of control, PC= Predictive control, ISG= Inability to stop gambling, IB= Interpretative bias.

To ensure that this set of correlations does not merely reflect the potential confounding between GRCS-S scores and GD severity, we carried out partial correlation analysis between GRCS-S and UPPSP measures, controlling for SOGS total score, in the validity sample (see supplementary materials, Appendix 2). The majority of the correlations lose strength, but the general pattern was very similar to the one in the first sample. Gambling expectancies lost significance with positive urgency and sensation seeking, and predictive control lost significance with negative urgency. The correlations between SOGS measures and the other factors did not show any qualitative changes in significance values.

[2] All treatment-seeking gamblers had very high SOGS scores, which means 5.8% of the total number of non-treatment-seeking gamblers presented a SOGS score equal to or above 5 (the problem gambling threshold). This percentage is approximately what would be expected, based on problem gambling prevalence data in the population of regular gamblers in Spain. So, it is unlikely that a desirability bias in SOGS responses could have significantly distorted our results. Still, a large majority of participants were assessed face-to-face. The presence of some desirability biases in these individuals can be somewhat reduced by ensuring confidentiality and introducing the evaluator as an experienced psychologist subject to strict ethical standards, but are not completely eliminated.

Table 4. Correlations of GRCS-S factors with gambling severity (SOGS) and alcohol and substance use (Multicage CAD-4)

	GE	ISG	IC	PC	IB	PC+IC+IB	PC+IB
SOGS total	.55**	.74**	.53**	.61**	.66**	.66**	.67**
SOGS dependence	.54**	.74**	.51**	.60**	.66**	.65**	.66**
SOGS debt	.41**	.51**	.34**	.42**	.44**	.46**	.46**
Alcohol use (MC)	.15	.16	.08	.05	.12	.09	.08
Substance use (MC)	.03	-.07	.02	.01	.04	.03	.03

Spearman's Rho correlations. *= p<.05; **= p<.01. Abbreviation: MC= MultiCAGE CAD-4, GE= Gambling expectancies, IC= Illusion of control, PC= Predictive control, ISG= Inability to stop gambling, IB= Interpretative bias.

Table 5. Correlations of GRCS-S factors with impulsivity (UPPS-P) measures

	GE	ISG	IC	PC	IB	PC + IC + IB	PC + IB
Negative urgency	.25**	.35**	.20*	.23**	.28**	.27**	.26**
Positive urgency	.33**	.30**	.28**	.41**	.37**	.40**	.41**
Sensation seeking	.18*	.14	.14	.31**	.31**	.31**	.32**
Lack of premeditation	-.03	.05	-.11	.02	.01	.01	.03
Lack of perseverance	.06	.07	-.05	-.01	.04	.01	.02

Spearman's Rho correlations. * p<.05; ** p<.01. Abbreviation: GE= Gambling expectancies, IC= Illusion of control, PC= Predictive control, ISG= Inability to stop gambling, IB= Interpretative bias.

Discussion

The first aim of this study was to develop a Spanish version of the GRCS (GRCS-S) to assess gambling cognitions in Spanish communities, and to determine the reliability and validity of this scale. Second, and more importantly, we sought to confirm and extend previously identified associations between gambling-related cognitive distortion levels, measures of impulsivity, and gambling behavior (Michalczuk et al., 2011).

Previous studies have identified a five-factor model in the GRCS: perceived inability to stop gambling (ISG), gambling expectancies (GE), interpretative bias (IB), illusion of control (IC) and predictive control (PC). Our study confirms the five-factor

model to provide good fit for a Spanish sample and supports the soundness of the psychometric properties of the GRCS-S. However, a more parsimonious, 4-factor model was also found to be viable. The superiority of the 4-factor model is attributable to parsimony, and, quite likely, also to the relatively lower internal reliability of the illusion of control factor. Tentatively, the lower reliability of the IC subscale, in turn, is attributable, first, to the fact that it is computed from only four items, and second, to the wording of one of such items in religious terms ('Praying helps me win'). Potentially, religiosity differences can have a large impact on responses to this item, and thus on global internal consistency. Conversely, the virtually constant IC internal consistency values observed across samples (from the factor analysis to the validity datasets) virtually discards the possibility that sample composition, different severity ranges, or treatment stage (in treatment-seeking gamblers) accounted for its relatively low value.

This study also verifies the concurrent and criterion-related validity of the GRCS-S, and replicates previous reports that the GRCS model provides specific correlates of gambling clinical features. However, in Michalczuk et al.'s study (2011), the strongest effect of group (gambling disorder patients vs. controls) was found for IC, and the weakest effect for PC and IB. In spite of the good general predictive value of the scale for clinically relevant features in both studies (group in one case, gambling severity in the other), this ordering is partially at odds with our finding that SOGS is strongly related to IB, but much more weakly to IC. This discrepancy can be attributed to differences across the study samples, to the fact that group categorization and SOGS severity are not equivalent variables, or to the differences in subscales reliabilities in the two versions of the scale. At this point, we have no evidence to favor any of these interpretations. Nonetheless, the present study replicated the main finding from Michalczuk et al.'s study (2011), in that impulsivity is highly correlated with increased cognitive distortion levels.

Most interestingly, correlations were only significant for affect- and motivation-driven components of impulsivity. The privileged link between gambling-related biases and emotion-driven impulsivity might be seen, in principle, as counterintuitive, considering that the UPPS-P contains specific dimensions straightforwardly assessing purely cognitive impulsivity (lack of premeditation and lack of perseverance). Recent, highly powered factorial analyses confirm this distinction, and separate a

conscientiousness/planning impulsivity component, from inadequate coping of *negative emotionality* (Knezevic-Budisin, Pedden, White, Miller, & Hoaken, 2015; Sharma, Markon, & Clark, 2014). This view is also consistent with the proposal that poor executive and decision-making functioning is further qualified in accordance to the stronger or weaker involvement of abnormal emotion processing (Billieux, Gay, Rochat, & Van der Linden, 2010; Chester, Lynam, Milich, Powell, Andersen, DeWall, 2016; Gunn & Finn, 2015).

Independent of the soundness of that factorization of impulsivity, evidence in the framework of the Theory of Planned Behavior has shown that heavy gambling is not necessarily accompanied by lack of planning (Martin et al., 2010), and, in a previous study, we have observed a less future-oriented decision-making style only in a sub-group, but not the general population of disordered gamblers (Perales et al., 2017). Our results corroborate that gambling-related cognitive distortions bear no strong connections with the conscientiousness/planning impulsivity dimension, as measured by UPPS-P dimensions lack of premeditation and lack of perseverance. Instead, strong cognitive distortions belong –along with affect-driven impulsivity– to a general executive and decision-making profile, in which emotions play a key role.

Several lines of evidence converge in stressing the importance of the link between emotion-driven processes and gambling-related cognitive distortions. For example, Clark, Studer, Bruss, Tranel, & Bechara, 2014) have recently shown that lesions of the insula, an area strongly involved in emotional appraisal, abolish the near-win effect (known to be strongly linked to the illusory control bias in gamblers). On the other hand, positive and negative urgency empirically and theoretically overlap with emotion dysregulation in gambling disorder and other risky behavior patterns (Weiss et al., 2015; Wolz et al., 2016), and a connection between abnormal emotion regulation and the cognitive symptoms of gambling disorder has been recently reported by Navas et al. (2016; Chapter 3 in this thesis).

These recent developments point out to the importance of dealing with cognitive distortions in therapy, while making sure their emotional and motivational underpinnings are not neglected, in line with models in which cognitions are shaped by emotions and motivations (Kunda, 1990). According to these models, the emotional stakes in the

conclusions influence the neurocognitive mechanisms by means of which such conclusions are reached (Westen, Baglov, Harenski, Kilts, & Hamann, 2006).

In the realm of GD, cognitive distortions are likely to play a subjectively protective role against the distress generated by losses, mounting debt, or the very fact of regarding oneself as a disordered gambler (which would explain why most relevant cognitive biases have to do with reinterpreting or underestimating losses, overestimating future gains, or fueling one's sense of mastery).

Our findings provide some useful indications to be considered in GD treatment and prevention. Although the cognitive differences between GD patients and non-problem gamblers, and the association of such differences to gambling severity, have been convincingly replicated, treatments specifically addressing cognitive distortions are less powerful than expected (Goodie & Fortune, 2013). In other words, the neglect of emotion regulation in attempts to restructure cognitive distortions in gambling disorder could account for the fact that patients with GD often experience problems generalizing cognitive change from therapeutic to daily-life settings (Ladouceur & Sevigny, 2003). Moreover, the abovementioned study by Navas et al. (2016) suggests that some emotion regulation strategies usually regarded as adaptive, and frequently included in CBT packages, could be counterproductive in GD, as they can blunt the emotional impact of losses and fuel cognitive distortions. Taken together, these results support the use of metacognitive techniques, aimed at increasing awareness and reconfiguring responses to inner states, as for example, detachment mindfulness, attention retraining, virtual reality exposure, and neurofeedback (Chu & Clark, 2015; Fernández-Aranda et al., 2012).

Limitations

In spite of the importance of these conclusions, this study has a number of non-trivial limitations. First, only convenience samples were used. Therefore, further research with systematic sampling methods is needed, in order to replicate the present findings in representative samples of sporadic, regular, problematic and disordered gamblers. In other words, equivalence of the scale's factor structure across different populations should not be taken for granted. Second, and in relation to the previous point, our factor analysis sample was mostly composed of college students, and very few of them showed potentially risky gambling behavior. The sample was also more homogeneous than the

one used for validation of the original scale, and contained more females than most studies with regular (both disordered and non-disordered) gamblers. This could compromise generalizability, and could also account for the low reliability of the IC dimension in subsample B. This problem is compensated in part by the fact that, in contrast, the validity sample was mostly composed by disordered and non-disordered gamblers recruited from gambling treatment centers and the general (non-college) population. In spite of its smaller size, this sample yielded good levels of reliability and usability for the GRCS-S scale.

Third, our clinical subsample was largely made up of male gamblers. Though the prevalence of problem gambling has repeatedly been found to be higher in male samples (Planzer et al., 2014), future research using the GRCS-S should aim to include more diverse samples.

Finally, the current study was cross-sectional and did not assess the sensitivity of the GRCS-S across time. Other authors have recommended that follow-up assessments take place at four time-points (short-term, medium-term, long-term and post-treatment) (Walker et al., 2006). Future studies are needed to examine the test-retest reliability of the GRCS-S.

Final Remarks

The GRCS has been proven to be a valuable tool in the study of gambling behavior correlates, and has helped to better understand gambling disorder symptomatology and temporal dynamics. In this paper we have shown the Spanish version of this questionnaire to have adequate psychometric properties in two samples of young, mostly non-problematic, sporadic gamblers, and older, heavier gamblers (some of whom had been previously diagnosed as disordered gamblers). Most importantly, however, we have replicated and extended previous results on the tight bond between gambling cognitions and emotional and motivational aspects of impulsivity, which points out to the importance of including emotion regulation training in psychoeducative interventions for gambling disorder prevention, treatment, and relapse control.

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Appendix 1: GRCS items worded in Spanish, as used in the present study.

Permission was granted to translate the original GRCS scale into Spanish from the authors of the original scale (Raylu and Oei, 2004). All items are responded using a 1-7 Likert-type scale (1-*I completely disagree*, 7-*I completely agree*).

1. Jugar me hace más feliz.
2. No puedo funcionar sin jugar.
3. Rezar me ayuda a ganar.
4. Las pérdidas en el juego, sin duda, van seguidas de una racha de ganancias.
5. Relacionar mis ganancias con mi habilidad y mi destreza en el juego hacen que siga jugando.
6. Jugar hace que las cosas parezcan mejores.
7. Estoy fuera de control, así que me resulta difícil parar de jugar.
8. Algunos colores y números incrementan mis probabilidades de ganar.
9. Hay que perder durante un tiempo si se quiere adquirir la experiencia necesaria para ganar.
10. Relacionar mis pérdidas con la mala suerte o a las circunstancias adversas me hace seguir jugando.
11. Jugar hace que el futuro parezca mejor.
12. No puedo resistir las ganas de jugar.
13. Guardo objetos que me ayudan a tener más probabilidades de ganar.
14. Si consigo ganar una vez, sin duda, seguiré ganando.
15. Relacionar mis pérdidas con la casualidad hace que siga jugando.
16. Echar una partida me ayuda a reducir la tensión y el estrés.
17. No soy lo suficientemente fuerte como para dejar de jugar.
18. Ciertos hábitos y rituales mejoran mis probabilidades de ganar.
19. A veces me siento con suerte, y aprovecho esas ocasiones para jugar.
20. Recordar cuánto dinero gané la última vez, me hace continuar jugando.
21. Nunca seré capaz de dejar de jugar.
22. Tengo cierta capacidad para predecir cuándo voy a ganar.
23. Si cambio los números a los que juego habitualmente, tengo menos posibilidades de ganar que si mantengo siempre los mismos números.

Appendix 2: partial correlations between GRCS and UPPS-P indices controlling for gambling severity

As noted in the Results section, the *n*=137 validity sample assessed in SOGS was composed of both problem and non-problem gamblers. Given that GRCS and UPPS-P scores have been observed to strongly predict gambling severity, the possibility exists that the correlations between GRCS and UPPS-P scores are driven by gambling severity, a possibility that cannot be tested in the factor analysis sample (as participants in this sample were not assessed with the SOGS). To discard that explanation, partial *r* correlation analyses (instead of Spearman's Rho analyses) were carried out on UPPS-P and GRCS subscores, whilst controlling for SOGS severity, in the validity sample.

Results from this analysis are shown in Table A1. Partial correlations replicated and clarified the pattern showed by non-controlled correlations. Negative urgency positively correlated with the perceived inability to stop gambling and the control illusion/interpretative bias combined score; positive urgency correlated with the same factors and predictive control; and sensation seeking correlated with predictive control and the combined control illusion/interpretative bias score. Somewhat unexpectedly, gambling expectations (the belief that gambling is rewarding or enjoyable) negatively correlated with impulsivity dimensions, reaching significance for negative urgency and lack of premeditations.

Table A1. Partial correlation analysis between GRCS and UPPS-P measures controlling for SOGS total score

	GE	PC	ISG	IC + IB
Negative urgency	-.09*	.08	.23**	.16*
Positive urgency	-.06	.22**	.18**	.20**
Sensation seeking	-.02	.17**	.03	.11*
Lack of premeditation	-.14**	.02	.05	.00
Lack of perseverance	-.07	.03	.07	.02

Pearson's *r* correlations * $p<0.05$; ** $p<0.01$. Abbreviations: GE= Gambling expectancies, IC= Illusion of control, PC= Predictive control, ISG= Inability to stop gambling, IB= Interpretative bias.

Supplemental material

Table S1. Indices of goodness of fit for each model for both datasets from the factor analysis sample (see text for the meaning of the different indices).

	Subset A (n=250)				Subset B (n=250)			
	One-factor solution	**3-factor solution**	**4-factor solution**	**5-factor solution**	**One-factor solution**	**3-factor solution**	**4-factor solution**	**5-factor solution**
χ^2 (df)	417.14 (230)	326.07 (227)	307.49 (224)	305.62 (220)	503.94 (230)	421.23 (227)	360.37 (224)	349.64 (220)
$\Delta \chi^2$	/	91.07 (<.01)	18.58 (<.01)	1.87 (ns)	/	82.71 (<.01)	60.86 (<.01)	10.73 (ns)
Relative χ^2	1.83	1.44	1.37	1.39	2.19	1.86	1.61	1.59
RMSEA (CI)	.06 (.05; .07)	.04 (.03; .05)	.04 (.03; .05)	.04 (.03; .05)	.07 (.06; .08)	.06 (.05; .07)	.05 (.04;.06)	.05 (.04; .06)
NFI	.98	.98	.98	.98	.97	.98	.98	.98
CFI	.99	.99	1.00	.99	.99	.99	.99	.99
ECVI (CI)	2.04 (1.83; 2.29)	1.70 (1.53; .91)	1.65 (1.48; 1.85)	1.68 (1.51; 1.88)	2.39 (2.15; 2.67)	2.09 (1.87; 2.33)	1.86 (1.67; 2.09)	1.85 (1.67; 2.07)

Abbreviations: RMSEA= Root Mean Square Error of Approximation, NFI= Normed Fit Index, CFI= Comparative Fit Index, ECVI= Expected Cross Validation Index

CAPÍTULO 3:
Cognitive emotion regulation strategies and their associations with gambling-related cognitive distortions in patients with gambling disorder

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Cognitive emotion regulation strategies and their associations with gambling-related cognitive distortions in patients with gambling disorder

Existing research shows that patients with gambling disorder (PGD) process gambling outcomes abnormally when compared against healthy controls (HCs). These anomalies present the form of exaggerated or distorted beliefs regarding the expected utility of outcomes and one's ability to predict or control gains and losses, as well as retrospective reinterpretations of what caused them. This study explores the possibility that the emotional-regulation strategies PGD use to cope with aversive events are linked to these cognitions.

Forty-one PGD and 45 HCs, matched in sociodemographic variables, were assessed in gambling severity, emotion regulation strategies (cognitive emotion regulation questionnaire, CERQ), and gambling-related cognitions (gambling-related cognitions scale, GRCS).

PGD showed higher scores in all gambling-related cognition dimensions. Regarding emotion regulation, PGD were observed to use self-blame and catastrophizing, but also positive refocusing, more often than controls. Additionally, in PGD, putatively adaptive CERQ strategies shared a significant portion of variance with South Oaks gambling screen severity and GRCS beliefs. Shared variability was mostly attributable to the roles of refocusing on planning and putting into perspective at positively predicting severity and the interpretative bias (PGD propensity to reframe losses in a more benign way), respectively.

Results show links between emotion regulation strategies and problematic gambling-related behaviors and cognitions. The pattern of those links supports the idea that PGD use emotion regulation strategies, customarily regarded as adaptive, to cope with negative emotions, so that the motivational and cognitive processing of gambling outcomes becomes less effective in shaping gambling-related behavior.

Introduction

Regular gambling is much more likely to generate losses than wins (LaBrie, Kaplan, LaPlante, Nelson, & Shaffer, 2008; Walker, Schellink, & Anjoul, 2008). Games' probabilistic structures and the types of reinforcement schedules they implement, along with the existence of a house edge (by virtue of which a percentage of bets never returns to players), ensure negative monetary utilities for most gamblers in a large majority of gambling episodes.

Despite being disadvantageous in monetary terms, gam-bling is present in virtually every human culture, and turns problematic in a significant percentage of the population (average rate across countries: 2.3%; [Williams, Volberg, & Stevens, 2012]). This fact challenges the common-sense principle that instrumental behaviors with negative expected utility should progress toward extinction but, simultaneously, has inspired research on the motivational factors that could contribute to make wins more effective as rewards, and losses less deterring (e.g. de Ruiter et al., 2009; Loxton, Nguyen, Casey, & Dawe, 2008).

Among the several factors contributing to abnormal adjustment to gambling outcomes in PGD, beliefs about the subjective utility of gambling, the predictability or controllability of wins and losses, and the causes of past outcome sequences are the ones that have inspired more research. Raylu and Oei's (2004) influential model, for example, proposes five major gambling-related belief domains with potential clinical significance: (a) gambling expectancies about the joy, pleasure, or other kinds of personal utility that can be derived from gambling; (b) beliefs about the inability to stop gambling; (c) perceptions of the controllability of gambling outcomes (control illusion); (d) perceptions of the predictability of gambling outcomes (predictive control); and (e) attributional styles mainly characterized by interpretation of losses as due to external, removable factors, and wins as due to skill (interpretative bias). The last three of these beliefs are customarily categorized together as gambling-related cognitive biases (as they boil down to distorted perceptions of the causal structure underlying wins and losses). Available evidence convincingly shows that PGD hold exaggerated or biased beliefs in the five domains (see Goodie & Fortune, 2013, for a review).

The novelty of this study relies on its focus on the potential entrenchment between emotion regulation strategies and cognitions about gambling outcomes. This idea emerges from the fact that four of the five gambling-related cognitions identified in Raylu and Oei's model (gambling expectancies and the three cognitive biases affecting

causal learning) are mostly about gambling outcomes, and stand as candidates to be sensitive to how gamblers deal with their emotional impact.

First, any strategy by means of which negative emotions are down-regulated can potentially decrease the impact of losses on GDP's gambling behavior. Indeed, the involvement of undersensitivity to losses in potentially problematic gambling behaviors is already well known. Abnormal reaction to losses discriminates between gamblers and other addicted patients (Torres et al., 2013), and some studies have also shown pathological and frequent gamblers to have lower scores in punishment sensitivity as measured by self-reports (Goudriaan, Oosterlaan, de Beurs, & van den Brink, 2004; Navas et al., 2014) and an abnormal brain response to monetary losses (see Quester & Romanczuk-Seiferth, 2015, for a review). Relatedly, loss processing has also been shown to be involved in gambling-related distorted cognitions (Billieux, Van der Linden, Khazaal, Zullino, & Clark, 2012; Michalczuk, Bowden-Jones, Verdejo-Garcia, & Clark, 2011; Worhunsky, Malison, Rogers, & Potenza, 2014). What remains to be investigated is the possible mediating role of emotion regulation strategies in this set of relationships between loss sensitivity, cognitive distortions, and gambling behaviors. Still, there are strong reasons to predict that such mediation exists. According to dominant associative learning models, any factor reducing the aversive impact of outcomes can modulate the effectiveness of cue-outcome and action-outcome contingency learning (see Shanks, 2007, for a review), including that responsible for beliefs on the causal relationships between one's behavior and gambling outcome (i.e. control illusion) or between environmental cues and gambling outcomes (i.e. predictive control). Similarly, strategies reducing the emotional impact of accumulated losses (and particularly certain reappraisal strategies) could help PGD cope with distress in the short term, but also motivate reinterpretation of such losses, and make future gambling more likely.

Second (and complementarily), emotion regulation strategies that boost the positive valence of wins will straight forwardly increase gambling expectancies. These strategies could also be used to highlight "positive" aspects of losses. For example, near-wins (loss events perceptually close to the jackpot; e.g. two dollar signs and a cherry aligned on the display of a slot machine) exert rewarding effects (Clark, Crooks, Clarke, Aitken, & Dunn, 2012; Clark, Lawrence, Astley-Jones, & Gray, 2009). Abnormal reaction to near-wins correlate with PGD' beliefs on the mastery of their instrumental or predictive skills, and, at the neurobiological level, is associated with

BOLD signal in the ventral striatum, comparable to the one caused by true wins (Chase & Clark, 2010; Habib & Dixon, 2010; Sescousse et al., 2016). In other words, up-regulating positive emotions could contribute, not only to gambling expectancies, but also to alter the mechanisms responsible for learning about appetitive aspects of gambling outcomes via, again, associative learning and causal attribution mechanisms.

In summary, in our working model, the strategies PGD could use to boost positive emotions or to curve negative ones may contribute to gambling expectancies, control illusion, predictive control, and interpretative biases, and thus to problematic gambling behaviors. However, and somewhat unfortunately, models of emotion regulation have mostly neglected positive emotions (despite the fact that dysregulation of positive emotions has an important role in impulse control and risky behaviors, e.g. Cyders et al., 2007) and, to our knowledge, there are no available psychometric tools directly assessing regulation of positive emotions. In view of the lack of validated instruments, specific hypotheses in the present work will mostly tackle on strategies for regulation of negative emotions.

Garnefski and Kraaij's (2007) emotion regulation model proposes that people can regulate the impact of negative emotions by using adaptive and non-adaptive strategies (see Gross [1999] for a different but conceptually related approach). The latter include obsessive focusing on the emotion (rumination), catastrophizing, blaming oneself, and blaming others, and are more likely to increase than to reduce the negative emotional impact of aversive events, adding preoccupation, fear, guilt, or anger to the original emotion. The former include acceptance, reappraisal of the causes of the experienced emotion, and the several ways to taking distance from the emotion (putting into perspective, positive refocusing, and refocusing on planning alternative behaviors), which can be useful at softening or putting aside negative emotions. In accordance with the rationale outlined above, any of these supposedly beneficial strategies could contribute to the maintenance of cognitive distortions and gambling behaviors, whereas catastrophizing, rumination, and blaming oneself or others, although clearly disadvantageous, are less likely to play that role. Hence, from our overarching hypothesis that emotion regulation strategies are entrenched with beliefs about gambling outcomes, the more specific (and counterintuitive) prediction can be de-rived that generally adaptive strategies people use to curve the impact of negative emotions could be counterproductive in PGD. We are aware that gamblers' atypical emotion regulation strategies could influence gambling in other ways (e.g. some PGD may also

make more use of plainly dysfunctional emotion regulation strategies, which might lead to enhanced sensitivity to losses and compulsive loss chasing; Shao, Read, Behrens, & Rogers, 2013). In these cases, however, it is less clear what, if any, the role of outcome-related beliefs would be. For the sake of parsimony, we will keep our hypotheses regarding the relationships between emotion regulation, gambling cognitions, and gambling behaviors restricted to so-called adaptive regulation strategies and outcome-related beliefs.

We assessed two groups of PGD and HCs using psychometric measures of gambling cognition, emotion regulation, and gambling severity, aiming to test the following set of hypotheses: first, we expected to corroborate previous reports that gambling-related beliefs in the domains identified by Raylu and Oei's (2004) model – and particularly those involving incentive properties of and attributions about gambling outcomes (gambling expectancies, control illusion, predictive control, and attributional bias) – are heightened in PGD (compared against matched controls) (Hypothesis 1). Second, given the high frequency of emotional (mostly negative) events in PGD lives, we also expected them to mobilize emotion regulation strategies to cope with them more often than controls (Hypothesis 2). Third, and most importantly, given the specificities of gambling, at least some of the so-called adaptive strategies (acceptance, reappraisal, putting into perspective, positive refocusing, and refocusing on planning) are predicted to correlate with gambling outcome-related cognitions (Hypothesis 3), and severity (Hypothesis 4), specifically in the GDP group.

Method

Participants

Forty-one patients with gambling disorder (PGD) and forty-five healthy controls (HCs), matched in age, education years, and intelligence quotient (IQ) (Table 1), took part in the study. PGD had been diagnosed as such by the clinicians of the treatment center from which they have been recruited [AGRAJER – Granada Association of Rehabilitated Pathological Gamblers, APLIJER – Linares Provincial Association of Rehabilitating Gamblers, and ALUJER – Jaén Association of Rehabilitated Pathological Gamblers, based on the towns of Granada, Linares, and Jaén (Andalusia, Spain)]. Most HCs were recruited among PGD political relatives and friends, and the sample was completed by posting notices at the University of Granada's and the researchers' Internet-based social networks.

Inclusion criteria for PGD, apart from the gambling disorder diagnosis (confirmed by their therapist by means of a semi-structured interview, carried out upon admission to treatment, and based on DSM-IV criteria), were (a) being in treatment for less than six months, (b) abstaining from gambling for at least 15 days (as reported by the participant and his/her therapist), and (c) an estimated IQ above 80, indicated by Matrix Reasoning and Vocabulary subtests of the Wechsler Adult Intelligence Scale (WAIS-IV) (Wechsler, 2008). Exclusion criteria were (a) comorbidity with any psychiatric diagnosis (including addictive disorders other that nicotine dependence and gambling disorder), and (b) previous history of neurological disease or brain trauma causing unconsciousness for 10' or longer, as informed by the participant. Inclusion criteria for HCs were the identical, except for the GD diagnosis and treatment. Coincidentally, no females met the criteria to be included in the GDP group, so only males were recruited as controls. Comorbidities were assessed using a semi-structured interview, carried out, in the case of PGD, by the patient's therapist, and, in the case of HCs, by a psychologist with clinical experience in assessment methods (first author).

Measures

Cognitive Emotion Regulation Questionnaire (CERQ, Spanish version; Domínguez-Sánchez, Lasa-Aristu, Amor, & Holgado-Tello, 2013). This tool consists of 27 5-point Likert-scale items, assessing the use of 9 different strategies for regulation of emotions caused by negative or distressing events. (a) *Self-blame* refers to thoughts about making oneself responsible for what has caused the emotion; (b) *other-blame* refers to thoughts of making others responsible for such an event; (c) *rumination* consists of obsessively focusing on the feelings and thoughts associated with the negative event; (d) *catastrophizing* refers to emphasizing and overestimating the negative experience or its consequences; (e) *putting into perspective* consists of thoughts brushing aside the seriousness of the event, or considering its relativity when compared to other events; (f) *positive refocusing* refers to redirecting attention to joyful or pleasant themes; (g) *positive reappraisal* refers to reinterpreting the event in positive terms of personal growth; (h) *acceptance* includes thoughts of nonjudgmental resignation, and (i) *refocus on planning* refers to thinking about the steps that should be taken to handle the situation resulting from the event.

Gambling-related cognitions scale (GRCS; Raylu & Oei, 2004). This questionnaire assesses five gambling-related cognitive distortions. *Inability to stop* and *gambling expectations*, refer to personal beliefs of lacking capacity to control gambling

impulses, and overvaluing the joy or reward that can be obtained from gambling, respectively. *Illusion of control, predictive control*, and *interpretative biases* have to do with how gamblers connect gambling outcomes between them, with environmental cues, or with one's behavior (causal attributions). The first one refers to the overestimation of personal control over gambling outcomes, the second to the perceived ability to predict future outcomes on the basis of previous ones or other cues in the environment, and the third to the tendency to reappraise losses accrued in time, and attribute such losses to bad luck, coincidence or other external removable factors.

The English version of the GRCS questionnaire was translated into Spanish, and then back-translated into English by a native English-speaking bilingual translator (see Chapter 2 in this thesis). Potential asymmetries between the original and the back-translated versions of the questionnaire were discussed and eventually polished from the Spanish version by the translator and one of the authors. In addition, the questionnaire has been validated in a separate study (Del Prete et al., 2017; Chapter 2) with an n=500 sample of pathological and recreational gamblers. This validation study has yielded a well-fitting factorial structure, and Cronbach's α values of .74, 0.71, .84, .90, and .86 for gambling expectancies, illusion of control, predictive control, inability to stop, and interpretative biases, respectively.

MultiCAGE-CAD4 (Pedrero Pérez et al., 2007). This is a quick screening tool to detect risk of alcohol abuse, illegal drug abuse, problem/pathological gambling, excessive Internet surfing, excessive videogaming, hypersexuality, compulsive money spending/shopping, and eating disorders. Each subscale is composed of four yes/no items, checking for subjectively informed craving, relatives', friends' or other acquaintances' complaints about the behavior under assessment, guilt or shame feelings/lack of acknowledgment, and self-reported compensatory behaviors. The questionnaire and its psychometric and diagnostic properties can be found in Pedrero-Pérez et al. (2007). For the present study we used the gambling, drugs use, and alcohol use subscales as control variables for sample matching.

South Oaks Gambling Screen (SOGS, Spanish version; Echeburúa, Báez, Fernández-Montalvo, & Páez, 1994). In order to estimate gambling severity, dependence, and debt accrual, as well as to estimate participation frequencies in different games, we used the Spanish version of SOGS. To date, this is the only validated instrument for the assessment of gambling severity in Spanish, it has been widely used, and has good psychometric properties.

Procedure

Recruitment notices provided general information about the criteria to participate in the study, although all of them were further checked during the assessment session. The instruments described here are part of a larger protocol including several neuropsychological tasks, electroencephalographic, magnetic resonance, and heart rate variability recordings, as well as several other self-report tools, none of which were directly relevant to the aims of the present study. The whole assessment protocol was composed of two sessions. All the instruments described here were included together in one of the sessions, which could be the first or the second one (depending on session balancing). Each session was divided into several clusters of tasks, separated by resting periods. Cluster order, and the order of tasks within each cluster were counterbalanced. The study was approved by the Ethics Committee of the University of Granada as part of the PSI2013-45055 (G-Brain) project, and was in accordance with the 1964 Helsinki declaration and its later amendments. Participants were informed about the aims and features of the study and all provided informed consent.

Statistical Analysis

Analyses of variance (ANOVA) were carried out to determine between-groups difference in (a) demographic variables, Matrix Reasoning and Vocabulary subtests of WAIS IV and (b) SOGS severity scores, and MultiCAGE gambling, alcohol and drugs subscores. Multivariate analyses of variance (MANOVA) were conducted to explore between-groups difference in (a) gambling-related cognitions and (b) cognitive emotion regulation strategies. Two linear stepwise regression analyses with CERQ scores as independent variables and SOGS severity and MultiCAGE gambling score as dependent measures were carried out to check for the relationship between emotion regulation strategies and gambling overt symptoms. In order to test the relationship between emotion regulation strategies and gambling-related cognitions (without incurring in underpowered multiple tests) we carried out an analysis in two steps. First, we applied K-means cluster analysis to discriminate between participants in term of their profile of gambling related beliefs. Secondly, we used logistic regression analysis, with emotion regulation strategies as predictors, to predict participants' classification in Cluster 1 vs. Cluster 2. This relationship was further explored by linear stepwise regression analyses with CERQ measures as predictors and GRCS measures as dependent variables.

Finally, we performed a mediation path analysis on the relationship between putatively adaptive emotion regulation strategies and SOGS severity score, using a global outcome-related beliefs score (computed as the sum of expectancy, control illusion, predictive control, and interpretative bias scores) as mediational variable. This analysis was carried out in three stages. First, a simultaneous regression approach was used to predict the GRCS composite score from emotion regulation strategies, and SOGS severity score from the GRCS composite score and emotion regulation strategies. Second, parameters were recomputed restricting the model to significant variables from the first stage. Finally, one-tailed Sobel tests (Sobel, 1982) were carried out to find out whether any paths from emotion regulation strategies to gambling severity were significant (following Soper, 2016). For all these and previous analyses a significant threshold of p=.05 was established.

Results

Sociodemographic Cariables

Mean (*SD*) age, education years and Matrix Reasoning and Vocabulary scores are displayed in Table 1. There were no differences in these variables. A χ^2 test yielded no effect of group either on the distribution of participants across income level categories, $\chi^2(5)=4.77$, p=.444. As noted above, all the participants in the study were males.

Gambling Severity and Alcohol and Drugs Misuse

Mean (*SD*) SOGS severity scores, and MultiCAGE gambling, alcohol and drugs subscores are displayed in Table 1. As expected, there were significant differences between the two groups in SOGS severity and the MultiCAGE gambling subscore. The two groups, however, did not differ in alcohol and drug misuse scores.

Gambling-related Cognitions across Groups

There was a strong multivariate effect of group regarding the five GRCS scores (see Table 2, first row). Table 2 also displays mean (*SD*) scores, and the results of exploring variable by variable between-subject effects. In all measures, PGD showed higher scores than HCs.

Cognitive Emotion Regulation Strategies across Groups

There was a strong multivariate effect of group regarding CERQ emotion regulation strategies (see Table 3, first row). Table 3 also displays mean (*SD*) CERQ scores for both groups and results from exploring variable-by-variable between-group

effects. PGD reported more frequent use of self-blame, catastrophizing, and positive refocusing (and, marginally, putting into perspective, p=.053), and less frequent use of other-blame than controls.

Table 1. Sociodemographic and clinical descriptive data of patients with gambling disorder (PGD) and healthy controls (HCs) groups**.**

	PGD	HCs			
	Mean (SD)	**Mean (SD)**	**F (1, 84)**	***p***	**η^2**
Age	35.22 (11.16)	33.22 (8.18)	0.91	.344	.01
Education	13.06 (4.26)	13.31 (3.13)	0.10	.756	.00
Months in treatment	3.11 (2.79)	-	-	-	-
Matrix Reasoning	98.00 (13.00)	100.67 (13.00)	0.89	.348	.01
Vocabulary	99.38 (14.20)	103.44 (13.13)	1.88	.174	.22
SOGS	10.05 (3.30)	0.58 (0.97)	338.97	<.001	.80
MC Gambling score	2.68 (0.85)	0.02 (0.15)	427.31	<.001	.84
MC Alcohol misuse	0.85 (1.06)	1.22 (1.17)	0.58	.130	.03
MC Substance misuse	0.48 (0.9)	0.67 (0.95)	1.27	.374	.01

Abbreviations: MC, MultiCAGE CAD-4

Table 2: Multivariate and variable-by-variable group effects on gambling-related cognitions as measured by the GRCS questionnaire.

			Wilks' λ	*p*	η^2
Multivariate effect			.29	**<.001**	.71
	PGD	HCs			
Between-subject effects	***Mean* (*SD*)**	***Mean* (*SD*)**	***F* (1, 84)**		
Interpretative control	18.76 (6.48)	6,18 (3.83)	122.57	**<.001**	.59
Illusion of control	10.37 (5.61)	5.44 (2.34)	29.13	**<.001**	.26
Predictive control	22.98 (9.96)	8.62 (3.90)	80.06	**<.001**	.49
Expectancies	15.54 (6.26)	5.44 (2.28)	102.23	**<.001**	.55
Inability to stop	21.51 (7.74)	5.58 (1.32)	184.71	**<.001**	.69

Relationships of Emotion Regulation Strategies with Gambling Severity and Cognitive Distortions

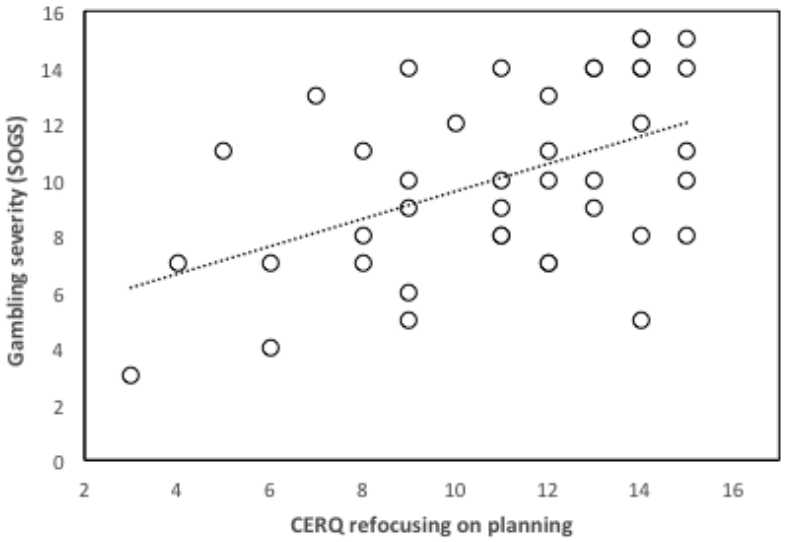
For illustrative purposes, Table S1 (supplemental material) shows bivariate correlations (for PGD only) between gambling disorder severity, cognitive distortions, and emotion regulation strategies, with no α growth correction. In order to find out which, if any, putatively adaptive emotion regulation strategies independently correlate with severity, we carried out a stepwise linear regression analysis with age, education, and the key emotion regulation strategies (putting into perspective, positive refocusing,

refocusing on planning, positive reappraisal, and acceptance) as predictors, and SOGS total score as dependent variable. Only refocusing on planning was included in the final model (after 1 step) (β=0.49, *t*=3.46, *p*<.01; see Figure 1). A similar analysis with MultiCAGE gambling score did not yield any significant effect.

Table 3: Multivariate and variable-by-variable group effects on emotion regulation strategies as measured by the GRCS questionnaire.

			Wilks' λ	*p*	η^2
Multivariate effect			.57	**<.001**	.43
	PGD	HCs			
Between-subject effects	***Mean* (*SD*)**	***Mean* (*SD*)**	***F* (1, 84)**		
Self-blame	11.05 (3.09)	7.2 (2.54)	40.14	**<.001**	.32
Other-blame	4.32 (1.54)	5.42 (1.83)	9.10	**.003**	.10
Rumination	11.07 (2.55)	10.42 (2.41)	1.59	.212	.02
Catastrophizing	8.1 (2.74)	6.02 (1.91)	16.85	**<.001**	.17
Putting into perspective	10.61 (2.82)	9.36 (3.09)	3.84	.053	.04
Positive refocusing	9.27 (2.26)	7.96 (2.87)	5.49	**.023**	.06
Positive reappraisal	9.85 (3.68)	11.13 (2.65)	5.45	.067	.04
Acceptance	12.41 (2.17)	11.80 (2.66)	1.36	.246	.02
Refocus on planning	10.98 (3.27)	11.56 (2.16)	0.10	.330	.01

Figure 1. Dispersion diagram representing the correlation between CERQ refocusing on planning score and SOGS total score (gambling severity). See text for significance statistics.



In order to test our hypothesis on the connection between gambling beliefs and emotion regulation strategies, avoiding α-error growth for multiple analyses, we carried out an analysis in two steps. First, a K-means cluster analysis with all PGD on GRCS measures yielded a two-cluster solution in 4 iterations, segregating between strongly-biased PGD (n=18) and a weakly-biased PGD (n=23). Interestingly, the strongest effect of cluster separation was found for predictive control (η^2=.77), followed by interpretative bias (η^2=.51), expectancy (η^2=.42), control illusion (η^2=.37), and inability to stop (η^2=.24). This result is interesting by itself, because it confirms that cluster separation mostly represents differential strength in outcome-related beliefs, but much less so in perceived inability to stop gambling (indeed, cluster separation yielded identical results if performed exclusively on the four outcome-related cognitions).

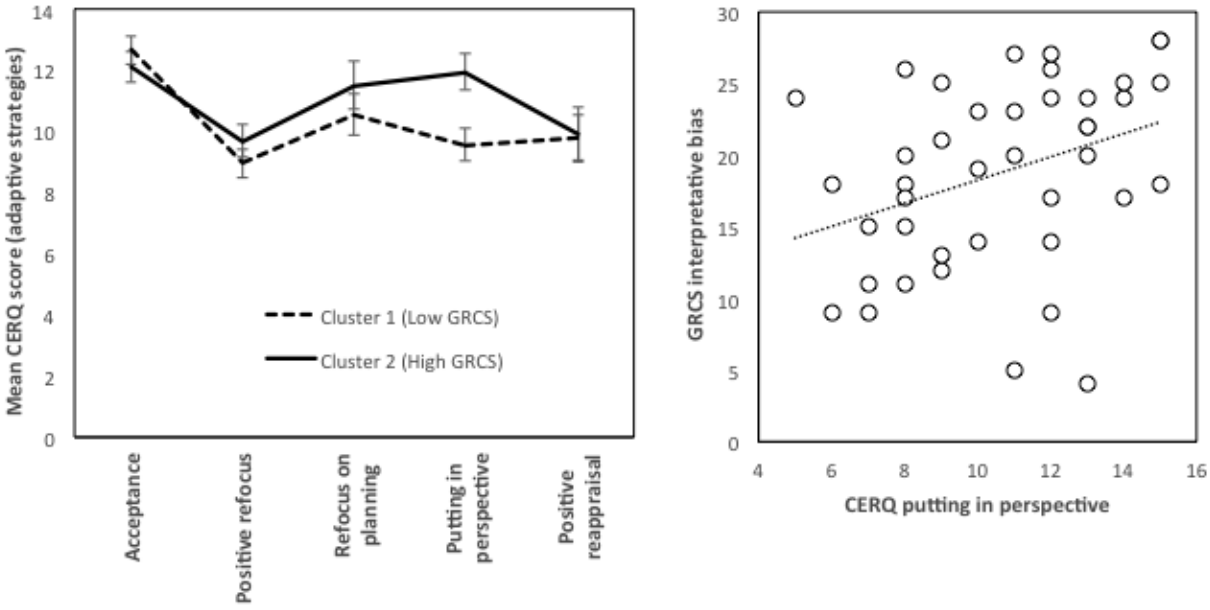
The two clusters did not differ in age, education, intellectual performance, months in treatment, alcohol and drug related problems (MultiCAGE), MultiCAGE gambling score (min. *p*=.190), but differed in SOGS severity [*F*(1, 38)=5.39, *MSE* =9.82, *p*=.026, η^2=.12). Not surprisingly, the strongly biased cluster (*SOGS* = 11.33, *SE*=.74) showed more severe gambling symptoms than the weakly biased one (*SOGS* =9.04, *SE*=.65).

In a second step, a forward conditional logistic regression analysis (with all the putatively adaptive emotion regulation strategies as predictors) yielded putting into perspective as the only significant predictor (*Wald*=6.45, *B*=.35, *p*=.01) of cluster membership. The one-predictor model correctly classified 73.9% of Cluster 1 (high bias), and 66.7% of Cluster 2 participants (low bias), Nagelkerke's R^2=.24. This effect remained significant (*Wald*=4.48, *B*=.31, *p*=.03) even if severity was included in a two-predictor model with putting into perspective. Hence, one emotion regulation strategy – putting into perspective– clearly emerged as the one most closely related to clustering based on gambling-related cognitive distortions. Figure 2 (left panel) displays mean CERQ scores for the strategies entering the logistic regression analysis in each of the two clusters.

As noted above, the specific pattern of covariations underlying this connection between emotion regulation strategies and gambling-related beliefs can be inspected in Table S1 (supplementary material). Still, we carried out stepwise linear regression analyses with putting into perspective, positive refocusing, refocusing on planning, positive reappraisal, and acceptance as predictors, and each of the gambling related

beliefs as dependent variables. This strategy yielded significant effects of refocusing on planning on control illusion (β=.34, *t*=2.27, *p*=.029), and of putting into perspective on inability to stop (β=.34, *t*=2.23, *p*=.032), and interpretative bias (β=.35, *t*=2.35, *p*=.024). Among these, the last one can be interpreted as contributing to the general pattern of heightened outcome-related GRCS scores (Figure 2, right panel).

Figure 2. Left panel: Mean CERQ scores for putatively adaptive strategies in the highly biased (Cluster 2) and weakly biased (Cluster 1) subgroups of PGD. Bars represent standard error of the mean. Right panel: dispersion diagram representing the correlation between CERQ putting into perspective score and GRCS interpretative bias. See text for significance statistics.

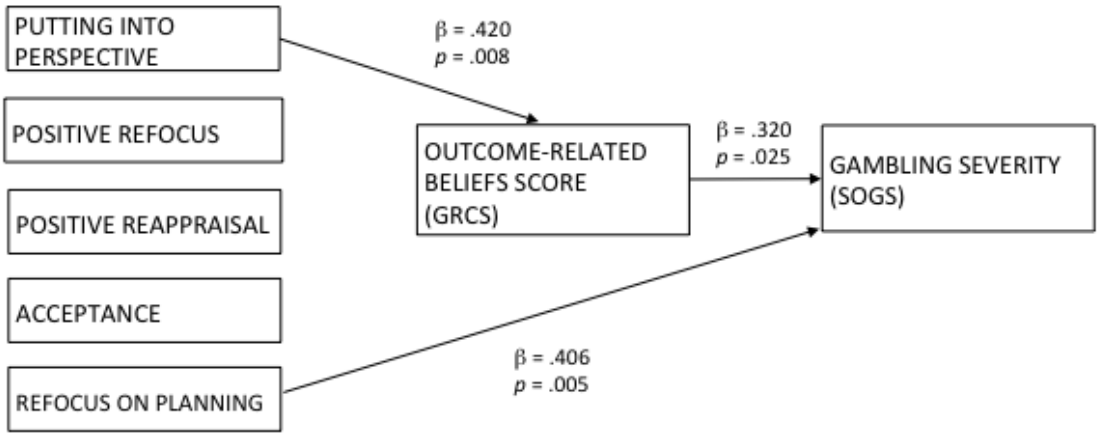


Mediation Analysis

The result of the mediation analysis is displayed in Figure 3. This confirmed putting into perspective as the only significant predictor of outcome-related beliefs, and the latter and refocusing on planning as independent predictors of SOGS severity[1]. More interestingly, an indirect effect (via outcome-related beliefs) on SOGS severity was found for the strategy putting into perspective.

[1] The initial (simultaneous) regression analysis of outcome-related cognitions score over the five emotion regulation strategies under consideration yielded a significant effect of acceptance. More specifically, acceptance was observed to inversely predict outcome-related cognitive distortions (β=-.43, *p*=.015). This effect, however, fell below significance when the most parsimonious model (including only significant factors from the first stage) was tested to obtain definitive model parameters (as shown in Figure 3).

Figure 3. Mediation analysis of CERQ putatively adaptive emotion regulation strategies on gambling severity in PGD, using the outcome-related belief score (computed from GRCS expectancy, control illusion, predictive control, and interpretative bias subscores) as hypothetical mediator.



Test for indirect effect (Putting into perspective-Gambling severity): Sobel=1.82, *p*=.035.

Discussion

The aims of this study were to explore the differences between PGD and HCs in gambling-related cognitions and use of emotion regulation strategies, and to test the connection of emotion regulation strategies with gambling severity and cognitive distortions in PGD. We expected (a) gambling-related beliefs, including those regarding gambling outcomes, to be exaggerated or more strongly biased in PGD when compared against HCs, and (b) PGD to make a more frequent use of regulation strategies to cope with negative emotion-laden events (regardless of the theoretical adaptive or non-adaptive role of such strategies). Finally, (c) we expected emotion regulation strategies, and particularly, those hypothetically effective at reducing negative emotions, to predict both the gambling severity and the intensity of gambling-related beliefs potentially linked to the processing of gambling outcomes.

Results fully confirmed our first prediction. All GRCS measures were higher in PGD than in HCs (Table 2). These results are in line with previous literature (see Goodie & Fortune, 2013, for a review); and also confirm our previous data (Perales, Navas, Ruiz de Lara, Maldonado, Catena, 2017) that, among causal attribution biases – control illusion, predictive control, interpretative bias– the latter emerges as the one most strongly predictive of gambling severity and clinical status. Other studies, however, have reported a different ordering of size effects for the GRCS subscales

(Michalczuk et al., 2011), which could be accounted for by the varying composition of the gamblers' samples across studies. Tentatively, a factor explaining the differences across studies could be the differences in preferred gambling modalities (a factor that has been shown to crucially determine the intensity and profile of cognitive distortions; Toneatto, Blitz-Miller, Calderwood, Dragonetti, & Tsanos, 1997).

Theoretically, the second prediction is more relevant, and was also partially confirmed (Table 3). PGD were more prone to use catastrophizing (e.g. 'I often think that what I have experienced is much worse than what others have experienced') and self-blame (e.g. 'I feel that I am the one to blame for it') than HCs, which is compatible with descriptions of generalized negative emotionality in PGD (Bagby et al., 2007), and with their consideration as non-adaptive emotion regulation strategies. More counterintuitively, however, PGD were also more prone to use positive refocusing (e.g. 'I think of pleasant things that have nothing to do with it'), which is customarily included within the set of adaptive strategies contributing to resilience and emotional wellbeing (Hanley & Garland, 2014; Min et al., 2013). This difference apparently contradicts previous reports in which positive refocusing has been observed to inversely correlate with specific and general measures of psychopathology (Garnefski, Kraaij, & van Etten, 2005; Kelly, Lydecker, & Mazzeo, 2012). Still, despite being normally regarded as adaptive, positive refocusing involves displacing attention from the emotion without reprocessing its causes. In that sense, the overuse of positive refocusing could not be fully incompatible with the previous finding that pathological gamblers make less use of reappraisal that controls (Williams, Grisham, Erskine, & Cassedy, 2012).

Finally, the third prediction was also partially confirmed. Refocusing on planning (e.g. 'I think about a plan of what I can do best') was the only emotion regulation variable significantly predicting gambling severity when tested against the other strategies in the confirmatory stepwise regression analysis (Figure 1). Putting into perspective (e.g. 'I think that it hasn't been too bad compared to other things'), on the other hand, independently correlated with cluster membership, namely, with global strength of distorted beliefs about gambling outcomes (which mostly seems to originate in its relationship with the interpretative bias; Figure 2). Refocusing on planning did not independently contribute to cluster membership, in spite of its independent correlation with control illusion and gambling severity.

In one way or another, refocus on planning and putting into perspective seem to signal gambling complications in the form of more severe symptoms or stronger

cognitive distortions, respectively. At difference with what we have argued for positive refocusing, putting into perspective, and refocusing on planning are forms of reappraisal that involve a deeper processing of whatever has caused the negative emotion. It is difficult to interpret these strategies as ambiguous with regard to their general beneficial value; and, on the other hand, the fact that they play a role both in gambling severity and in gambling-related cognitive distortions seems to indicate that the more effective the strategy is, the worse are their clinical implications in the gambling context. Consequently, at least some emotion regulation strategies that can be considered useful to confront emotions with little cost for the individual, and sometimes even recommended to be included in cognitive-behavioral therapy packages (Min et al., 2013), are likely to have a paradoxical negative role in gambling disorder.

Complementarily, we found some very preliminary evidence that a different putatively adaptive emotion regulation strategy (acceptance, e.g. 'I think that I have to accept the situation') could play a protective role against cognitive biases. Acceptance is in a way the opposite of self-deception, and is regarded as an essential component of third-wave psychotherapies (e.g. Hayes, 2004). Our data on this regard are very partial and only allow speculation, but probably point out to an interesting future research target.

Still, the links between specific emotion regulation strategies, and gambling-related beliefs, severity and other clinically relevant gambling features deserve further investigation. Our results seem to imply, as it happens with other trait variables, that those factors most strongly contributing to differences between PGD and HCs are not necessarily the same contributing to individual differences among PGD (Álvarez-Moya et al., 2010). Indeed, gambler subtypes can be qualitatively different, with different patterns of beliefs playing an important role in gambling subtyping (Myrseth, Brunborg, & Eidem, 2010; Toneatto et al., 1997).

A possible implication of our results regarding emotion regulation strategies is that their role in psychopathology is disorder type-dependent. In disorders where unrealistic pessimistic biases contribute to symptomatology (e.g. internalizing problems; Garnefski et al., 2005), putting negative events in perspective, or redirecting attention toward positive things or alternative plans, could reduce emotional impact without significant side effects. GD is different from such disorders in the sense that it courses with overestimation of self-efficacy in gambling settings –at least in some

gamblers– and reducing the impact of feedback without correcting the underlying overestimation is potentially counterproductive.

These findings are also interpretable in terms of the tentative pathways leading to GD that could be addressed in therapy. Despite the –many times replicated– differences in cognitive distortions between gamblers and non-gamblers, and between PGD and non-problem gamblers, and the association of the same cognitive distortions to gambling severity, treatments specifically tackling on such distortions –although significant– are less powerful than expected (Goodie & Fortune, 2013). Our results support the importance of tackling cognitive distortions in a contextualized manner, that is, taking into account the individual emotions that they could be functionally related to. This functional connection between emotions evoked by gambling and gambling-related cognitions has been recently unveiled by studies showing that the insula (a key structure in emotional processing, Ochsner, Silvers, & Buhle, 2012) plays a role in the maintenance of the gambler's fallacy. Patients with specific damage of this region do not exhibit the bias, and do not show either the usual heightened motivation to gamble that normally follows near-wins (Clark, Studer, Bruss, Tranel, & Bechara, 2014). Our finding that emotion regulation strategies, and not only emotions *per se*, correlate with cognitive distortions seems to unveil at least one of the mechanisms underlying that emotion-cognition link.

This argument provides a way to surpass a frequently mentioned limitation of cognitive-behavioral therapy: PGD often experience problems generalizing cognitive change from therapeutic to daily-life settings. Ladouceur and Sevigny (2003) suggest that patients 'switch off' their newly acquired rational beliefs when gambling. In view of that obstacle, Lindberg, Clark, and Bowden-Jones (2014) proposed a metacognitive treatment approach designed to make patients become aware and reconfigure the connection between triggers and the cognitions induced by those triggers; in the present case, between loss-related aversive events and mostly automatic, over-practiced emotion regulation strategies that could end up fueling cognitive distortions and gambling behavior. As alternatives to such strategies, Lindberg et al. (2014) explicitly propose detachment mindfulness and attention retraining. Our results support this general view, but, at the same time, suggest that some strategies, despite being superficially adaptive, can distort the meaning of gambling outcomes, and do more harm than good in the long term.

Limitations and Strengths

Several limitations can constraint the interpretation of the present results. First, the cross-sectional nature of the study makes impossible to establish with certainty the direction of causal links. In our mediation analysis, we have favored the interpretation that general, non-specific emotion regulation strategies underlie situational, gambling-specific distortions. However, other causal models are also viable. Future research is required to experimentally determine whether intervening on such strategies does produce a change in gambling-related cognitions. Second, our results are based on self-report measures. Laboratory-based emotion regulation tasks, inserted into real or simulated gambling are a promising tool to obtain more reliable measures, not affected by memory biases or social desirability. Third, and relatedly, these measures do not allow to directly evaluate outcome processing (e.g. win/loss sensitivity) in real gambling settings, so that our interpretation that emotion regulation strategies are used to diminish the emotional impact of negative outcomes must be inferred from the pattern of relationships observed between specific emotion regulation strategies and cognitive distortions, and thus remain partially speculative. Fourth, out sample was composed only of males. Given that emotional pathways to gambling have been shown to be particularly relevant in females (e.g. Blaszczynski & Nower, 2002), generalizability must not be taken for granted. And fifth, availability of PGD for research in our setting is limited, which precludes the possibility to use large samples. That means that α-growth across multiple tests is likely to be problem for multiple correlation and between-subject comparisons across multiple dependent variables. The multivariate approach used for group differences in GRCS and CERQ, as well as the logistic regression analysis to predict cluster membership in PGD, were aimed at surpassing that limitation. Multivariate effects allow for stronger, although more general, conclusions, that are further explored via effects on individual variables. Effects on individual measures should thus be interpreted more cautiously.

On the side of strengths, in spite of the several sources of evidence linking gambling behavior and gambling-related cognition to emotional processing, this is the first study so far aimed at directly investigating the relationship between emotion regulation strategies and gambling-related cognitions. Additionally, confirming our interpretation would straightforwardly provide a way to improve the currently available treatments for gambling disorder.

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Supplementary material

Table S1: Results of correlation analysis between severity of gambling, as measured by SOGS and MultiCAGE, and cognitive distortions related to gambling and cognitive strategies of emotion regulation, in the GDP group. The area within dotted borders represents correlations between SOGS severity and GRCS/CERQ scores. The shaded and delimited area contains GRCS – CERQ intercorrelations. ***p<.001; **p<.01; *p<.05.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. SOGS															
2. MultiCAGE(Gambling)	.26														
3. Interpretative bias	.42**	.05													
4. Illusion of control	.42**	-.01	.61***												
5. Predictive control	.34*	.07	.82***	.65***											
6. Gambling exp.	.30	.10	.62***	.48**	.67***										
7. Inability to stop	.45**	.15	.68***	.35*	.51**	.66***									
8. Self-blame	.26	.10	-.01	.08	-.10	-.11	.08								
9. Other-blame	.05	-.09	.12	.31	.24	.24	.08	-.29							
10. Rumination	.22	.13	.12	.15	0	-.08	.10	.39*	-.08						
11. Catastrophizing	.22	.1	-.02	.06	-.09	-.10	.07	.62***	.05	.57***					
12. Putting/perspective	.34*	.19	.35*	.31	.29	.30	.34*	.32*	.18	.25	.26				
13. Positive refocusing	.27	-.09	.02	.22	.1	.11	.10	.22	.07	.46**	.42**	.39*			
14. Positive reappraisal	.26	.04	.22	.27	.13	.16	.07	.05	.18	.54***	.15	.18	.35*		
15. Acceptance	.17	-.05	-.15	-.03	-.14	-.23	-.10	.45***	-.05	.43**	.39*	.24	.39*	.48**	
16. Refocus on planning	.49**	-.04	.29	.34*	.21	.02	.1	.29	.06	.42**	.22	.34*	.37*	.68***	.42**

CAPÍTULO 4:
Emotion dysregulation and affect-driven impulsivity, and their brain basis, in patients with gambling disorder

The content of this chapter has been published as Navas, J. F., Contreras-Rodríguez, O., Verdejo-Román, J., Perandrés-Gómez, A., Albein-Urios, N., Verdejo-García, A., & Perales, J. C. (2017). Trait and neurobiological underpinnings of negative emotion regulation in gambling disorder. *Addiction, 112*(6), 1086–1094.

Emotion dysregulation and affect-driven impulsivity, and their brain bases, in patients with gambling disorder

Gambling disorder is characterized by poor regulation of negative emotions and impulsive behaviors. This study aimed to (a) compare patients with gambling disorder (PGD) and healthy controls (HCs) in self-report and brain activation measures of emotion regulation; and (b) establish its relationship with negative emotion-driven impulsivity.

PGD and HCs were recruited from specialized gambling clinics in Andalusia (Spain), where they were following outpatient treatment, and from the community, respectively. Study 1 included 41 PGD and 45 HCs and Study 2 included 17 PGD and 21 HCs. In Study 1, we compared both groups on suppression and reappraisal emotion regulation strategies (Emotion Regulation Questionnaire [ERQ]). In Study 2, we compared PGD with HCs on brain activation associated with downregulation of negative emotions in a Cognitive Reappraisal Task, measured with functional magnetic resonance imaging (fMRI). In both studies, we correlated the measures of emotion regulation with mood-related impulsivity indicated by negative urgency (UPPS-P scale).

PGD relative to HCs showed higher levels of emotional suppression and higher activation of the premotor cortex and middle frontal gyrus during negative emotion regulation in the fMRI task. Negative urgency positively correlated with emotional suppression and middle frontal gyrus activation during negative emotion regulation in PGD.

Gambling disorder is associated with greater use of emotional suppression and stronger premotor cortex and middle frontal gyrus activation for regulating negative emotions, compared with healthy controls. Emotional suppression use and middle frontal gyrus activation during negative emotion regulation are linked with negative emotion-driven impulsivity in this disorder.

Introduction

Gambling Disorder (GD) is now recognized as a behavioral addiction, based on its clinical and neurobiological overlap with substance use disorders (1,2). Nevertheless, GD includes a distinct diagnostic criterion –gambling when feeling distressed– with no correspondence in substance-related disorders (Association, 2013; Potenza, 2013). This criterion reflects the key role of poor emotion regulation (i.e. the difficulty to cope with negative emotions) in the clinical characterization of GD (Blaszczynski & Nower, 2002; Chu & Clark, 2015; Sharpe, 2002). Despite its relevance, research on the trait and neurobiological underpinnings of emotion regulation in GD populations has been surprisingly scarce.

In accordance with a broadly validated model (Etkin, Büchel, & Gross, 2015; Gross & John, 2003) downregulation of negative emotions can be exerted via *reappraisal*, namely, reinterpretation of the meaning of an emotional state, or via *suppression*, the effortful inhibition of the expressive component of an emotion. Generalized use of reappraisal strategies, measured with self-reports, predicts better health and psychosocial adjustment, whereas regular use of emotional suppression strategies is linked to negative psychosocial outcomes (Aldao, Nolen-Hoeksema, & Schweizer, 2010; Cutuli, 2014). Accordingly, GD has been linked to a lesser disposition to use reappraisal strategies (Williams, Grishman, Erskine & Cassedy, 2012, although see Navas, Verdejo-García, López-Gómez, Maldonado, & Perales, 2016).

The neural underpinnings of emotion regulation can be assessed using a *cognitive reappraisal task* (Buhle et al., 2014). Participants are presented with series of trials depicting negative affect-laden stimuli, and asked to regulate or just experience the emotional states evoked by them. Cognitive regulation of the emotional impact of negative pictures evokes reliable brain activations, predominantly in regions of the lateral prefrontal cortex (Bhule et al., 2014; Kohn, et al., 2014). Despite the relevance of this paradigm in other areas (i.e. Albein-Urios, 2014) it has not yet been used to study the neurobiological bases of GD.

Emotional suppression strategies and poor cognitive control of emotions have been conceptually linked to trait impulsivity (Cheetham, Allen, Yücel, & Lubman, 2010). The UPPS-P model identified five different pathways to impulsivity: sensation seeking (the proneness to engage in novel, arousing activities), lack of premeditation (lack of consideration of future consequences of decisions), lack of perseverance (a tendency to quit boring or demanding tasks), and positive and negative urgency (acting rashly under positive and negative emotions, respectively) (Cyders & Smith, 2007; see Canale, Vieno, Bowden-Jones, Billieux, 2017, for a brief review of their implications in GD). Among these, negative

urgency (NU) is particularly relevant in the context of GD (Billieux et al., 2012; Michalczuk, Bowden-Jones, Verdejo-Garcia, & Clark, 2011; Torres et al., 2013) and is strongly related to emotion regulation (Albein-Urios et al., 2014; Canale et al., 2017; Cyders & Smith, 2008). In addition, neuroimaging studies in non-clinical samples have linked NU to greater activation of prefrontal regions during performance of a behavioral inhibition task, specifically under the influence of negative emotions (Chester et al., 2016). Such over-recruitment could result from the extra cognitive burden generated by regulating negative emotions in individuals with high NU (Chester et al., 2016).

Thus, indirect evidence suggests an important role of emotion regulation in GD. However, there is a lack of primary research in this domain. We carried out two studies, following complementary approaches with fully independent samples. Considered together, the studies were aimed at (a) testing differences between patients with gambling disorder (PGD) and healthy controls (HCs) in self-report measures of emotion regulation strategies (Study 1), and brain activation during negative emotion regulation in a lab-based task (Study 2); and (b) testing the links between NU and emotion regulation (Study 1), and between performance in the cognitive reappraisal task, and fMRI measures (particularly, lateral prefrontal activity) of emotion regulation (Study 2), across groups. We hypothesized PGD to show less adaptive emotion regulation strategies (lesser use of reappraisal and/or more use of emotional suppression) and greater activation of lateral prefrontal regions during cognitive reappraisal. Higher NU was hypothesized to associate with higher use of non-adaptive emotion regulation strategies and greater activation of prefrontal cognitive control regions during emotion downregulation.

Study 1. Method

Design

Cross-sectional, case-control study comparing convenience samples of PGD and HCs in self-report measures of emotion regulation.

Participants and Procedure

Forty-one PGD and 45 HCs participated in this study (15 PGD and 3 HCs were discarded after applying exclusion criteria). PGD were recruited from specialized gambling clinics in Andalusia (Spain), where they followed cognitive behavioral therapy and social support outpatient treatment. HCs were recruited from the same area and sociodemographic context. Descriptive data for the two samples are displayed in Table 1. Inclusion criteria for PGD were (a) being currently in treatment for gambling problems (≤6 months), and (b)

having remained abstinent for at least 15 days, as self-reported and corroborated by collaterals. Exclusion criteria for both groups were: (a) current mental disorders (different to GD in the clinical group); (b) current or prior history of brain injury or any neurological disease, and (c) intelligence quotient (IQ) <80.

In PGD, GD diagnosis and psychiatric comorbidities were assessed by the clinicians at the recruitment site. The assessment consisted of a semi-structured interview based on DSM-IV criteria. No females met the criteria to be included in the GDP group, so the sample was exclusively composed of males. In the first assessment session of our protocol (composed by several measures some of which were not relevant to the aims of this study and are reported elsewhere [i.e. Navas et al., 2016; Chapter 3]), a psychologist with three-year experience in assessment confirmed the absence of mental health comorbidities in PGD, and any mental health disorders in HCs. Self-report measures of GD severity and substance use were taken in order to corroborate GD diagnosis and to ensure the control of comorbid substance abuse. Besides, IQ was estimated using the Matrix reasoning and Vocabulary subtests of the Wechsler Adult Intelligence Scale (WAIS-IV) (Wechsler, 2008). The Human Research Ethics Committee of the University of Granada approved the study.

Measures

South Oaks Gambling Screen (Spanish version; Echeburúa, Báez, Fernéndez-Montalvo, & Páez, 1994). The SOGS is a 20-item scale that identifies gambling symptoms and negative consequences in order to estimate gambling severity (Cronbach's α=0.94). In the version used in this work, a score above 5 indicates probable gambling disorder (Lesieur & Blume, 1987).

MultiCAGE CAD-4 (Pedrero Pérez et al., 2007). This screening tool includes 4 yes/no dichotomous items for several potentially problematic or excessive behaviors, including gambling, alcohol use and illegal drug use. Reported Cronbach's α values are above 0.70 for these subscales. A 3-point threshold (three or more positive answers) has shown good criterion validity for the probable presence of gambling/substance use disorder (Pedrero Pérez et al., 2007).

Brief UPPS-P impulsivity scale (Spanish version; Cándido, Orduña, Perales, Verdejo-García, & Billieux, 2012). This questionnaire allows a multidimensional assessment of impulsivity, including five different traits: (a) negative urgency; (b) positive urgency; (c) sensation seeking; (d) lack of premeditation, and (e) lack of perseverance. It has shown adequate psychometric properties (Cronbach's α values ranging from 0.61 to 0.81). Our interest focused on NU, due to its relationship with GD severity and poorer treatment

outcomes (Billieux et al., 2012; Michalczuk et al., 2011; Torres et al., 2013), and emotion dysregulation (Albein-Urios et al., 2014; Canale et al., 2017; Cyders & Smith, 2008). The Cronbach's α of the NU subscale in the current sample was 0.81.

Table 1. Descriptive data and between-group differences in sociodemographic and clinical variables in studies 1 and 2.

	HCs	PGD			
STUDY 1	**Mean (SD)**	**Mean (SD)**	**F (1, 84)**	***p***	η^2_p
Age	33.22 (8.18)	35.22 (11.16)	0.91	.344	.011
Years of Education	13.31 (3.13)	13.06 (4.26)	0.10	.756	.001
Sex	45 (M)	41 (M)	-	-	-
Manipulative IQ*	100.67 (13.00)	98.00 (13.00)	0.89	.348	.011
Verbal IQ*	103.44 (13.13)	99.38 (14.20)	1.88	.174	.220
Substance misuse					
MC Alcohol	1.22 (1.17)	0.85 (1.06)	0.58	.130	.027
MC Illegal drugs	0.67 (0.95)	0.48 (0.90)	1.27	.374	.009
Gambling characteristics					
Age of GD onset	-	21.41 (5.70)	-	-	-
Type of problem gambling	-	16 (S) / 25 (P)	-	-	-
SOGS	0.58 (0.97)	10.05 (3.30)	338.97	**<.001**	.801
MC Gambling	0.02 (0.15)	2.68 (0.85)	427.31	**<.001**	.836
STUDY 2	**Mean (SD)**	**Mean (SD)**	***F* (1, 36)**	***p***	η^2_p
Age	31.00 (4.60)	32.94 (7.77)	0.92	.345	.025
Years of education	10.38 (1.96)	10.06 (1.95)	0.26	.617	.007
Sex	20 (M) / 1 (F)	16 (M) / 1 (F)	-	-	-
Manipulative IQ**	103.19 (10.69)	97.00 (11.43)	2.96	.094	.076
Verbal IQ**	105.76 (8.75)	102.06 (7.14)	1.98	.168	.052
Laterality	20 (R) / 1 (L)	16 (R) / 1 (L)	-	-	-
Gambling characteristics					
Age of GD onset	-	22.07 (9.18)	-	-	-
Type of problem gambling	-	3 (S) / 12 (P)^	-	-	-

Note. *, measured by WAIS-IV; **, measured by KBIT. ^Data were lost for 2 participants. Abbreviations. HCs: Healthy controls; PGD: Patients with gambling disorder; M: Male; F: Female; IQ: Intelligence quotient; MC: Multicage CAD-4; R: Right-handed; L: Left-handed. S: Strategic gambling modalities (e.g. card games, sport bets), P: Passive gambling modalities (e.g. slot machine, lotteries).

Emotion Regulation Questionnaire (ERQ, Spanish version; Cabello, Salguero, Fernández-Berrocal, & Gross, 2013). This instrument assesses the dispositional use of two emotion regulationstrategies: reappraisal and emotional suppression. This questionnaire has shown adequate validity and internal consistency (Cronbach's α=.75; .71, respectively).

Statistical Analysis

Potentially confounding factors (age, years of education, IQ, and MultiCAGE alcohol and drugs use), GD indices (MultiCAGE gambling subscale and SOGS severity scores), and target emotion regulation variables (ERQ reappraisal and suppression) were submitted to independent analyses of variables with group (GDP, HC) as between-participants factor. These analyses were complemented with Bayesian t-tests, aimed at checking whether Bayes factors supported the null hypothesis for all potentially confounding variables, and the alternative hypothesis for significant effects on target variables.

We calculated bivariate correlations (Pearson *r* coefficients) between the five UPPS-P subscales and emotional suppression and reappraisal. As hypotheses favored direct NU-suppression correlations, and inverse NU-reappraisal ones, a Bonferroni familywise α error correction (for a 10-test family) was applied on one-tailed *p*-values (corrected threshold $p \leq .005$).

Study 1. Results

Between-group Comparisons

Differences between groups in control variables were non-significant. Groups differed in SOGS severity and the MultiCAGE gambling subscore (Table 1, upper panel). With regard to the target variables, PGD showed higher emotional suppression [mean differences HC-GDP = 2.43, 95% confidence interval (CI) = 4.71, 0.16], but there were no differences in reappraisal (Table 2, upper panel). Differences in UPPS-P dimensions are displayed in supplementary material (Table S3).

Between-participants two-sided Bayesian t-tests (supplementary material, Study 1 analyses and Table S2) showed substantial support for the alternative hypothesis regarding emotional suppression, and only anecdotal evidence for the null hypothesis regarding reappraisal. For control variables, the Bayes Factor (BF_{10}) was below 1, but for verbal IQ and alcohol use it remained in the anecdotal range.

Correlations between Impulsivity Dimensions and Emotion Regulation Strategies

Correlations between the UPPS-P dimensions and emotion regulationstrategies are reported in supplementary material (Table S3). In PGD, among UPPS-P dimensions, only NU correlated significantly with emotional suppression (r=.40, 95% CI= 0.10, 0.63, one-tailed p=.005). This correlation was non-significant in HCs (r=.04, one-tailed p=.403). The two correlation coefficients significantly differed across groups (z=1.72, one-tailed p=.043).

The observed correlation between NU and reappraisal in the HCs (r=-.34) fell below significance after correction (one-tailed p=.011).

Table 2. Descriptive data and between-group differences in self-report measures of emotion regulation strategies (Study 1) and in the intensity of emotion experienced on each condition of the fMRI-task (Study 2), in healthy controls (HCs) and gambling disorder (PGD).

	HCs	PGD			
Study 1	**Mean (SD)**	**Mean (SD)**	***F*(1, 84)**	***p***	η^2_p
ERQ scores					
Reappraisal	30.05 (7.11)	29.07 (5.37)	0.50	.480	.01
Emotional suppression	14.93 (5.21)	17.37 (5.38)	4.53	**.036**	.05
Study 2	**Mean (SD)**	**Mean (SD)**	***F*(1, 36)**	***p***	η^2_p
Inside-scanner ratings					
Observe	1.68 (0.72)	1.63 (0.67)	-	-	-
Experience	3.11 (0.96)	3.57 (0.94)	-	-	-
Regulate	2.69 (1.00)	3.19 (0.78)	-	-	-
Emotion reduction score	0.42 (0.87)	0.38 (0.84)	0.03	.870	.00

Study 2. Method

Design

Cross-sectional, case-control study comparing a convenience sample of PGD and HCs in a functional magnetic resonance imaging measure of negative emotion regulation.

Participants and Procedure

Seventeen PGD and 21 HCs participated in this study (10 PGD and 2 HCs were discarded after applying exclusion criteria). Recruitment and inclusion/exclusion criteria were the same as in Study 1. Descriptive data for the two samples are displayed in Table 1. Diagnosis of Axis I and II disorders was indicated by the Structured Clinical Interview for DSM-IV Disorders —Clinician Version (SCID-CV) (Michael, Robert, & Miriam, 1997), and the International Personality Disorder Examination (Loranger, Sartorius, Anfreoli, Buchheim, & Channabasavanna SN., 1994). IQ was indexed by the Kaufman Brief Intelligence Test (KBIT) (Kaufman & Kaufman, 1990). Assessment was conducted by a psychologist, with three-year experience in clinical assessment. The University of Granada Human Research Ethics Committee approved the study.

Measures

UPPS-P impulsivity scale (Spanish version; Verdejo-García, Lozano, Moya, Alcázar, & Pérez-García, 2010). Impulsivity was assessed with the full Spanish version of the UPPS-P. Except of the number of items, this version is equivalent to the brief one (with Cronbach's

α values ranging from .79 to .93). Following Study 1, and the overarching aim of the whole study, UPPS-P analyses were restricted to NU (Cronbach's α=0.87).

Cognitive Reappraisal fMRI Task (Phan et al., 2005). fMRI measures of this task have been shown to be reliable and valid (Etkin et al., 2015; Buhle et al., 2014). Before scanning, participants were instructed in cognitive reappraisal (transforming negative emotions into positive ones) (Gross, 1999). The task contained interleaved blocks of neutral and negative pictures. Eight neutral pictures (e.g. household objects) and 16 highly unpleasant pictures (e.g. mutilations) extracted from the International Affective Picture System (IAPS) (Lang, Bradley & Cuthbert, 2001) were used. The images were selected according to Spanish IAPS normative valence and arousal values (Moltó et al, 1999; see Albein-Urios et al., 2014, for details).

Participants went through three experimental conditions: in the 'Observe' condition, participants were asked to look at neutral pictures; in the 'Experience' condition they had to experience the emotion produced by each emotional picture; and in the 'Regulate' condition, they were prompted to reappraise the emotion elicited by each negative picture, as previously trained. In total, there were 4 blocks per condition, and 2 pictures per block (resulting in the 16 aversive and 8 neutral pictures). The 12 resulting blocks were pseudo-randomized. Each block commenced with a 4s prompt, presented on the center of the screen, indicating the strategy to use during the block ('Observe', 'Experience', or 'Regulate'). Then, participants viewed two different pictures of the same category, presented sequentially, for 10 seconds each, and had to apply the strategy requested. Immediately after the presentation of each block, participants rated the intensity of the emotion experienced in a 1 (neutral) –5 (extremely negative) scale, by means of a five-button box (Evoke Response Pad System; Resonance Technology Inc.). Blocks were separated by 10s-long fixation crosses.

Brain images were acquired using a 3.0 Tesla MRI scanner equipped with an eight-channel phased-array head coil (InteraAchieva, Philips Medical Systems, Eindhoven, The Netherlands). During task performance, 234 brain volumes were obtained using a T2*-weighted echo-planar imaging (EPI) sequence, according to the following parameters: Repetition time (TR)=2000 ms, Echo time (TE)=35 ms, Field of view (FOV)=230 x 230 mm, matrix: 96 x 96, 21 axial slices of 4 mm with 1 mm gap.

Statistical Analysis

Behavioral measures. Potentially confounding factors (age, years of education, IQ) were submitted to independent analyses of variance with group (GDP, HC) as between-participants factor. Emotion intensity scores from each condition and group were submitted

to a 3 (observe, experience, regulate) x 2 (GDP, HC) repeated measures ANOVA. An emotion reduction score was also computed as the difference in emotion intensity between the 'Regulate' and 'Experience' conditions (with larger scores indicating more success in downregulating the emotion triggered by negative pictures). This score was also submitted to a one-factor (group) ANOVA, and correlated with NU in the two groups. Given that, due to the small sample size, these analyses are probably underpowered, we carried out Bayesian tests for all between-group contrasts. Correlations were tested and compared using a two-tailed $p \leq 0.05$ significance criterion.

Neuroimaging. Preprocessing and statistical analysis of the anatomic imaging data were conducted using MATLAB version R2008b (The MathWorks, Inc, Natick, Massachusetts) and statistical parametric mapping software (SPM8; Wellcome Trust Centre for Neuroimaging, UCL, London, United Kingdom). Preprocessing included re-slicing to the first image of the time series, slice timing correction, normalization to an EPI template in the Montreal Neurological Institute (MNI) space, and spatial smoothing by convolution with a 3D Gaussian kernel (full width at half maximum=8mm). Participants with a degree of movement above 2.5mm in any of the six directions were excluded from the analyses. First-level (single-subject) SPM contrasts images were estimated for the following two main task effects of interest: 'Experience'>'Observe' and 'Regulate'>' Experience'. According to the main aim of the study and results for the first one, analyses were focused on the contrast 'Regulate'>' Experience'. Results for the contrast 'Experience'>'Observe' are reported in the supplementary material (table S4, Figure S1). Conditions were modeled for the 20s that the images were on the screen and did not include instruction and rating periods. The BOLD response at each voxel was convolved with the SPM8 canonical hemodynamic response function (using a 128-s high-pass filter). The resulting first-level contrast images were then carried forward to subsequent second-level random-effect (group) analyses. One-sample t-test was used to assess the main task effects and two-sample t-tests to assess between-group differences.

Correlation between NU and emotion regulation triggered fMRI activation. Voxel-wise whole brain correlation analyses were performed in SPM8 to estimate the association between NU and brain activation during the emotion regulation in both groups, and between-group interactions. PGD' β eigenvalues corresponding to peak coordinates of each cluster yielding a significant correlation with NU were extracted from the correlation model in SPM8. Additional within-group correlation analyses were carried out in SPSS to estimate the

degree to which NU (and the brain signal previously identified to associate with it) correlate with the emotional reduction score. 1 participant showing +2*SD* in his activation pattern was discarded from NU-brain activation correlational analyses (Tabachnick & Fidell, 2013).

Thresholding criteria. We selected a threshold of $p \leq .005$, which has been shown to be adequate to balance the risk of Type I and Type II errors when using well-established fMRI paradigms (Woo, Krishnan, & Wager, 2014). The spatial extent threshold for the imaging analyses was determined by 1000 Monte Carlo simulations using AlphaSim as implemented in the SPM REST toolbox (Song, Dong, Long, Li, & Zuo, 2011). In addition to a voxel significance of $p \leq .005$, input parameters to AlphaSim included a cluster connection radius of 5 mm and the actual smoothness of the data. To correct one-sample activation and correlation t-tests maps we used a brain mask of 128190 voxels. A minimum cluster size (CS) of 896 mm^3 (112 voxels) was estimated. Significance in all two-sample t-tests was assessed using the same input parameters but using a mask of 17261 voxels created from the conjoint activation of the study groups during the 'Regulate'>' Experience' contrast. A minimum cluster of 400 mm^3 (50 voxels) was estimated.

Study 2. Results

Behavioral Data

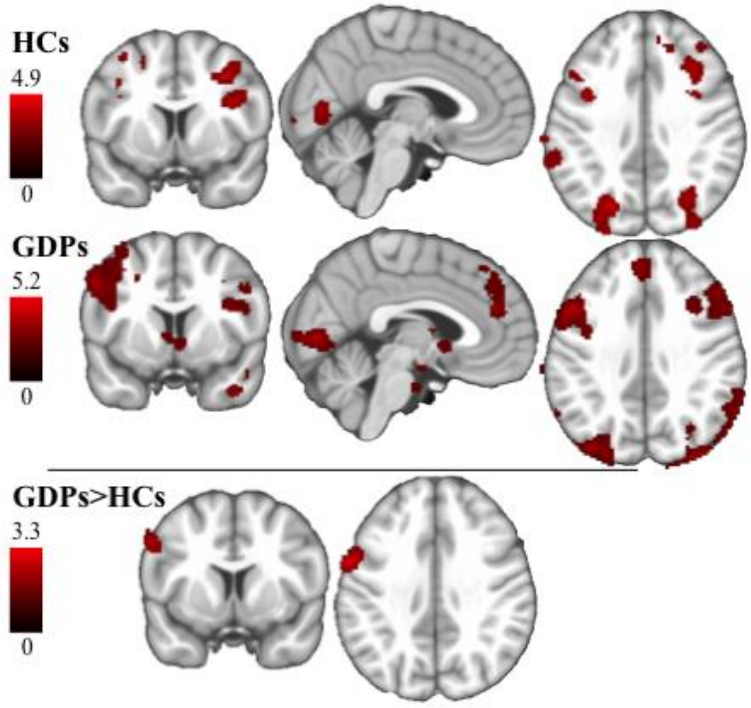
We found a significant effect of condition $F(2, 35)=67.171$, $MSE=31.309$, $p<.001$, $\eta^2_p=.65$; but there were no significant effects of group ($p=.177$) or the condition x group interaction ($p=.143$). Accordingly, there was no difference between groups in the emotion reduction score (Table 2).

The complementary Bayesian ANOVA (supplementary materials, Study 2 analyses and Table S5) on the emotion reduction score yielded substantial evidence supporting the absence of a group effect. Bayesian t-tests yielded Bayes factors below 1, but in the anecdotal evidence range for all control variables.

Emotion Regulation Triggered Activation ('Regulate' vs. 'Experience')

In within-participant analyses, both groups showed significant activation in a cluster of the lateral prefrontal cortex comprising middle and inferior frontal gyri, in the superior parietal cortex bilaterally, and in temporal and medial occipital cortices. PGD showed additional activation in the dorsomedial prefrontal cortex and in the caudate nucleus (supplementary materials, Table S6, Figure 1).

Figure 1. Regions showing significant 'Regulate' minus 'Experience' activations in healthy controls (HCs) and patients with gambling disorder (PGD); and between group differences.



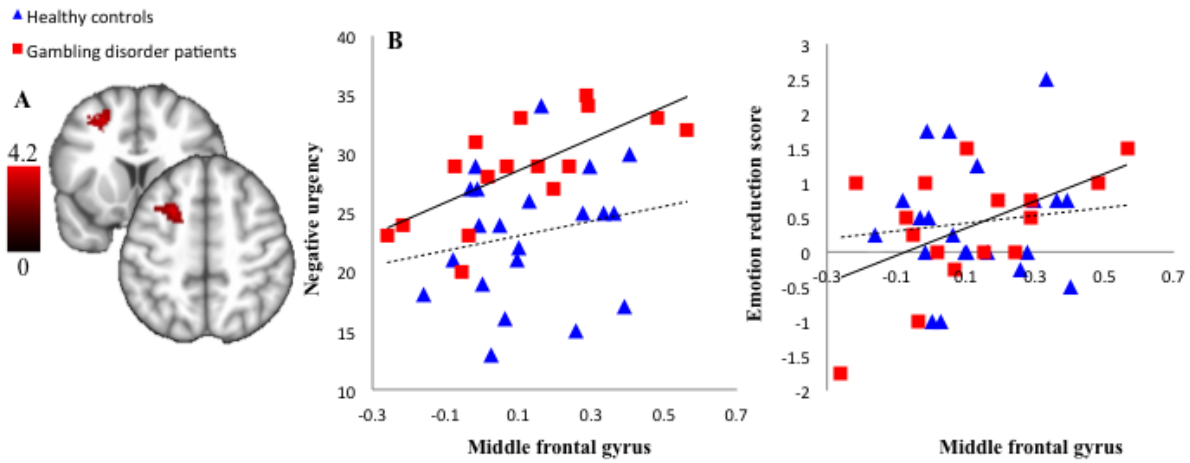
Note. Right hemisphere is displayed on the right. The color bars indicate t-value.

In between-group analyses, PGD showed increased activation in the left lateral frontal cortex, comprising premotor and middle frontal (prefrontal) cortices, relative to HCs (peak cluster MNI coordinates, x=-60, y=20, z=32, *t*=3.3, *CS*=54) (Figure 1). No brain regions showed increased activation in HCs relative to PGD.

Correlations with Negative Urgency

NU showed a significant positive association with the emotion reduction score in PGD (*r*=.57, two-tailed *p*=.017), but this correlation was non-significant in HCs (*r*=.29, two-tailed *p*=.200). The correlation coefficients did not significantly differ across groups (*z*=0.98, one-tailed *p*=.164). In PGD, NU was positively associated with activation in the left middle frontal (Figure 2) and medial occipital cortices (supplementary materials, Table S7). The former was adjacent to the cluster showing hyperactivation in PGD during cognitive emotion regulation. Actually, the peak signal in that cluster also significantly correlated with the emotion reduction score [*r*=.52, *p*=.039 (Figure 2)]. Several regions associated with NU in HCs (Table S7), although no one associated with the emotion reduction score.

Figure 2. Main brain activation related to negative urgency in Study 2, and correlation with negative urgency and the emotion reduction score in the cognitive reappraisal task.



A. Area in the middle frontal gyrus showing positive significant correlation with negative urgency in patients with gambling disorder. Right hemisphere is displayed on the right. The color bar indicates t-value. B. Correlations between activation of the middle frontal gyrus (peak coordinates from panel A) and negative urgency and the emotion reduction score.

Discussion

We found that PGD relative to HCs have higher use of emotional suppression strategies and higher activation of left premotor and middle frontal cortices to regulate negative emotions. Negative urgency positively correlated with self-reported emotional suppression and left middle frontal cortex activation in PGD.

The findings regarding emotion regulation strategies partially concur with Williams et al. (Williams et al., 2012), who also showed that PGD used dysfunctional regulation strategies (although Williams at al. reported less frequent use of reappraisal). Emotional suppression has been shown to relate to higher anxiety and lower mood in clinical and subclinical samples (Aldao et al., 2010; Cutuli, 2014). Moreover, experimental evidence has demonstrated that emotional suppression can deplete self-control resources (Vohs & Heatherton, 2000). In the context of GD, the link between emotional suppression and NU supports the finding that the disorder is associated with dysfunctions in top-down self-control mechanisms (Brevers et al., 2012; van Holst, van den Brink, Veltman, & Goudriaan, 2010).

Despite brain activation differences during negative emotion regulation, PGD and HCs did not differ in task performance. These results are compatible with the proposal that PGD overrecruited cognitive control areas because of their difficulties at doing the task as instructed. A similar mechanism has been proposed by van Holst et al., (2012), who found

PGD to activate prefrontal areas more strongly than HCs during response inhibition in non-affective contexts. The triple correlation between NU, reduction of negative emotions in the cognitive reappraisal task, and prefrontal activation in PGD reinforces this interpretation. This result can be interpreted in two ways. According to an *ego depletion/compensatory* account, PGD can have difficulties to disengage from negative events, and require more cognitive control resources for regulating emotions. A non-mutually exclusive possibility is that PGD and HCs use different strategies, with PGD using more emotional suppression, which is a heavily resource-consuming strategy (Vohs & Heatherton, 2000). The linkages between emotion regulation and NU in Study 2, and between NU and emotional suppression in Study 1, point out in that direction. However, the involvement of emotional suppression in emotion reduction in Study 2 remains indirect (as no measures of reappraisal versus suppression were taken).

Our findings have to be interpreted in the context of some limitations. First, the cross-sectional design precludes causal interpretations. Second, the ERQ questionnaire is used in Study 1, whereas a cognitive laboratory task is used in Study 2. Both are well-validated measures of emotion regulation, but their conceptual overlap has not been tested. Moreover, the emotions triggered by the cognitive reappraisal task are probably less intense than those experienced in daily life. Items from NU and emotion regulation scales are likely to be more representative of such situations. Finally, sample size may have limited the power of our neuroimaging analysis. Still, we targeted brain networks that have been previously defined in studies using the same task and are spatially specific (Albein-Urios et al., 2014; Phan et al., 2005).

A significant aspect of this work is that it is the first to show emotion regulation deficits in GD measured with different methodologies including self-reports and neuroimaging. Our findings also have important clinical implications, as they suggest that certain emotion regulation therapies, as mindfulness or attention debiasing, are worth to be considered in the treatment of GD (Chu & Clark, 2015). In contrast with standard restructuration, based on conscientiously identifying and changing erroneous beliefs, these techniques require gradually learning to acknowledge and detach from negative emotions, without actively suppressing them. This process shares some features with stimulus desensitization and counterconditioning, and is hypothesized to result in an automatic (*model-free* [Etkin et al., 2015]) type of emotion regulation, instead of a more effortful (*model-based* [Etkin et al., 2015]) reprocessing of emotions.

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Supplementary materials

Supplementary analyses, Study 1. Bayesian analyses of between group differences in control and interest variables.

Two-sided Bayesian t-tests on potential confounders yielded Bayes factors (BF_{10}) between 0.235 and 0.623, in all cases on the side of anecdotally or substantially supporting the null hypothesis (Table S1).

Hypothesis driven one-sided Bayesian t-tests (BF_{10}, GDP>HC) were performed on impulsivity (UPPS-P Scale) and the emotional suppression strategy (ERQ). These tests yielded extreme evidence supporting the alternative hypothesis for the group effect on negative urgency, strong evidence supporting the alternative hypothesis for the group effect on lack of premeditation, substantial evidence supporting the alternative hypothesis regarding emotional suppression, and substantial evidence supporting the null hypothesis (no effect) regarding sensation seeking and lack of perseverance. A one-sided Bayesian t-test (BF_{10}, HC>GDP) was performed on reappraisal strategy (ERQ), yielding anecdotal evidence supporting the null hypothesis. The direction of tests was based on the hypotheses, described in the article, that PGD are more impulsive, make more use of emotional suppression, and less use of reappraisal, than HCs (Table S1).

Table S1. Bayesian t-tests results on potential confounders, impulsivity (UPPS-P scale) and emotional regulation strategies (ERQ) in Study 1.

Dependent Variable	BF_{10}	error %
Age	0.34	$2.939 \cdot 10^{-4}$
Education years	0.24	$2.927 \cdot 10^{-4}$
Manipulative IQ	0.29	$3.022 \cdot 10^{-4}$
Verbal IQ	0.52	$2.035 \cdot 10^{-4}$
MC Alcohol	0.62	$1.776 \cdot 10^{-4}$
MC Illegal drugs	0.32	$2.979 \cdot 10^{-4}$
Negative urgency	260.46	$\sim 3.077 \cdot 10^{-7}$
Positive urgency	1.18	$\sim 1.717 \cdot 10^{-4}$
Sensation seeking	0.33	$\sim 2.978 \cdot 10^{-4}$
Lack of premeditation	17.23	$\sim 2.225 \cdot 10^{-6}$
Lack of perseverance	0.29	$\sim 2.923 \cdot 10^{-4}$
Emotional suppression	3.11	$\sim 3.056 \cdot 10^{-5}$
Reappraisal	0.42	$\sim 3.024 \cdot 10^{-4}$

Note. Tests of potential confounders are two-sided. Test of UPPS-P and ERQ are one-sided: PGD>HCs for UPPS-P measures and emotional suppression, HCs>PGD for reappraisal. *Abbreviations.* MC: Multicage CAD-4; IQ: Intelligence quotient; PGD: Patients with gambling disorder; HCs: Healthy controls.

Supplementary analyses, Study 2. Bayesian analyses of between group differences in control and interest variables.

Two-sided Bayesian t-tests were performed on age, education years, manipulative IQ, and verbal IQ. Bayes factors were below 1 in all cases, but only the one for education years was close to the recommended threshold for considering evidence positively supportive of the null hypothesis ($BF_{10} \leq 0.33$) (Table S2).

One-sided (GDP>HC) Bayesian t-tests for impulsivity measures yielded very strong evidence for the effect of group on positive and negative urgency, substantial evidence for an effect on lack of premeditation, and substantial evidence favoring the null (no effect) for sensation seeking (Table S2).

A JZS Bayes Factor Group x Condition ANOVA with default prior scales on emotional evaluations of the cognitive reappraisal task yielded the following Bayes Factors: $BF_{10}=3.467 \cdot 10^{14}$ for the task condition effect model vs. the null model; $BF_{10}=0.455$ for the task group effect model vs. the null model, and $BF_{10}=0.455$ for the task condition + group + task condition · group. When the analysis was restricted to the 'Regulate' minus 'Experience' emotion reduction score, the one factor (Group) Bayesian ANOVA yielded a Bayes Factor, $BF_{10}=0.320$ for the group effect model (vs. the null model).

Table S2. Bayesian t-tests results on potential confounders, and impulsivity (UPPS-P scale) in Study 2.

Dependent Variable	BF_{10}	**error %**
Age	0.45	$2.493 \cdot 10^{-5}$
Education years	0.35	$7.671 \cdot 10^{-6}$
Manipulative IQ	0.68	$9.408 \cdot 10^{-6}$
Verbal IQ	0.99	$4.620 \cdot 10^{-5}$
Negative urgency	61.23	$\sim 8.805 \cdot 10^{-8}$
Positive urgency	31.13	$\sim 1.317 \cdot 10^{-7}$
Sensation seeking	0.23	$\sim 7.777 \cdot 10^{-6}$
Lack of premeditation	4.20	$\sim 1.672 \cdot 10^{-5}$
Lack of perseverance	2.55	$\sim 6.959 \cdot 10^{-5}$

Note. Tests of potential confounders are two-sided. Test of UPPS-P are one-sided: PGD>HCs
Abbreviations. IQ: Intelligence quotient; PGD: Patients with gambling disorder; HCs: Healthy controls.

Table S3. Descriptive data and between-group differences in UPPS-P dimensions of both studies in healthy controls (HCs) and patients with gambling disorder (PGD).

	PGD	HCs			
Study 1*	***Mean (SD)***	***Mean (SD)***	**F (1, 84)**	***p***	η^2
Negative urgency	2.23 (0.69)	2.84 (0.74)	15.32	**<.001**	.15
Positive urgency	2.25 (0.56)	2.46 (0.69)	2.40	.125	.03
Sensation seeking	2.21 (0.74)	2.29 (0.85)	0.23	.636	.00
Lack of premeditation	1.77 (0.57)	2.17 (0.69)	8.57	**.004**	.09
Lack of perseverance	1.78 (0.61)	1.82 (0.62)	0.09	.087	.00
Study 2	***Mean (SD)***	***Mean (SD)***	**F (1, 84)**	***p***	η^2
Negative urgency	23.19 (5.46)	29.18 (4.70)	12.79	**.001**	.26
Positive urgency	29.88 (6.49)	22.57 (7.11)	10.73	**.002**	.23
Sensation seeking	30.41 (3.39)	31.52 (8.46)	0.26	.614	.01
Lack of premeditation	26.00 (3.73)	23.05 (4.25)	5.06	**.031**	.12
Lack of perseverance	22.24 (2.97)	20.10 (3.69)	3.75	.061	.09

* Short Spanish version

Table S4. Correlations among emotional regulation strategies and impulsivity in healthy controls (HCs) and patients with gambling disorders (PGD).

		Supp	**NU**	**PU**	**SS**	**LPrem**	**LPers**
HCs							
1. Reappraisal	*r*	.15	-.34	-.02	-.02	-.13	-.17
	p	.12	.01	.44	.44	.20	.14
2. Emotional suppression	*r*		.04	.18	.10	-.17	.08
	p		.40	.12	.26	.14	.30
PGD							
1. Reappraisal	*r*	.23	.21	.15	.02	-.27	-.02
	p	.08	.10	.18	.46	.04	.45
2. Emotional suppression	*r*		**.40**	.09	-.01	-.19	.01
	p		**.005**	.28	.48	.11	.48

Note. Significant correlations are indicated in bold. *Abbreviations.* Supp: emotional suppression; NU: Negative urgency; PU: Positive urgency; SS: Sensation seeking; LPrem: Lack of premeditation; LPers: Lack of perseverance

Table S5. Regions showing significant activations during emotional experience (Experience >Observe) in healthy controls (HCs) and patients with gambling disorder (PGD); and between groups differences.

Brain region	Coordinates			Coordinates			Coordinates		
	x, y, z	**t**	**CS**	**x, y, z**	**t**	**CS**	**x, y, z**	**t**	**CS**
	HCs			PGD			HCs>PGD		
Inferior frontal gyrus	-	ns	-	-44, 26, -22	3.6	145	32, 52, 18	4.3	69
	-	ns	-	58, 26, 22	3.8	115	-	ns	-
Medial PFC	-6, 56, 34	5.4	1373	-	ns	-	8, 60, 26	3.4	74
Dorsomedial PFC	-6, 20, 62	3.9	391	-	ns	-	-	ns	-
ACC	-8, 28, 28	4.4	228	-	ns	-	-	ns	-
PCC	2, -50, 26	3.7	22535*	-	ns	-	-	ns	-
Caudate-Putamen	-18, 4, 4	4.1	*	-16, 0, -4	4	284*	-	ns	-
Thalamus	0, -4, 6	4.7	*	-8, -4, 0	3.5	*	-	ns	-
Hypothalamus	-4, 2, -12	4.0	*	-	ns	-	-	ns	-
Amygdala	-22, -2, -24	3.9	*	-28, 4, 22	3.4	8771#	-	ns	-
Hippocampus	-30, -12, -18	3.6	*	-28, -20, -12	3.5	#	-	ns	-
Periaqueductual	0, -34, -2	4.4	*	-	ns	-	-	ns	-
Temporal cortex	-	ns	-	-46, -24, -16	5.1	8771#	-	ns	-
Parietal cortex	56, -66, 8	4.6	*	52, -72, 14	6.2	5876^	-	ns	-
	-52, -66, 8	7.7	*	-52, -72, 8	5.9	#	-	ns	-
Occipital cortex	42, -80, -4	8.5	*	36, -86, -10	9	^	-	ns	-
	-42, -86, 0	7.4	*	-42, -88, -10	6.7	#	-36, -78, 28	3.9	86
Cerebellum	-4, -70, -26	7.1	*	-8, -70, -28	4.8	#	-	ns	-

Note. Coordinates (x, y, z) are given in Montreal Neurological Institute (MNI) space. *, #, ^ part of the large cluster. *Abbreviations*. CS: Cluster size; PFC: Prefrontal cortex; ACC: Anterior cingulate cortex; PCC: Posterior cingulate cortex; ns: non-significant.

Table S6. Regions showing significant activations during emotion regulation (Regulate> Experience) in healthy controls (HCs) and patients with gambling disorder (PGD).

Brain region	Coordinates			Coordinates		
	x, y, z	**t**	**CS**	**x, y, z**	**t**	**CS**
	HCs			PGD		
Middle frontal gyrus	36, 24, 40	4.9	2746*	40, 40, 30	2.9	2577
	-28, 4, 54	3.4	345#	-48, 16, 36	4.8	1800*
Inferior frontal gyrus	48, 28, 12	4.1	2746*	38, 32, -22	3.5	140
	-36, 18, 18	3.3	345#	-42, 10, 24	3.5	*
Superior frontal gyrus	12, 36, 54	4.0	182	-	ns	-
Dorsomedial PFC	-	ns	-	6, 44, 22	4.4	565
Caudate	-	ns	-	6, 10, -4	3.3	225
Thalamus	-	ns	-	-12, -12, 12	3.8	83
Superior Parietal	28, -70, 40	4.1	974	28, -72, 58	5.2	2279
	-28, -76, 48	4.5	1405	-30, -74, 54	4.2	2193
Temporal cortex	-62, -46, 12	3.7	175	42, 12, -36	5.1	288
Fusiform gyrus	28, -56, 10	3.3	1801^	26, -54, -10	4.2	3056#
Occipital cortex	10, -78, -2	4.9	1801^	10, -78,-2	6.4	#

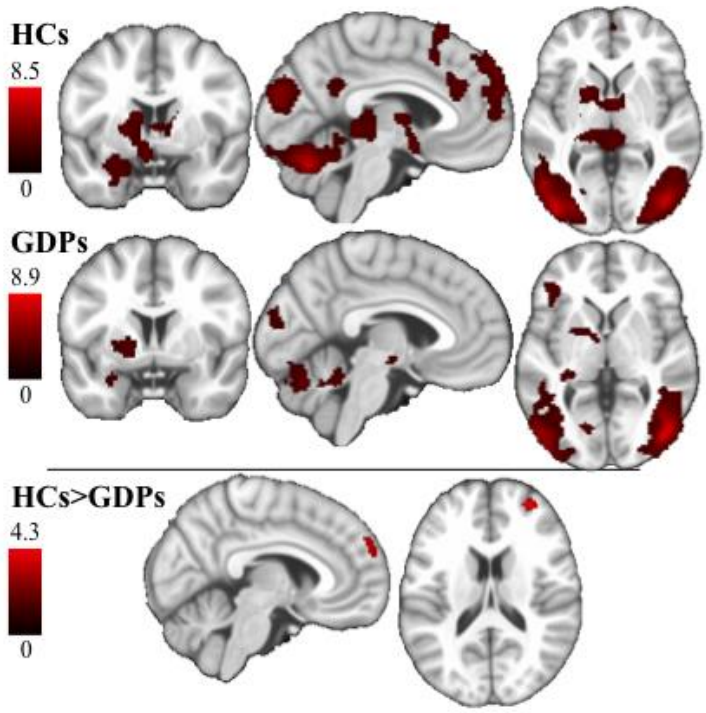
Note. Coordinates (x, y, z) are given in Montreal Neurological Institute (MNI) space. * and # part of the large cluster. *Abbreviations.* CS: Cluster size; PFC: Prefrontal cortex; ns: non-significant.

Table S7. Brain regions associated with negative urgency in healthy controls (HCs) and patients with gambling disorder (PGD).

Brain Regions	Coordinates				Coordinates			
		x, y, z	**t**	**CS**		**x, y, z**	**t**	**CS**
		HCs				PGD		
Middle frontal gyrus	(+)	-40, 32, 30	4.2	324	(+)	-24, 10, 48	4.2	133
Lateral OFC	(+)	48, 42, -16	4.3	369		-	ns	-
	(+)	-44, 30, -14	3.4	118		-	ns	-
Amygdala	(+)	-24, 4, -20	4.4	1057*		-	ns	-
Striatum	(+)	-30, 22, -32	4.7	*		-	ns	-
Brainstem	(+)	-4, -30, -12	3.8	264		-	ns	-
Temporal pole	(+)	-30, 22, -32	4.7	*		-	ns	-
STG	(+)	-66, -20, 10	4.0	469		-	ns	-
Angular	(+)	-56, -52, 22	3.7	313		-	ns	-
Parietal-Occipital	(+)	28, -76, 40	4.1	547		-	ns	-
Medial Occipital	(+)	-6, -88, 22	4.0	245	(+)	-2, -86, 22	4.0	150

Note. Coordinates (x, y, z) are given in Montreal Neurological Institute (MNI) space. * part of the large cluster. The signs (+) indicates positive significant correlations. *Abbreviations.* CS: Cluster size; PFC: Prefrontal cortex; OFC: Orbitofrontal cortex; STG: Superior temporal gyrus; ns: non-significant.

Figure S1. Regions showing significant activations during emotional experience (Experience >Observe) in healthy controls (HCs) and patients with gambling disorder (PGD); and between groups differences. Right hemisphere is displayed on the right. The color bar indicates t-value.



IV. DISCUSIÓN GENERAL, CONCLUSIONES Y PERSPECTIVAS FUTURAS

Índice de la discusión

El objetivo general de esta tesis era describir y analizar diferentes mecanismos de procesamiento afectivo en el trastorno por juego de azar (TJA), para aumentar el conocimiento existente sobre su involucración específica en este trastorno, discernir su contribución a las diferencias clínicamente relevantes entre pacientes y contribuir, de esta manera, al diseño de intervenciones más individualizadas. En esta sección se resumirán los hallazgos principales de los cinco estudios que se han descrito en los cuatro capítulos previos y se discutirán dentro de un marco de evidencia proveniente de los campos de la psicología y la neurociencia. Adicionalmente, se esbozará, a modo de recapitulación final de las conclusiones, un modelo teórico sobre la heterogeneidad en el TJA que hemos propuesto recientemente (Navas, Billieux, Verdejo-García, & Perales, 2018) y que está parcialmente sustentado por los resultados de los estudios de esta tesis. Finalmente, se propondrán implicaciones clínicas y posibles líneas futuras de investigación que se podrían derivar de este trabajo.

1. Resumen de los hallazgos

El objetivo del estudio descrito en el Capítulo 1 fue disociar la influencia del estatus clínico y las preferencias por determinadas modalidades de juego sobre la sensibilidad a la recompensa y al castigo, la impulsividad rasgo, la impulsividad en la elección (i.e. menor tolerancia a la demora de la recompensas) y las distorsiones cognitivas relacionadas con el juego. Se realizaron comparaciones sobre estos procesos, por un lado, entre jugadores con TJA y jugadores regulares (i.e. jugadores que no cumplen los criterios para el diagnóstico de TJA) y, por el otro, entre jugadores con preferencias por diferentes actividades de juego, cruzando ambas factorialmente. En primer lugar, los jugadores con TJA en comparación con jugadores regulares mostraron mayor sensibilidad a la recompensa, urgencia positiva y negativa, impulsividad en la elección e intensidad de distorsiones cognitivas relacionadas con el juego. No obstante, mostraron también una menor falta de perseverancia. En segundo lugar, los jugadores fueron separados en función de su preferencia declarada por dos modalidades de juego. Éstas habían sido identificadas en un análisis preliminar de componentes principales sobre las frecuencias de participación en distintos juegos. Se utilizaron las etiquetas neutrales Tipo I (i.e. cartas, otros juegos de casino [incluyendo ruleta], y apuestas de habilidad) y Tipo II (i.e. máquinas tragaperras, loterías y bingo) para definirlas y así evitar asunciones teóricas sobre las razones de dicha clasificación. Los jugadores Tipo I comparados con los Tipo II mostraron mayor sensibilidad a la recompensa y mayor fuerza

de las distorsiones cognitivas relacionadas con el juego. Los jugadores Tipo II manifestaron mayor impulsividad en la elección que los jugadores Tipo I. Sin embargo, es importante hacer notar que las diferencias entre grupos en esta clase de impulsividad se debieron a las diferencias entre jugadores con TJA Tipo II y los jugadores regulares Tipo I, mientras que las diferencias en sensibilidad a la recompensa se debieron, en gran medida, a la puntuación de los jugadores con TJA Tipo I en comparación con los jugadores Tipo II, independientemente de su estatus clínico.

El objetivo del estudio descrito en el Capítulo 2 fue examinar las asociaciones de las distorsiones cognitivas de juego con la impulsividad rasgo y la severidad del juego en una muestra de jugadores con TJA y jugadores regulares. Los resultados mostraron cómo la intensidad de estas distorsiones estaba asociada con la severidad del juego y con las dimensiones afectivas del modelo UPPS-P (i.e. búsqueda de sensaciones y urgencia positiva y negativa), pero no con sus dimensiones cognitivas (i.e. falta de perseverancia y falta de premeditación).

En el estudio del Capítulo 3 se abordaron los siguientes objetivos: (a) corroborar que los pacientes con TJA comparados con controles sanos mostraban mayores distorsiones cognitivas relacionadas con el juego, (b) explorar las diferencias entre estos grupos en el uso de estrategias cognitivas de regulación emocional y (c) examinar el conjunto de asociaciones entre estas estrategias, las distorsiones cognitivas relacionadas con el juego y la severidad del juego. Así, los pacientes informaron de mayores puntuaciones en distorsiones cognitivas y una mayor tendencia disposicional a usar la catastrofización y autoculpa como estrategias de regulación emocional. Sorprendentemente, también informaron de un mayor uso de la refocalización positiva, es decir, una estrategia que es comúnmente definida como adaptativa y promotora de bienestar emocional (Garnefski y Kraaij, 2007). Por otro lado, otra estrategia de esta naturaleza, poner en perspectiva, estaba vinculada directamente a la fuerza global de diversas distorsiones cognitivas relacionadas con el juego (i.e. ilusión de control, control predictivo, sesgo interpretativo y expectativas de juego). Además, estaba asociada indirectamente a través de estas distorsiones a la severidad del trastorno. Asimismo, otra de las estrategias de regulación emocional comúnmente definidas como adaptativas, la refocalización en la planificación, también estaba asociada a la severidad del TJA aunque de manera directa, es decir, no a través de las distorsiones cognitivas.

En el Capítulo 4 se describen dos estudios complementarios. El primero de ellos examinó las diferencias entre pacientes con TJA y controles sanos en su uso disposicional de *reapprasial* y supresión emocional, y se exploró el vínculo entre estas estrategias de regulación emocional y

la urgencia negativa rasgo en ambos grupos. En el segundo estudio se examinaron las diferencias entre pacientes y controles en la activación cerebral durante la regulación de emociones negativas en una tarea de laboratorio de *reappraisal* bajo resonancia magnética funcional. También se exploró la asociación entre la urgencia negativa y la ejecución en dicha tarea. Los resultados indicaron que los pacientes con TJA tenían una tendencia a usar más frecuentemente que los controles la supresión emocional cuando abordan situaciones emocionales en sus vidas cotidianas, y que esta estrategia estaba asociada a una mayor urgencia negativa en el grupo clínico (pero no en el grupo de controles sanos). Por lo tanto, a mayor tendencia disposicional a la supresión del componente expresivo de las emociones, mayor era la propensión a perder el control bajo la influencia de estados emocionales negativos en pacientes con TJA. En la tarea de *reappraisal*, aunque los pacientes tuvieron una ejecución similar a la de los controles, es decir, no difirieron en el nivel de reducción subjetiva de la emoción experimentada, se hallaron diferencias entre los grupos a nivel cerebral. Comparado con los controles, los pacientes con TJA mostraron una mayor activación del cortex premotor y prefrontal medio izquierdos mientras regulaban sus emociones. Además, la urgencia negativa estaba asociada a una mayor activación del cortex prefrontal medio izquierdo solo en el grupo de jugadores con TJA.

2. Discusión general

La presente tesis está inspirada en diversas líneas de investigación, todas ellas relacionadas de una forma u otra con el objetivo general de esclarecer los mecanismos de procesamiento afectivo en el TJA. Específicamente nos referimos a (a) aquellas que resaltan la relevancia de la alteración del procesamiento de la recompensa y castigos y de la falta de autocontrol en el desarrollo y mantenimiento del TJA, (b) aquellas que destacan la centralidad de la desregulación emocional en los trastornos adictivos y cómo las emociones y otros eventos afectivos pueden interferir en el autocontrol; y, finalmente, (c) aquellas que proponen la existencia de un amplia heterogeneidad en poblaciones de jugadores con TJA y cómo las diferencias individuales en diversos procesos afectivos pueden explicar inconsistencias en la literatura actual sobre este trastorno. Las diferentes formas en la que la presente tesis contribuye a estas líneas se discute en las siguientes subsecciones.

2.1. Sensibilidad a la recompensa y al castigo y su asociación con el estatus clínico y la modalidad de juego preferida

Tal y como se mencionó en la sección de *Introducción*, los estudios de sensibilidad a la recompensa y al castigo a nivel de rasgo han tratado de apuntalar la evidencia empírica sobre la híper o hipo-sensibilidad a las ganancias y pérdidas monetarias. Esta tesis puede complementar indirectamente el *corpus* de conocimiento actual sobre alteraciones en su procesamiento, en tanto que ofrece evidencia sobre cómo la sensibilidad a la recompensa y al castigo se relacionan con la severidad de la conducta de juego y las preferencias por modalidades específicas de juegos de azar.

Habíamos argumentado que las discrepancias existentes en la literatura con respecto a la sensibilidad a la recompensa rasgo podían deberse a diferencias en el estadio del proceso de adicción y/o a diferencias individuales relacionadas con la modalidad de juego preferida (Balodis et al., 2014; Goldstein y Volkow, 2011; Sharpe et al., 1995). De acuerdo con algunas teorías de adicción, según el trastorno adictivo progresa, los reforzadores naturales pierden gradualmente su capacidad para ser recompensantes (Goldstein y Volkow, 2011). De esta manera, una menor sensibilidad a la recompensa sería de esperar en individuos con trastornos adictivos de largo recorrido. Sin embargo, nuestros hallazgos no son plenamente coincidentes con esta idea, en tanto que encontramos que los jugadores con TJA informaron de una mayor sensibilidad a la recompensa que los jugadores regulares. Además, un análisis más detallado reveló que los jugadores con TJA Tipo I fueron aquellos con mayor sensibilidad a la recompensa en comparación al resto de grupos. Este resultado está en consonancia con evidencia previa que muestra que los jugadores que prefieren juegos estratégicos son más sensibles a la recompensa que aquellos que prefieren juegos de puro azar –una clasificación casi totalmente solapada con la nuestra (Tipos I y II) excepto por los juegos de ruleta– (Balodis et al., 2014; Sharpe et al., 1995). Esta cuestión sugiere la importancia de tener en cuenta la modalidad de juego en el estudio de la sensibilidad a la recompensa para evitar incosistencias en la literatura a este respecto.

En relación a la sensibilidad al castigo, se ha sugerido que los jugadores mostrarían una tendencia a jugar de manera más severa dada su insensibilidad a las pérdidas (e.g. Goudriaan et al., 2004). Sin embargo, la hipersensibilidad al castigo se ha relacionado con propensión al neuroticismo y a alteraciones del estado de ánimo (Corr, 2004). En consonancia, otras fuentes de evidencia en la literatura de juego sugieren que los jugadores con alta sensibilidad al castigo tienden a jugar más severamente como una forma de afrontar estados de distrés (Wardell et al., 2015; Weatherly y Miller, 2013). En el presente trabajo, no se encontraron asociaciones de este

rasgo con la severidad de juego. Este resultado sugiere la existencia de cierta variabilidad dentro de las poblaciones jugadores con TJA en cómo de sensibles son a eventos aversivos en general y en sus tendencias disposicionales a evitarlos. Además, tampoco se encontraron asociaciones de este rasgo con la modalidad de juego preferida; lo que podría indicar que dicha variabilidad puede encontrarse también en jugadores Tipo II. Por tanto, existe la posibilidad de que la conducta de juego en algunas poblaciones de este tipo de jugadores esté dirigida por estrategias de afrontamiento emocional (como muestra la evidencia previa; Balodis et al., 2014; Fang y Mowen, 2009; Thomas, Allen, y Phillips, 2009) en lugar de por el neuroticismo o los trastornos del estado de ánimo, que podrían estar más ligados a lo que la sensibilidad al castigo del SPSRQ captura.

Es importante hacer notar, sin embargo, que la sensibilidad a la recompensa y al castigo, como se miden en el SPSRQ (Aluja y Blanch, 2011), reflejan sensibilidad general y no capturan enteramente la sensibilidad a las propiedades apetitivas y aversivas específicas del juego de azar. Por lo tanto, no está claro cómo pueden relacionarse directamente con la híper- o hipo-sensibilidad a las ganancias y pérdidas monetarias. De manera complementaria e ilustrativa, cabe decir que nuestros hallazgos sobre las distorsiones cognitivas relacionadas con el juego podrían ser informativos a este respecto, ya que hacen referencia directamente a fuentes de reforzamiento específicas del juego (Clark, 2017; Raylu y Oei, 2004). Por un lado, los resultados sobre la escala de expectativas de juego del GRCS (Raylu y Oei, 2004) pueden ofrecer información sobre la sensibilidad a diversas recompensas que están presentes en el juego de azar. Esta escala examina algunas de las motivaciones que pueden llevar a los jugadores a perseverar en la conducta de juego, como motivos financieros o de búsqueda de la diversión, alegría y excitación que el juego puede producir. De esta manera, puede informar acerca de la sobrevaloración de los aspectos apetitivos del juego. En este sentido, nuestros resultados también podrían señalar tanto que los jugadores con TJA son más sensibles a recompensas específicas del juego comparados con controles (Capítulo 3) y jugadores regulares (Capítulo 1), como que también lo son los jugadores Tipo I en comparación con jugadores Tipo II (Capítulo 1). Por otro lado, en la siguiente subsección se discutirán los resultados sobre la relación entre las distorsiones cognitivas relacionadas con el juego y el uso de estrategias regulación de emociones negativas. El análisis de esta relación puede ser también informativo de ciertas alteraciones en el procesamiento de los resultados del juego (i.e. ganancias y pérdidas) presentes en el TJA.

Aunque somos conscientes de la necesidad de abordar experimentalmente el estudio de la sensibilidad a las ganancias y pérdidas monetarias y la potencial alteración en su procesamiento en pacientes con TJA, hemos estado metodológicamente constreñidos por limitaciones éticas. Es decir, no hemos podido investigar con jugadores con TJA en escenarios reales o utilizar tareas de juego de laboratorio que impliquen dinero real. Así que la generalización de nuestros hallazgos a dominios más específicos de juego debe hacerse con cautela. Sin embargo, la importancia de nuestros resultados sobre sensibilidad a la recompensa y al castigo a nivel de rasgo reside en su contribución a entender el porqué de algunas inconsistencias previas sobre su rol en el TJA, y así arrojar luz sobre diferentes fuentes potenciales de heterogeneidad dentro de poblaciones de jugadores.

2.2. Regulación emocional y distorsiones cognitivas relacionadas con el juego de azar

Otro de los puntos de inicio de esta tesis tenía que ver con la sugerencia de la centralidad de la emoción en trastornos adictivos, incluyendo también el TJA (Blaszczynski y Nower, 2002; Cheetham et al., 2010). Una de nuestras hipótesis de partida era que las distorsiones cognitivas relacionadas con el juego pueden ser producto de mecanismos que participan en la regulación de emociones con respecto a los resultados de juego, y que, por tanto, podrían participar de alguna manera en incrementar o reducir las emociones que ganar y perder dinero producen. Esta hipótesis podría apoyarse en diversos estudios previos. Por ejemplo, Clark, Lawrence, Astley-Jones, y Gray, (2009) encontraron que un mayor nivel de control personal subjetivo en una tarea de juego en el laboratorio producía una mayor valoración hedónica de las ganancias. Es decir, los participantes informaban de un mayor placer subjetivo cuando recibían recompensas en ensayos en los que habían elegido por ellos mismos cómo jugar, que cuando esa elección había sido realizada por un ordenador, a pesar de que las recompensas tenían la misma magnitud.

Otros estudios también sugieren que las distorsiones cognitivas relacionadas con el juego pueden reducir el impacto emocional negativo de las pérdidas. Por ejemplo, los ensayos *near-win* –pérdidas cercanas a un premio, que son procesados cerebralmente de manera cualitativamente similar a las ganancias a pesar de ser pérdidas netas (Clark et al., 2009)– pueden ayudar a los jugadores a re-enmarcar subjetivamente las pérdidas de una manera no tan perjudicial como cabría esperar (Griffiths, 1991). Esto podría ocurrir por la reinterpretación de los ensayos *near-win* como signos de una inminente ganancia y/o como evidencia subjetiva de una mejora de las habilidades personales para ganar en el juego (Clark et al., 2009). En este

sentido, un deseo incrementado por continuar jugando después de un ensayo *near-win* en una tarea de juego también se ha relacionado con la fuerza del control predictivo y del sesgo interpretativo (Billieux et al., 2012). Esta última distorsión cognitiva puede ser un buen ejemplo de cómo una reinterpretación retrospectiva de los resultados de juego puede ayudar a manejar su impacto emocional. Cabe recordar que este sesgo hace referencia a que las ganancias se reinterpretan como debidas a factores internos (e.g. habilidades personales) y las pérdidas se deben a factores externos (e.g. mala suerte). De esta manera, su impacto emocional positivo o negativo puede ser aumentado o minimizado. Por lo tanto, existe ya evidencia que sugiere que las distorsiones cognitivas relacionadas con el juego pueden incluir un componente de *reappraisal* emocional y, de esta manera, pueden ser sensibles a cómo los jugadores incrementan o decrementan las emociones producidas por los resultados del juego.

Nuestros hallazgos sobre el vínculo entre el uso de algunas estrategias de regulación emocional comúnmente tomadas por formas adaptativas de regular emociones negativas y la fuerza de las distorsiones de juego –especialmente con el sesgo interpretativo– apoyan esta idea, al menos con respecto a las pérdidas monetarias. Es importante hacer notar que poner en perspectiva es una forma de *reappraisal* en tanto que implica la reinterpretación del significado de eventos emocionales negativos. Así, una de las sugerencias principales de este trabajo es que las distorsiones del juego pueden ser productos de un mecanismo emocional que satisface una función protectora del ego, llevando a los jugadores a un estilo de pensamiento de autoengaño; en línea con los postulados de modelos de razonamiento motivado (Kunda, 1990).

No obstante, hay que tener en cuenta dos limitaciones a este argumento. Por un lado, el *Cognitive Emotion Regulation Questionnaire* de Garnefski y Kraaij, (2007), utilizado en esta tesis, hace referencia a regulación de emociones negativas en general. Por lo tanto, la sugerencia de generalizarlo a pérdidas monetarias específicamente es parcialmente especulativa. Por otro lado, no hemos comprobado directamente si estas estrategias también podrían participar en incrementar la intensidad de emociones positivas. No obstante, sugerimos que tal mecanismo podría existir también para las ganancias monetarias y, por lo tanto, estaría involucrado en aumentar también el valor apetitivo de éstas. Aún con todo, investigaciones futuras deberían demostrar la existencia de tal mecanismo por medio de diseños experimentales (véase la sección de *Perspectivas futuras*).

Por otro lado, la doble asociación entre las distorsiones cognitivas relacionadas con el azar y las estrategias de regulación emocional teóricamente adaptativas con la severidad del juego sugiere que la fuerza de este estilo de pensamiento es un factor que también podría contribuir a la variabilidad dentro de poblaciones de jugadores con TJA. En este sentido, existe la posibilidad de que este mecanismo sea incluso más fuerte en jugadores con preferencia por juegos Tipo I, ya que las distorsiones de juego están incrementadas en estos jugadores independientemente de su estatus clínico, tal y como se expone en el Capítulo 1.

2.3. Desregulación afectiva en el juego de azar

2.3.1. *Distorsiones cognitivas relacionadas con el juego y la impulsividad.* Más allá del rol de las distorsiones cognitivas relacionadas con el juego en la regulación emocional *per se*, los resultados del Capítulo 2 apoyan la existencia de un vínculo con otro proceso afectivo. Estas distorsiones están más estrechamente asociadas con dimensiones de impulsividad afectiva del Modelo UPPS-P que con las cognitivas, tanto en jugadores con TJA como en jugadores regulares. Este resultado está en consonancia con resultados previos exclusivamente observados en muestras de jugadores con TJA (Michalczuk et al., 2011). Su relevancia puede entenderse en dos sentidos. Por un lado, la falta de asociación con las dimensiones cognitivas de impulsividad puede verse como un signo de que la severidad del juego no tiene porqué estar necesariamente vinculada a problemas ejecutivos en la planificación. Está visión estaría en línea con propuestas recientes que cuestionan el perfil clásico de jugador caracterizado por amplias disfunciones ejecutivas (e.g. planificación, flexibilidad, memoria de trabajo; Verdejo-García y Manning, 2015). Además, también concuerda con los resultados del estudio del Capítulo 1 que muestran que la impulsividad en la elección –otra forma de impulsividad basada en problemas de planificación– es solo especialmente prominente en jugadores con TJA Tipo II. Es decir, en jugadores en los que la fuerza de las distorsiones cognitivas es menor que en jugadores con TJA Tipo I. Así, existe la posibilidad también de que las distorsiones cognitivas del juego reflejen la preservación del funcionamiento cognitivo. Resultados de nuestro equipo avalan esta idea al mostrar una mejor ejecución en tareas de laboratorio en jugadores con fuertes distorsiones cognitivas relacionadas con el juego (Perales et al., 2016).

Por otro lado, la asociación de estas distorsiones y las dimensiones de impulsividad afectiva estaría en consonancia con diversos estudios de neuroimagen que han descrito conexiones entre algunas de estas distorsiones y alteraciones en regiones cerebrales implicadas

en procesos afectivos, incluyendo su regulación. Así, por ejemplo, hay evidencia en pacientes con TJA de (a) una respuesta incrementada ante ensayos *near-win* en el estriado y la ínsula, –centros claves para el procesamiento de la recompensa y la emoción– (Clark et al., 2009; Sescousse et al., 2016), (b) una asociación entre la fuerza de diversas distorsiones cognitivas como la ilusión de control y una conectividad incrementada durante estados de activación en reposo en estructuras cerebrales que engloban la ínsula, la amígdala y el cortex prefrontal medial –centros claves para la atribución de saliencia, el procesamiento emocional, y el control cognitivo *top-down*, respectivamente– (van Timmeren, Zhutovsky, van Holst, y Goudriaan, 2018); o (c) el vínculo entre el sesgo interpretativo y un volumen reducido de materia gris en el cíngulo anterior dorsal –un centro clave en el control cognitivo *top-down*– (Ruiz de Lara, Navas, Soriano-Más, Sescousse y Perales, 2008).

En el estudio del Capítulo 2, sugerimos como una posible interpretación de este resultado que las distorsiones cognitivas relacionadas con el juego podrían ser un producto de los mismos mecanismos que están involucrados en la pérdida de control de emociones positivas y negativas. Sin embargo, en una relectura de estos resultados –y tal como se refleja en el material suplementario de dicho estudio–, se observa que la fuerza de las asociaciones entre la ilusión de control, el control predictivo y el sesgo interpretativo con la urgencia negativa decae en un mayor grado que en el caso de la urgencia positiva después de controlar por la severidad del juego. Así, mientras que para la urgencia negativa tal reducción cae incluso por debajo del umbral de significación en el caso del control predictivo, para la urgencia positiva todas las asociaciones halladas permanecen significativas. Por lo tanto, parece que el vínculo entre distorsiones cognitivas y urgencia positiva es más fuerte que el de la urgencia negativa. Esta cuestión apoyaría la idea mencionada anteriormente de que las distorsiones cognitivas no tienen por qué implicar necesariamente problemas ejecutivos y/o los problemas de desregulación afectiva general con los que ha sido asociada la urgencia negativa –y que se expondrán en las siguientes subsecciones–.

Por otro lado, este resultado puede apuntar también a la existencia de un camino diferenciado por el cual tanto la urgencia positiva como la negativa influencian la conducta de juego y sus características clínicas. Esta cuestión estaría en consonancia con el trabajo seminal de Cyders y colaboradores (2007) en el que se mostró que las dos urgencias explicaban porciones diferentes de la varianza en varias conductas adictivas y otras conductas de riesgo.

Este hallazgo supuso la inclusión de la urgencia positiva en el actual Modelo UPPS-P, ya que en la anterior versión solo se contemplaba la existencia de la urgencia negativa (Whiteside y Lynam, 2001). Este resultado ha sido replicado después en muy diversas ocasiones (e.g. Fischer, Smith, y Cyders, 2008; Navas et al., 2015), incluso en el TJA (e.g. Steward et al., 2017). En la siguiente subsección, se discutirá en mayor profundidad el papel de ambas urgencias en este trastorno.

2.3.2. *El rol de la impulsividad guiada por el afecto***.** Basándonos en la relevancia de la interferencia del afecto sobre el autocontrol en los trastornos adictivos (Cheetham et al., 2010), examinamos el rol de la urgencia positiva y negativa en diversas características del juego de azar. Aparte de su vínculo comentado anteriormente con las distorsiones cognitivas relacionadas con el juego, se debe destacar que ambos rasgos arrojan los tamaños de efectos mayores de entre todas las dimensiones de la UPPS-P cuando se compararon jugadores con TJA y jugadores regulares (Capítulo 1). Otro resultado interesante es que ambas urgencias no se relacionaron con la modalidad de juego preferida.

La relevancia de las urgencias en el TJA está en consonancia con evidencia previa que señala su vínculo más potente con conductas externalizantes en comparación con dimensiones no afectivas de la impulsividad (Jhonson et al., 2017). No obstante, de entre las dos urgencias, es la negativa la que más estrechamente se relaciona con tales conductas (Jhonson et al., 2017). Este hecho concuerda también con los resultados de ambos estudios recogidos en el Capítulo 4 que sugieren la preponderancia de la urgencia negativa en el TJA. Es decir, cuando se comparan los jugadores con TJA y los controles sanos es la urgencia negativa el rasgo que mejor diferencia entre ambos grupos. Así, aunque ambas urgencias juegan un rol en la severidad de la conducta de juego, independientemente de la modalidad preferida, la urgencia negativa podría destacar o bien como una característica más clara del TJA, o bien como un signo de potencial complicación del mismo. Ambas cuestiones han sido sugeridas en la literatura. Es decir, existe amplia evidencia que la ha vinculado específicamente con la severidad del TJA, pero también con la comorbilidad con otros trastornos adictivos y otros problemas externalizantes, además de haberla señalado como un marcador de mal pronóstico terapéutico (Berg et al., 2015; Billieux et al., 2012; Michalczuk et al., 2011; Torres et al., 2013b).

A favor de que la urgencia negativa es un indicador de psicopatología más allá del TJA en vez de un marcador del mismo se encuentra la serie de estudios en los que se describe su

validez transdiagnóstica. La urgencia negativa podría reflejar parcialmente lo que se ha denominado *factor p*, una dimensión de psicopatología general que subyacería a los trastornos psicopatológicos y que se asociaría a una disfunción importante del funcionamiento psicosocial (Berg et al., 2015; Caspi et al., 2014).

Los mecanismos por los cuales se podría explicar la contribución de la urgencia negativa a la psicopatología en general están siendo sometidos a un intenso escrutinio (e.g. King, Feil, Halvorson, 2018). No obstante, resultados recientes de nuestro laboratorio pueden ser orientativos para entender cómo influye específicamente en el TJA. Así, hemos encontrado una relacionan entre la urgencia negativa y una reducción del volumen de materia gris en el cortex ventrolateral prefrontal (Ruiz de Lara et al., 2018). Esta región cerebral es clave para el control cognitivo y se ha relacionado también con la capacidad de regulación de emociones negativas (Aron, Robbins, y Poldrack, 2014; Wager, Davidson, Hughes, Lindquist, y Ochsner, 2008). Un resultado interesante es que aquellos jugadores con menor urgencia negativa no se diferenciaban de controles sanos en la materia gris de esta área. Este resultado podría señalar que la urgencia negativa es un indicador de potencial complicación del cuadro clínico en el TJA. Asimismo, puede plantear que existen al menos ciertos subgrupos de jugadores con TJA que no presentan puntuaciones elevadas de este rasgo ni sus potenciales alteraciones psicobiológicas subyacentes.

Los resultados del estudio descrito en el Capítulo 4 de esta tesis en los que se vincula la urgencia negativa a diversos índices de desregulación emocional podrían también ser de ayuda para aumentar nuestro conocimiento sobre dichas potenciales alteraciones psicobiológicas. Al mismo tiempo, dichos resultados señalan que la urgencia negativa es una importante fuente de variabilidad individual en poblaciones de pacientes con TJA.

2.3.3. *Desregulación emocional en el trastorno por juego de azar.* En los estudios del Capítulo 4 se muestra que la urgencia negativa está asociada tanto a una tendencia disposicional a suprimir el componente expresivo de las emociones (i.e. supresión emocional), como a la necesidad de una mayor activación del giro frontal medio –otro centro cerebral clave para el control cognitivo– para reducir la intensidad de emociones negativas al nivel de controles en una tarea de *reappraisal*. Interpretamos estos resultados en dichos estudio como un indicador de que los jugadores con TJA caracterizados por este rasgo necesitan invertir más recursos cognitivos que controles sanos para regular la experiencia emocional. Está interpretación se apoyó también en resultados experimentales previos que señalan que la supresión emocional es una estrategia

altamente demandante (Richards y Gross, 2000) y que puede afectar al autocontrol por el gasto de recursos que supone (John y Gross, 2004). El porqué de dicho gasto tiene que ver con que la supresión emocional a diferencia del *reappraisal* se implementa en estadios tardíos del proceso de regulación emocional, es decir, cuando la respuesta emocional ha sido completamente activada (Gross, 2014). De esta manera, supone una mayor demanda de control que la primera ya que el individuo ha de lidiar completamente con las tendencias de acción de la emoción (Gross, 2014).

Sin embargo, en una relectura de estos resultados es posible hacer una interpretación complementaria. Recientemente, hemos propuesto que la urgencia negativa es un marcador de la disfunción de los mecanismos de regulación emocional *model-free* (Navas et al., 2018); esto es, de la regulación emocional automática guiada por señales dopaminérgicas de error de predicción (Etkin et al., 2015). El fallo de este tipo de regulación implica la necesidad de que los sistemas de control cognitivo tengan que entrar en juego para implementar una regulación emocional basada en un modelo interno (i.e. *model-based*; Etkin et al., 2015). El vínculo hallado entre la urgencia negativa y la supresión emocional puede evidenciar dicha interacción entre procesos de regulación emocional *model-free* y *model-based*. Sin embargo, una pregunta que podría hacerse en este momento es porqué los pacientes con TJA y alta urgencia negativa tienen dificultades para implementar otras estrategias de alto orden que sean más eficientes que la supresión emocional (como sería el caso del *reappraisal*). Para una posible respuesta se tendría que tener en cuenta, por un lado, que el fallo de los mecanismos de regulación emocional *model-free* se puede experimentar subjetivamente como una excesiva intromisión de las emociones (Navas et al., 2018), por otro, que una excesiva emocionalidad interfiere drásticamente en la capacidad de procesamiento cognitivo (e.g. Pessoa, 2008; Bishop, Duncan, Brett, y Lawrence, 2004) y, por último, que el *reappraisal* esencialmente implica una operación cognitiva compleja de manipulación de información mientras que la supresión emocional requiere el manteamiento sostenido de control sin requerir necesariamente manipulación cognitiva alguna (Ochsner y Gross, 2008). Esta interpretación podría también apoyarse en los resultados de neuroimagen comentados anteriormente, es decir, a mayor urgencia negativa en pacientes con TJA una mayor activación del giro frontal medio para regular la emoción mediante el uso del *reappraisal*.

De esta manera, se puede argumentar que aquellos jugadores caracterizados por una urgencia negativa rasgo elevada tienen dificultades para regular sus emociones negativas de

manera automática. Además, utilizan disposicionalmente la supresión emocional como una estrategia de último recurso para regular sus emociones por dificultades en implementar estrategias cognitivas de regulación emocional de alto orden.

Este argumento ofrece también una explicación de la inexistencia de un vínculo fuerte entre urgencia negativa y distorsiones cognitivas relacionadas con el juego que se ha comentado anteriormente. Cabe recordar que los jugadores con altas distorsiones son precisamente aquellos que sí podrían implementar diferentes estrategias de *reappraisal* para regular emociones negativas.

2.4. Fortalezas y limitaciones

Los resultados de esta tesis deben ser entendidos a la luz de una serie de limitaciones generales que afectan a todos los estudios. Primero, la naturaleza transversal de los estudios nos impide realizar asunciones causales sobre el patrón de asociaciones hallado. En segundo lugar, el procedimiento para seleccionar la muestra no garantiza su representatividad, en tanto que en ningún caso se ha utilizado un método de muestreo sistemático. Los pacientes con TJA fueron elegidos por tres centros diferentes especializados en el tratamiento de este trastorno. Dado que todos estos centros forman parte de la misma federación regional y trabajan con métodos de reclutamiento y terapia similares, existe la posibilidad de que los jugadores que han participado pertenezcan a un subgrupo social determinado. Los jugadores regulares y los controles sanos fueron reclutados en gran medida a través de las redes sociales tanto de los jugadores como de los investigadores por lo que es posible que estas muestras no sean tan heterogéneas como sería deseable. Asimismo, las muestras de tres de los cinco estudios estaban formadas exclusivamente por hombres, y en los otros dos el porcentaje de mujeres era muy pequeño. Dado que ciertos procesos importantes en el TJA son especialmente relevantes en el caso de mujeres, como es el caso del *telescoping* o jugar como una forma de afrontamiento emocional (Grant, Odlaug, y Mooney, 2012; Blaszczynski y Nower, 2002), la generalización de nuestros hallazgos a mujeres puede verse comprometida.

Una limitación extra que también puede afectar a la generalización tiene que ver con el solapamiento parcial amplio de las muestras en los estudios de los Capítulos 1 y 2 y el total solapamiento entre el estudio del Capítulo 3 y el estudio 1 del Capítulo 4. Por lo tanto, existe un riesgo de extraer conclusiones generales en función de observaciones realizadas en un número limitado de casos. De esta manera, la replicación de nuestros resultados en muestras totalmente

diferentes se hace necesaria. En este sentido, es importante notar que la disponibilidad de pacientes con TJA que pudieran participar en nuestros estudios estaba constreñida por dos cuestiones. La primera es que nuestros centros colaboradores tienen una capacidad de atención limitada por cuestiones económicas y de recursos humanos, también relacionadas con el hecho de que son organizaciones no gubernamentales sin ánimo de lucro. En segundo lugar, se han utilizado criterios de selección razonablemente estrictos con el objetivo de controlar, entre otras cuestiones, psicopatología concomitante. Así, un número no desdeñable de participantes potenciales fue excluido de su participación.

Otra de las limitaciones, en cierta manera también relacionada con la anterior, tiene que ver con que en ningún estudio el tamaño de la muestra estuvo empíricamente determinado. Este hecho puede ser relevante especialmente para los estudios de los Capítulos 3 y 4, ya que están realizados con muestras relativamente pequeñas. Más allá de algunas de las precauciones tomadas como, por ejemplo, el apuntalamiento de los resultados con análisis bayesianos en los estudios del Capítulo 4, existe la posibilidad de que el poder de estos estudios sea limitado. Por lo tanto, puede ser que algunos hallazgos relevantes no hayan sido detectados, a la vez que haya cierto riesgo de falsos positivos (Button et al., 2013).

Adicionalmente, la mayor parte de nuestros resultados provienen de instrumentos de autoinforme, por lo tanto, no están exentos de haber sido influenciados por sesgos de memoria y/o deseabilidad social. Finalmente, ninguno de los estudios ha sido previamente prerregistrado. Aunque hemos hecho un esfuerzo para aplicar la estrategia analítica más adecuada para cada caso y en función de nuestras hipótesis *a priori*, somos conscientes de la importancia de prácticas de ciencia abierta. Dado que estás prácticas no solo se están expandiendo actualmente, sino que son necesarias para aumentar la calidad de la ciencia, su transparencia y replicabilidad (e.g. Open Science Collaboration, 2015), estamos trabajando actualmente en esta dirección en nuestros proyectos (e.g. https://osf.io/q3t5w/).

Más allá de estas limitaciones, del lado de las fortalezas, se puede destacar la novedad de algunos de los temas abordados. Hasta donde sabemos, por primera vez, (a) hemos examinado varios procesos centrales en el juego de azar, considerando conjuntamente tanto jugadores regulares como jugadores con TJA, y disociándolos en función de su modalidad de juego preferida; (b) hemos descrito el vínculo entre estrategias supuestamente adaptativas y distorsiones cognitivas relacionadas con la emoción, y (c) entre estrategias disfuncionales de

regulación emocional, como es el uso disposicional de la supresión emocional, con la urgencia negativa; un constructo central en el TJA y probablemente en psicopatología en general. Además, (d) hemos examinado el funcionamiento cerebral –y su vínculo con la urgencia negativa– en pacientes con TJA durante la realización de una de las tareas paradigmáticas de la regulación emocional en neurociencia afectiva (Phan, Fitzgerald, Nathan, Moore, Uhde, y Tancer, 2005), como es la tarea de *reappraisal* cognitivo utilizada en el Capítulo 4.

Asimismo, no se puede olvidar que hemos prestado especial atención al cuidado no solo de los criterios de inclusión y exclusión para seleccionar las muestras, sino también a la igualación de los grupos de pacientes y controles en potenciales variables confusoras, como la edad, la escolaridad y, en la medida de lo posible, el cociente intelectual. Finalmente, más allá del interés e implicaciones teóricas de esta tesis, otra de sus fortalezas reside también en las sugerencias clínicas que se derivan de ella y que son expuestas en la siguiente sección.

3. Conclusiones

De los diferentes estudios que conforman esta tesis se pueden extraer las siguientes conclusiones generales:

- Existen ciertas dimensiones afectivas que pueden ser especialmente relevantes en jugadores con preferencias por determinadas modalidades de juego de azar independientemente de su estatus clínico, como es el caso de la impulsividad en la elección, la sensibilidad a la recompensa y las distorsiones cognitivas relacionadas con el juego.
- Las distorsiones cognitivas relacionadas con el juego están específicamente relacionadas con impulsividad de base afectiva (i.e. urgencia positiva, negativa y búsqueda de sensaciones) tanto en jugadores regulares como en jugadores con TJA. Los mecanismos subyacentes a dicha conexión permanecen actualmente desconocidos, por lo que puede ser relevante su investigación futura.
- Estas distorsiones están asociadas a estrategias de regulación de emociones negativas comúnmente reconocidas como estrategias que fomentan el bienestar psicológico. A su vez, este tipo de estrategias se asocian a la severidad del TJA. Estos resultados sugieren que las distorsiones cognitivas relacionadas con el azar podrían formar parte de un mecanismo de regulación emocional que ayuda a mantener la conducta de juego mediante la reducción de la

intensidad de las emociones producidas por las pérdidas monetarias.

- Los jugadores con TJA muestran alteraciones en la regulación emocional *model-based,* tal y como se observa en el uso disposicional de estrategias de regulación emocional desadaptativas (e.g. supresión emocional) y alteraciones en el funcionamiento cerebral al regular emociones en vivo en una tarea de *reappraisal.*
- Los jugadores con TJA muestran alteraciones en la regulación emocional *model-free,* tal y como pueden reflejar los resultados sobre urgencia negativa. Esta dimensión de impulsividad afectiva puede ser particularmente insidiosa en jugadores con TJA independientemente de sus preferencias de juego. Además, es la dimensión de impulsividad del modelo UPPS-P que mejor distingue entre jugadores con TJA y controles sanos. Asimismo, está asociada a algunos de los índices de desregulación emocional *model-based* comentados en el punto anterior (i.e. supresión emocional y alteración en el funcionamiento cerebral durante la regulación de emociones a través del *reappraisal*).

3.1. The Gambling Space Model: un modelo teórico sobre la importancia del afecto en el trastorno por juego de azar

Los resultados de esta tesis se han integrado de manera coherente en un modelo teórico de juego que hemos propuesto recientemente, *the Gambling Space Model* (GSM; Navas et al., 2018), en el que se sitúan algunas de las alteraciones en el procesamiento afectivo abordadas en los diferentes estudios de este trabajo como base fundamental del TJA y la heterogeneidad dentro del mismo. A modo de recapitulación final, presentamos de manera breve dicho modelo.

El GSM está inspirado en el *Pathways Model* de Blaszczynski y Nower (2002) (ver sección *Fuentes de heterogeneidad en el trastorno por juego de azar* en la *Introducción* de la tesis); así, uno de sus puntos de partida es que todos los jugadores con TJA son *jugadores conductualmente condicionados*. Esta cuestión se debe a que los procesos de condicionamiento asociados a los programas de reforzamiento de razón aleatoria son la base para la sensibilización del incentivo y, por tanto, para producir potencialmente la pérdida de control sobre el juego en individuos vulnerables (Berridge, 2012). Uno de los principios fundamentales del GSM es que existen cuatro dimensiones afectivas que son fuentes de variabilidad dentro del TJA, en tanto que contribuyen de manera diferencial a las manifestaciones conductuales y clínicas de este

trastorno. Los diferentes subtipos de jugadores surgirían de la combinación entre el efecto de los procesos de condicionamiento presentes en el juego y dichas fuentes de variabilidad.

Las cuatros dimensiones que contempla el GSM son (1) *la sensibilidad a las propiedades apetitivas del juego*, (2) *la sensibilidad a los componentes de reforzamiento negativo del juego*, (3) *la desregulación emocional generalizada*, y (4) *la elaboración cognitiva motivada y de autoengaño.*

Es importante hacer notar que las dos primeras dimensiones, aunque están parcialmente relacionadas con la sensibilidad al castigo y a la recompensa, hacen referencia a cuestiones específicas de motivación de juego, o cómo de sensibles son los jugadores a los diferentes elementos reforzantes presentes en esta actividad. Asimismo, estas dimensiones ilustran la idea de que jugar puede ser utilizado específicamente como una estrategia de regulación afectiva (e.g. mejorar el afecto positivo, afrontar estados afectivos negativos). Ambas dimensiones podrían interactuar con las características de determinados tipos de juego y moldear preferencias individuales por ellos. Por ejemplo, jugadores que prefieren juegos como el póker, apuestas de habilidad y otros juegos de casino podrían estar más motivados por las características apetitivas del juego que jugadores que prefieren el bingo, las loterías o las tragaperras (ver Capitulo 1). Por otro lado, existe la posibilidad de que rasgos de afectividad negativa también interactúen con las características del juego para modificar el afecto. De esta manera, jugadores caracterizados por estos rasgos podrían preferir juegos que favorezcan estados disociativos, como las máquinas tragaperras (Balodis et al., 2014). En este sentido, jugar como una forma de afrontamiento afectivo se ha asociado a la comorbilidad del TJA con depresión y mayor riesgo de recaída (Ledgerwood y Petry, 2006; Lister, Milosevic y Ledgerwood, 2015).

La tercera de las dimensiones (*desregulación emocional generalizada*) hace referencia a la alteración de los mecanismos de regulación emocional implícita o *model-free*. Éstos podrían reflejarse en una elevada urgencia negativa. Teniendo en cuenta la asociación de la urgencia negativa con problemas externalizantes (Berg et al., 2015), se hipotetiza que en el TJA tal desregulación estaría vinculada a la comorbilidad del trastorno con problemas de dicha naturaleza (e.g. otros trastornos adictivos, conductas antisociales, etc.)

Finalmente, la última de las dimensiones, es decir, la *elaboración cognitiva motivada y de autoengaño* hace referencia al uso de estrategias de regulación emocional *model-based* en combinación con distorsiones cognitivas del juego. Este estilo de pensamiento podría ayudar a

los jugadores a acomodar las emociones negativas producidas por las pérdidas monetarias e incrementar el valor de las características positivas del juego. Un mecanismo protector del ego de similar naturaleza se ha identificado como un factor que contribuye al mantenimiento del consumo de sustancias y a la resistencia al tratamiento (Martínez-González, Vilar-López, Becoña-Iglesias y Verdejo-García, 2016). Este tipo de autoengaño tiene una función de regulación emocional, en línea con modelos de razonamiento motivado (Kunda, 1990).

El GSM tiene un carácter aplicado en tanto puede suponer una guía de intervención para clínicos. Así, la eficacia de los tratamientos para el TJA podría incrementarse al ser adaptados al perfil psicológico de los pacientes. Es decir, tras un *screening* previo del paciente en estas cuatro dimensiones, se podrían elegir los tratamientos basados en evidencia más ajustados para los déficits que éstos pudieran presentar (ver sección de *Implicaciones clínicas*).

4. Implicaciones clínicas

El tratamiento de elección basado en evidencia para el TJA es la Terapia Cognitivo-Conductual (TCC) (e.g. Grant y Odlaug, 2012), ya que ha demostrado su eficacia en reducir la severidad del trastorno a corto y medio plazo en una amplia serie de ensayos clínicos (ver Cowlishaw, Merkouris, Dowling, Anderson, Jackson, y Thomas, 2012 para un revisión al respecto). Aunque el peso del contenido cognitivo y conductual de la TCC varía a lo largo de los estudios, este tratamiento está principalmente fundamentado en la corrección de distorsiones cognitivas, el desarrollo de habilidades sociales, de planificación y solución de problemas, el aprendizaje del manejo del craving y la prevención de recaídas (e.g. Rash y Petry, 2014). Pero esta terapia también tiene diversas limitaciones, como, por ejemplo, que su eficacia a largo plazo es modesta y que presenta altos índices de abandono y recaídas (Cowlishaw et al., 2012; Echeburúa et al., 2014; Ledgerwood y Petry, 2006; Melville, Casey, y Kavanagh, 2007). Asimismo, su eficacia es moderada con pacientes con ciertos perfiles psicológicos, como aquellos con una elevada impulsividad y otros déficits en la regulación afectiva (i.e. algunos de los factores que se han expuesto a lo largo de esta tesis; Jara-Rizzo, Navas, J. F., Steward, Jiménez-Murcia, Fernández-Aranda, y Perales, 2018; Maccallum, Blaszczynski, Ladouceur, y Nower, 2007; Mestre-Bach et al., 2016).

Para tratar de paliar esta circunstancia y aumentar la eficacia de la TCC, ésta se ha combinado con diversas intervenciones, desde el uso de Mindfulness a Entrevista motivacional,

realidad virtual o el uso de videojuegos terapéuticos (Menchón, Mestre-Bach, Steward, Fernández-Aranda, y Jiménez-Murcia). A pesar de que estas intervenciones están produciendo resultados prometedores en la reducción de la severidad del TJA y sintomatología concomitante, todavía hay inconsistencia en dichos resultados (Menchón et al., 2018; Rash y Petry, 2014).

Esta cuestión puede poner de relieve la limitación de aquellos tratamientos que no tienen en cuenta la variabilidad de los pacientes en función de su perfil psicobiológico. Desde un marco de neurociencia traslacional, la indivualización de los tratamientos, en contraposición a la aplicación de un paquete terapéutico estandarizado independientemente del mismo, se considera esencial para maximizar la probabilidad de éxito (Daughters, Lejuez, Lesieur, Strong, y Zvolensky, 2003; Oslin, 2011).

Los factores que esta tesis sugiere tener en cuenta para la individualización de los tratamientos del TJA hace referencia a las dimensiones del GSM, es decir, la sensibilidad a las propiedades reforzantes del juego, la desregulación emocional generalizada o la alteración de mecanismos de regulación *model-free* (que podrían ser capturados por la urgencia negativa), y la fuerza de un mecanismo elaboración cognitiva motivada y de autoengaño caracterizado por altas distorsiones cognitivas relacionadas con el juego asociadas a ciertas estrategias de *reappraisal*. Todas estas dimensiones tienen diferentes asociaciones con características clínicas relevantes del TJA y podrían ser abordados a través de diferentes técnicas de tratamiento.

En primer lugar, establecer las fuentes de reforzamiento que el paciente encuentra en el juego puede ser un primer paso para empezar a establecer objetivos de tratamiento. Por ejemplo, aquellos jugadores con una excesiva sensibilidad a las recompensas apetitivas del juego de azar que a su vez presenten una baja sensibilidad a otras recompensas más allá del juego podrían beneficiarse de intervenciones conductuales dirigidas a promover el establecimiento de conductas alternativas reforzantes. Este tipo de intervención se utiliza en trastornos que cursan con anhedonia (e.g. Martin y Pear, 2008). Por otro lado, para aquellos jugadores que utilicen el juego como una forma de evitar o de escapar de estados emocionales negativos, podría ser útil la inclusión en su tratamiento de técnicas orientadas específicamente a desarrollar habilidades de afrontamiento emocional (Petry, Litt, Kadden, y Ledgerwood, 2007; Rychtarik y McGillicuddy, 2006).

En otro orden de ideas, hay que tener en cuenta que aquellos jugadores caracterizados por una urgencia negativa alta y que, por tanto, podrían tener una alteración de los mecanismos de

regulación emocional *model-free*, pueden verse seriamente contrariados o frustrados por técnicas que contengan elementos de confrontación directa. La TCC puede ser especialmente directiva, por ejemplo, durante la discusión cognitiva o por el empleo de técnicas conductuales como el control de estímulos. A modo de sugerencia tentativa, estos jugadores podrían beneficiarse de tratamientos basados por ejemplo en el Mindfulness, tal y como se ha observado en otros trastornos adictivos (Hoppes, 2006). Ésta técnica puede potencialmente redundar en una mejora de los procesos de regulación emocional *model-free*, ya que puede compartir ciertas características de la desensibilización sistemática y del contracondicionamiento. Hay que tener en cuenta que éstas son técnicas esenciales para la extinción de fobias (e.g. Antony y Swinson, 2000) y que los procesos automáticos de extinción del miedo condicionado son el ejemplo paradigmático del funcionamiento correcto de este tipo de mecanismos de regulación (Etkin et al., 2015). Por otro lado, el uso de técnicas semidirectivas como la Entrevista motivacional, puede ser especialmente útil para evitar confrontaciones con este tipo de pacientes, sobre todo en los primeros estadios del tratamiento. Esta terapia se basa en técnicas de guía estratégica, en las que a través de una conversación colaborativa se orienta a los pacientes para que realicen cambios conductuales lo más ajustados posibles a sus necesidades individuales (Miller y Rollnick, 2012).

Por otro lado, hay que tener en cuenta que la fuerza de las distorsiones cognitivas relacionadas con el azar según el GSM representan un funcionamiento cognitivo preservado, dados entre otros los resultados comentarios con anterioridad de que los jugadores con distorsiones cognitivas más fuertes realizan mejor tareas de aprendizaje de discriminación de contingencias (Perales et al., 2017). De esta manera, con estos jugadores podría ser adecuado el uso de técnicas metacognitivas a pesar de que éstas requieren una importante capacidad de *insight* (Wells, 2013). Dichas técnicas tienen por objetivo el aumento de conciencia sobre la base motivacional y emocional de procesos de pensamiento para así poder modificarlos (Wells, 2013). En el caso de este tipo de jugadores, dicha intervención podría ir orientada a aprender a monitorizar cómo los resultados del juego pueden elicitar automáticamente determinadas estrategias de regulación emocional y cómo esta cuestión, a su vez, puede estimular creencias distorsionadas sobre su propia habilidad. Es importante resaltar que este tipo de jugador resuena al perfil emergente de jugador que se caracteriza por su juventud, un funcionamiento cognitivo relativamente preservado, una alta sensibilidad a la recompensa, fuertes distorsiones cognitivas

relacionadas con el azar y preferencias por juegos de habilidad/estrategia (juegos Tipo I; Griffiths et al., 2009; Myrseth et al., 2010). Un reto añadido para intervenir con estos jugadores puede ser la falta de conciencia de tener un problema con el juego de azar (Gainsbury, Hing, y Suhonen, 2014; Moreau, Chabrol, y Chauchard, 2016). Una creencia generalizada en estos jugadores es que es necesario perder durante un tiempo para convertirse en un experto en el juego (Moreauet, Chabrol, y Chauchard, 2016); una cuestión que puede dificultar el acceso a la búsqueda de tratamiento. Por ese motivo, la Entrevista motivacional podría ser efectiva, al menos, para ayudarles a salir de ese estado de precontemplación y ayudarles a iniciar un tratamiento completo para su problema de juego.

A pesar de que existen sugerencias teóricas sobre la relevancia de incluir entrenamientos en regulación emocional en los paquetes terapéuticos del TJA (Chu y Clark, 2015), hay que tener en cuenta la existencia de esta dimensión de elaboración cognitiva motivada y de autoengaño. De esta manera, en un hipotético entrenamiento en regulación emocional se habría de tener en cuenta que potenciar determinadas estrategias de *reappraisal* puede tener un efecto contraproducente en algunos jugadores. Es decir, se podrían fomentar estrategias para sobreestimar la autoeficacia personal y/o reducir el impacto emocional de las pérdidas monetarias. Por lo tanto, el entrenamiento en regulación emocional y la reestructuración cognitiva de distorsiones relacionadas con el juego deberían hacerse de manera conjunta y mutuamente contextualizada.

Por último, según el GSM aquellos jugadores que se sitúan en el extremo bajo de esta dimensión de elaboración cognitiva motivada y de autoengaño podrían estar más cercanos al clásico perfil de jugadores con problemas de funcionamiento ejecutivo generalizado (Verdejo-García y Manning, 2015). Éstos podrían beneficiarse de entrenamientos neuropsicológicos dirigidos a portenciar estas funciones. En este sentido, por ejemplo, intervenciones dirigidas a mejorar la capacidad de planificación se han asociado con incrementos en la tolerancia de demoras en la gratificación y mejoras en la toma de decisiones en la vida cotidiana en pacientes con trastornos adictivos relacionados con sustancias (Verdejo-García, 2016).

5. Perspectivas futuras

Esta tesis doctoral permite realizar una serie de preguntas relevantes de investigación en el campo del TJA que podrían ser abordadas en estudios futuros. Entre ellas puede destacar:

- Examinar la existencia de diferencias en el funcionamiento cerebral durante el procesamiento de recompensas monetarias, ya sea durante su anticipación como durante su recepción, entre jugadores con preferencias por modalidades de juego Tipo I y Tipo II, e investigar su relación con la sensibilidad a la recompensa rasgo.
- Investigar por medio de diseños experimentales y técnicas de neuroimagen la existencia de alteraciones en la regulación emocional de pérdidas monetarias y su base cerebral en pacientes con TJA, y evaluar el papel que pudieran desempeñar las distorsiones cognitivas relacionadas con el juego.
- Investigar con los mismos medios y técnicas mencionados en el punto anterior, si las distorsiones cognitivas también pueden ejercer un rol en potenciar la intensidad de las emociones positivas asociadas a ganar dinero en el juego.
- Explorar los mecanismos específicos que podrían explicar los vínculos entre las dimensiones afectivas de impulsividad y las distorsiones cognitivas relacionadas con el juego. En este sentido, la inducción de estados emocionales tanto positivos como negativos en tareas experimentales diseñadas para producir distorsiones cognitivas como la ilusión de control podría ser de especial utilidad a este respecto.
- Apuntalar experimentalmente la propuesta de que la urgencia negativa refleja la alteración de mecanismos de regulación emocional *model-free*. En este sentido, se esperaría que, por ejemplo, en tareas de extinción, las personas con mayor urgencia negativa tenderían a extinguir de manera más lenta la respuesta emocional asociada en primera instancia a estímulos neutros. Aplicada al campo del juego de azar, sería de esperar que los jugadores con TJA caracterizados por este rasgo tendrían mayores dificultades para extinguir respuestas condicionadas a estímulos de juego en comparación con jugadores sin alta urgencia negativa.
- Explorar si la urgencia negativa está asociada a comorbilidades en pacientes con TJA. Es importante notar que en los estudios de esta tesis se excluyó a participantes con trastornos psicopatológicos concomitantes y, por tanto, esta cuestión no pudo ser explorada.
- Desarrollar ensayos clínicos en los que se pongan a prueba la eficacia de diversas técnicas de TCC y terapias de tercera generación (e.g. Mindfulness) adaptadas a la alteración de los diferentes factores de desregulación afectiva del jugador con TJA.

V. INTERNATIONAL DOCTORATE

SUMMARY, CONCLUSIONS AND FUTURE PERSPECTIVES

Summary

Background and rationale

One of the current challenges for policy makers, researchers, clinical practitioners, and other social agents concerned with gambling issues is to identify and describe the primary processes involved in the development of gambling addiction, in order to help vulnerable individuals to maintain control over their gambling behavior. The present thesis is aimed at studying affect generation and regulation processes relevant to gambling and its transition towards addiction, as well as the high level of individual heterogeneity among gamblers (e.g. Blaszczynski & Nower, 2002; van Holst, van den Brink, Veltman, & Goudriaan, 2010). Advances in this area are regarded here as necessary steps to tailor clinical interventions.

Quite often, however, affect-related terms are used vaguely. Here, in line with the works of Gross and his collaborators (Etkin, Buchel & Gross, 2015; Ochsner & Gross, 2008) we propose to use *affect* as an overarching, top-level category that includes a variety of states involving relatively rapid valence discriminations (i.e. pleasure vs. displeasure). Hence, at a lower level, this general label comprises a number of affective states, among which *impulses* and *emotions* (Gross & Thompsom, 2007) are particularly relevant in relation to gambling disorder, as emphasized by most influential and comprehensive reviews on the neurobiology of gambling (Limbrick-Oldfield, van Holst, & Clark, 2013; Goudriaan, Oosterlaan, de Beurs, & van den Brink, 2004; Goudriaan, Yücel & van Holst, 2014; van Holst et al., 2010), as well as by seminal theoretical models (e.g. Blaszczynski & Nower, 2002). *Grosso modo*, an impulse can define as the automatic expression of a basic motive (Woodworth, 1918) that spurs the organism to move toward pleasure and away from pain (Dollard & Miller, 1950; Feltman & Elliot, 2012). Emotions, in turn, refer to states that involve a set of relatively quick psychobiological responses triggered by specific events that are biologically relevant for individuals (Scherer, 2005).

Here, impulses will be considered from two points of view. First, this thesis deals with *reward and punishment sensitivity*, namely the dispositional tendencies to approach or avoid sources of pleasure and pain, respectively. According to Gray´s psychobiological model (Gray, 1981, 1995), these tendencies are governed by two separate biological systems that determine the very foundations of personality. In other words, one of the aims of the studies presented here is aimed to ascertain whether and how hyper- or hypo-responsivity to reward and punishments (and the cues signaling them) affect gambling behavior.

Our second construct of interest is *impulsivity*. Whereas reward and punishment sensitivity have to do with the emergence or generation of certain type of impulses, impulsivity relates to the difficulty to successfully overcome them (Hofmann, Schmeichel, & Baddeley, 2012; Bari & Robins, 2013). Recent meta-analytic research has identified three separate domains of impulsivity: impulsive action (i.e. diminished motor response inhibition), impulsive choice (i.e. the tendency to prefer immediate small rewards over of delayed but larger ones), and impulsive trait (i.e. the dispositional tendency to act rashly; McKillop, Weafer, Gray, Oshri, Palmer, & de Wit, 2016; although for a different clustering approach see Sharma, Markon, & Clark, 2014). Impulsive action, however, does not necessarily imply the control of impulses (as defined above) but, mainly, the control of preponderant motor responses. Thus, only impulsive choice and impulsive trait will further considered in the remaining of the present work.

Whereas measures of impulsive choice (i.e. temporal discounting tasks) do not differ much among them (e.g. Bickel, Odum, & Madden, 1999; Brady, 2006), there is quite a broad range of options to measure impulsivity as a trait. Our decision to favor the UPPS-P model (Cyders & Smith, 2008) over other factorizations is based on (a) its preponderance in gambling research (see Canale et al., 2016 for a review), (b) the existence of an extensive corpus of evidence relating at least some dimensions of the model to biological systems (Canale, Vieno, Bowden-Jones, & Billieux, 2016; Kayardi, Coskunpinar & Ciders, 2012), and, most importantly, (c) the fact that the model explicitly includes two dimensions for affect-driven impulsivity, namely, positive and negative urgency (i.e. the tendencies to loss control under the influence of strong positive and negative emotions, respectively). These two constructs, as discussed later, are essential to link the regulation of emotions to impulse control, and to explain how emotions incidentally interfere with self-control, an interference that has been shown to be central in addictive disorders (Cheetham, Allen, Yücel, & Lubman, 2010).

With regard to emotions, the third and last construct of interest here is *emotion regulation*, namely the more or less explicit modulation of emotional experience and expression (Gross, 1999, 2014). In order to conceptualize and measure emotion regulation, we will use the two leading models in current literature. The model proposed by Gross and cols. (e.g. Gross & John, 2003) comprises cognitive reappraisal (i.e. deliberated change of the meaning of an emotion) and emotional suppression (i.e. deliberated inhibition of the expressive component of an emotion). Complementarily, Garnefski & Kraaij (2007) proposed of more complex model to categorize as

many as nine cognitive emotion regulation strategies, which are separeted in strategies that promote psychological well-being (e.g. *positive refocusing*, redirecting attention to joyful or pleasant themes) or increase emotional suffering (i.e. *catastrophizing*, emphasizing and overestimating the negative experience or its consequences).

Importantly, all these constructs are both connected between them and linked to the behavioral and cognitive manifestations of gambling. By the end of the present work, we are expecting to have drawn a comprehensive map of how processes of generation and regulation of affective states (including reward and punishment sensitivity, impulsivity facets, and emotion regulation) map onto (1) individual differences in gambling preference patterns, (2) cognitive manifestations of gambling, including cognitive distortions involving misattribution of gambling outcomes, and overestimation of personal control or predictive ability in gambling settings, and (3) severity of gambling and its clinical consequences.

Summary of studies and findings

On the basis of this rationale, we designed the five interrelated studies that have been described in the four previous chapters. In the study described in Chapter 1, we examined the potential associations of sensitivity to reward and punishment, impulsive choice, impulsivity trait and gambling-related cognitive distortions, with gambling preferences and clinical status, in a sample of regular non-problem and disordered gamblers. The aim was to discriminate which of these processes are related to individual preferences for certain types of games, to the severity of gambling, or to both.

Based on a principal component analysis, we identified two clusters of gamblers as a function of their preferred gambling modality. In order to avoid theoretical presumptions, these were labeled as *Type I* (preferring card and casino games [including roulette], and skill-based bets), and *Type II* (preferring slot machines, lotteries and bingo). Results showed, on the one hand, that disordered gamblers in comparison to regular ones present higher reward sensitivity, negative and positive urgency, impulsive choice, and intensity of gambling-related cognitive distortions, but lower lack of perseverance. On the other hand, Type I gamblers compared to Type II showed higher reward sensitivity and gambling-related cognitive distortions. Besides, Type II gamblers showed higher impulsive choice (i.e. less tolerance to delayed rewards) than Type I gamblers. Between-group differences in impulsive choice were mostly driven by differences between Type II disordered gamblers and Type I regular gamblers, while differences

in reward sensitivity were due to the higher scores of Type I disordered gamblers compared to Type II gamblers, irrespectively of their clinical status. These results suggest that some characteristics (urgency) are equally insidious in patients with gambling disorder regardless their gambling modality preferences, while others (gambling-related cognitions, reward sensitivity and impulsive choice) are elevated in gamblers preferring certain game modalities.

Studies in Chapters 2 and 3 were aimed at exploring the connection of affective processes with gambling-related cognitive distortions. In the study described in Chapter 2, we have replicated and expanded previous findings that these distortions are more directly associated with affect-driven dimensions of impulsivity than with cognitive ones in disordered gamblers (Michalczuk, Bowden-Jones, Verdejo-García & Clark, 2011). Therefore, our results suggest that the intensity of gambling-related cognitive distortions is associated with the affective dimensions of the UPPS-P (i.e. negative urgency, positive urgency, and sensation seeking), but not with its cognitive facets (i.e. lack of perseverance and premeditation). This finding is consistent with the idea that cognitive distortions may be used by some gamblers to deal with the same positive and negative emotions that spur urgent impulsive behaviors. Additionaly, the lack of association of cognitive distortions with the cognitive dimensions of impulsivity is a sign that severe gambling is not necessarily linked to planning or mental effort-related executive problems. In other words, the executive dysfuction model of addiction (Verdejo-García & Manning, 2015) does not seem to apply to all gamblers' profiles.

In the study described in Chapter 3 we further explored the links of these distortions with the emotion regulation strategies proposed by Garnefski and Kraaij (2007) in their *Cognitive Emotional Regulation Strategies Questionnaire* (CERQ). Our aim was to test the hypothesis that cognitive distortions may serve as a mechanism to cope with the negative emotions produced by negative gambling outcomes. Indeed, results showed that the strength of distorted outcome-related beliefs (i.e. illusion of control, predictive control, interpretative biases and gambling expectancy) correlate with the use of *putting into perspective*, namely an emotion regulation strategy that has been associated with psychological well-being (Garnefski & Kraaij, 2007). This strategy was indirectly related to gambling severity through outcome-related beliefs, and other emotional regulation strategy of the same kind (*refocusing on planning*) also showed a direct, non-mediated association with gambling severity. Therefore, our results seem to confirm that patients with gambling disorder may use certain emotion regulation strategies customarily

regarded as adaptive to curb the impact of negative emotions, and cognitive distortions can be a product or mediator of that relationship; that is, some gambling beliefs are probably motivated by the desire of the gambler to maintain its emotional wellbeing.

In the two studies described in Chapter 4 we further examined emotion regulation in patients with gambling disorder, from a different methodological and measurement perspective. In this case, we analyzed both the dispositional use of the emotion regulation strategies proposed by Gross and John (2003) in the *Emotional Regulation Questionnaire* (ERQ; *cognitive reappraisal* and *emotional suppression*), and fMRI brain activity during reappraisal of negative emotions in a lab task, as well as their respective links with negative urgency. The outstanding relevance of negative urgency in disordered gambling is implied by the preponderance of negative emotions in diagnostic tools of gambling; gambling when feeling distressed, for example, is a specific diagnostic criteria of gambling disorder in DSM5 (APA, 2013). Moreover, evidence shows that this dimension (a) yields the greatest effect sizes among all dimensions of the UPPS-P in comparisons between patients with gambling disorder and controls (McLaren, Fugelsang, Harrigan, & Dixon, 2011; Michalczuk et al., 2011), (b) is specifically related to gambling severity (Torres et al., 2013b), and (c) it may signal clinically relevant concomitant problems, as it has been identified as a hallmark of generalized externalizing psychopathology (Berg, Larzman, Bliwise, & Lilienfeld, 2015; Johnson, Tharp, Peckham, Carver, & Haase, 2017). Importantly, a recent proposal (Navas, Billieux, Verdejo-García, & Perales, 2018) suggest that lack of control over impulses when feeling distressed, frustrated, or angry, as measured by negative urgency, results from the malfunctioning of automatic emotion regulation processes that take place during the very process of emotion appraisal, and thus before intentional emotion regulation strategies (as measured by CERQ or ERQ) are put in motion.

Complementing the results from the study in Chapter 3 (showing that patients with gambling disorder were more prone than controls to use CERQ self-blame and catastrophizing), in the first study in Chapter 4 patients with gambling disorder reported a more frequent use of emotional suppression (ERQ) to deal with emotional events in their daily lives. Besides, in the second study from Chapter 4, patients performed similarly than controls in the reappraisal task (i.e. they did not differ in the subjective reduction of the level of negative emotions experienced), but there were between-group differences in brain activity during that task. Relative to controls, patients with gambling disorder showed higher activation of left premotor and middle frontal

cortices while regulating negative emotions. And, what is more important, in disordered gamblers negative urgency was linked both to the tendency to use emotional suppression and to left middle frontal cortex hyper-activation during cognitive reappraisal. These results suggest that regulation of negative emotions may become an added burden for disordered gamblers. A compensatory mechanism of this nature has been previously described in disordered gamblers using non-affective response inhibition paradigms (van Holst, van Holstein, van Den Brink, Veltman, & Goudriaan, 2012). According to our interpretation, negative urgency reflects the malfunctioning of initial, preconscious emotion regulation mechanisms. In that way, negative emotions become preponderant and overwhelming, which drives some patients to use last-resource strategies (i.e. suppression) that deplete self-control resources (John & Gross, 2004), and over-recruit brain areas involved in top-down cognitive control. The pattern of correlations of negative urgency strongly suggest that this difficulty in regulate emotion is even greater in disordered gamblers characterized by this trait.

Conclusions

Based on results from the different studies comprised by this thesis, we can draw the following conclusions:

- Certain signs of affect dysregulation, such us positive and negative urgency, are particularly widespread in patients with gambling disorder regardless their gambling modality preferences.
- Other affective features, such us impulsive choice and sensitivity to reward may be especially prominent in gamblers with preferences for certain gambling modalities regardless of their clinical status. By virtue of this clustering, sensitivity to reward also becomes associated with distorted gambling-related cognitions.
- Gambling-related cognitive distortions are specifically associated with affect-driven impulsivity (i.e. positive and negative urgency, and sensation seeking) both in disordered gamblers and in regular ones. Although the motivated reasoning hypothesis of cognitive distortions allows that association, its precise underlying mechanisms remain poorly understood, which opens a path for further research (see next section).
- These distortions are also positively associated with emotion regulation strategies that are typically related to psychological wellbeing. And, at the same time, strategies of this kind are linked to gambling disorder severity. These results suggest that gambling-related cognitive

distortions may be part of a self-deceptive thinking style that helps maintain gambling behavior by contributing to reduce the emotional impact of gambling negative outcomes.

- Disordered gamblers show anomalies in emotion regulation, as reflected by their tendency to self-blame, catastrophize, and suppress the expressive component of emotions. These behavioral manifestations are associated with brain hyper-activation in regions involved in top-down control during emotion regulation in a cognitive reappraisal lab-task.
- Negative urgency emerges as a characteristic of especial clinical relevance in gambling disorder. Firstly, because, among all dimensions of impulsivity of the UPPS-P model, it is the dimension that best discriminate between disordered gamblers and controls. And secondly, because it is associated with some of the emotional dysregulation indices mentioned in the previous point, namely emotional suppression and prefrontal activation during cognitive reappraisal in a lab-task.

Finally, in order to wrap the main results up, and to provide a general and coherent view of their theoretical relevance, we include a brief summary of a theoretical model –*The Gambling Space Model* (GSM; Navas, Billieux, Verdejo-García, & Perales, 2018)– that we have recently proposed, partially as results of the evidence from the studies presented in this thesis.

In the GSM four affective dimensions play different roles in shaping gambling disorder vulnerability, development, and individual variability in gamblers' populations. The two first dimensions refers to *sensitivity to appetitive properties and negative reinforcement components of gambling*, which are partially related to reward and punishment sensitivity, and may explain a high enrollment in gambling activities driven by positive or coping motives, respectively. Both dimensions, but especially the former, could interact with gambling features in shaping individual gambling preferences.

The third dimension is *generalized emotion dysregulation*, which refers to the malfunctioning of implicit or *model-free* emotion regulation mechanisms related to ventral prefrontal regions (Etkin, Büchel, & Gross, 2015), and is reflected by heightened negative urgency (Navas, Billieux, Verdejo-García, & Perales, 2018). Indirectly, deficits in this mechanism involve the necessity to implement control by means of explicit emotion regulation mechanism, related to dorsal prefrontal structures (Etkin et al., 2015). Given that negative urgency is a hallmark of externalizing psychopathology, the possibility exists that this dimension

would be a marker of gambling disorder complication, and, thereby a factor with special clinical relevance.

The fourth dimension represents a mechanism of *cognitive elaboration and self-deception*, which refers to the motivated use of emotion regulation strategies –intentional or *model-based* emotion regulation– in combination with gambling-related cognitive distortions. This mechanism seems to play and ego-protective function, and may contribute to the maintenance of gambling by curbing the negative consequences of gambling and/or enhancing its appetitive properties. This mechanism could be especially distinctive of gamblers preferring card and casino games, and skill-based bets (Type I gamblers), who are characterized by overconfidence and an increased sense of mastery at gambling (Myrseth, Brunborg, & Eidem, 2010).

Future perspectives

The work presented here reveals a complex, but mostly coherent picture of the role of affect generation and regulation in behavioral and cognitive manifestations of gambling, but also opens questions and poses challenges for future research. Among them, we will highlight the following ones:

- To examine differences in brain functioning during the processing of monetary and non-monetary rewards, during either its anticipation or its delivery, between Type I and Type II gamblers, and to investigate their association with reward sensitivity as a trait.
- To use experimental designs and neuroimaging techniques to explore abnormalities in emotional regulation of monetary losses and its brain bases in patients with gambling disorder, and to assess the potential role of gambling-related cognitive distortions in such abnormalities.
- To use those techniques to investigate the potential relationship of gambling-related cognitive distortions, not only to cope with negative gambling-related emotions, but also to enhance the intensity of positive ones, including wins, thrill, and other sources of subjective gambling utility.
- To clarify the specific mechanisms that underlie the link between gambling-related cognitive distortions and affect-driven impulsivity. A useful approach would be to induce positive and negative emotional states during performance in experimental task designed to prompt

cognitive distortions (e.g. illusion of control), and test whether people differing in urgency and sensation seeking are more or less sensitive to the effects of emotion induction on distorted cognitions..

- To deepen our understanding of negative urgency. Recently, we have proposed that this dimension may reflect the malfunctioning of model-free, pre-conscious emotion regulation mechanisms (Navas, Billieux, Verdejo-García, Perales, 2018). According to Etkin et al. (2015) this malfunctioning arises from the disruption of learning mechanisms necessary to update the affective value of conditioned cues (e.g. extinction, counterconditioning, occasion setting and reward devaluation). If our hypothesis regarding negative urgency is right, these value updating mechanisms should be slower to operate in individuals with scoring high in this trait.
- To develop clinical trials to test the efficacy of tailored interventions that target the affect generation and regulation factors studied throughout this thesis.

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Curriculum vitae

Juan F. Navas nació en Burgos (Gamonal), España. En 2005 terminó sus estudios de Educación Social en la Universidad de Burgos. En 2007 realizó estudios de post-grado de Especialista en Servicios Sociales en la misma universidad. Desde 2005 a 2008 trabajó como educador social en diversos proyectos sociales para la prevención de trastornos adictivos en poblaciones de alto riesgo, tanto en Burgos como en Barcelona. Se trasladó a Granada en 2008, y realizó en la Universidad de Granada la Licenciatura de Psicología (2008-2013) y un máster en Neurociencia cognitiva y del comportamiento (2014). Recibió por parte del Ministerio de Educación, Cultura y Deporte, un 3er Premio Nacional Fin de Carrera en Ciencias Sociales y Jurídicas y una beca predoctoral (programa FPU) para realizar estudios de doctorado por su desempeño durante los estudios de licenciatura. Durante el periodo de tesis, realizó una estancia de 5 meses en el *Monash Institute of Cognitive and Clinical Neurosciences (MICCN)*, en Australia, 2 meses en el *Medical Academic Center of University of Amsterdam*, en los Países Bajos; y 2 meses en el *Centro de Investigación Biomédica-IDIBELL*, en España. En los 4 años de sus estudios de doctorado, más allá de los artículos de esta tesis, fue autor de otros 19 artículos científicos publicados en revistas corregidas por pares, de dos capítulos de libro publicados por editoriales internacionales y de más de 70 comunicaciones en congresos científicos nacionales e internacionales. Es miembro del grupo de investigación Aprendizaje, Emoción y Decisión de la Universidad de Granada.

Juan F. Navas was born in Burgos (Gamonal), Spain. In 2005, he completed a degree in Social Education at University of Burgos. In 2007, he completed a post-graduate course as Specialist in Social Services at University of Burgos. From 2005 to 2008, he worked at social educator in several projects aimed at achieving social inclusion of high-risk populations for addictive behaviors, both in Burgos and Barcelona. He then moved to Granada and completed a degree in Psychology in 2013, and a master in Cognitive and Behavioral Neuroscience, in 2014, at University of Granada. He was awarded with a 3rd National Price for his performance during degree studies, and with a predoctoral grant (FPU program) to complete doctorate studies from the Spanish Ministry of Education, Culture and Sport. For his thesis, he spent 5 months at the Monash Institute of Cognitive and Clinical Neurosciences (MICCN), in Australia; 2 months in the Medical Academic Center of University of Amsterdam, in the Netherlands; and 2 months in the Biomedical Research Center-IDIBELL, in Spain. During his doctorate studies, beyond the articles of his thesis, he was author of another 19 articles published in peer-reviewed journals, two book-chapters published by international editorials and more than 70 communications in national and international scientific meetings. He is member of the Learning, Emotion and Decision Research Group of the University of Granada.

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