UNIVERSITAT DE BARCELONA

Impulsivity and compulsivity as transdiagnostic clinical features in gambling and eating disorders

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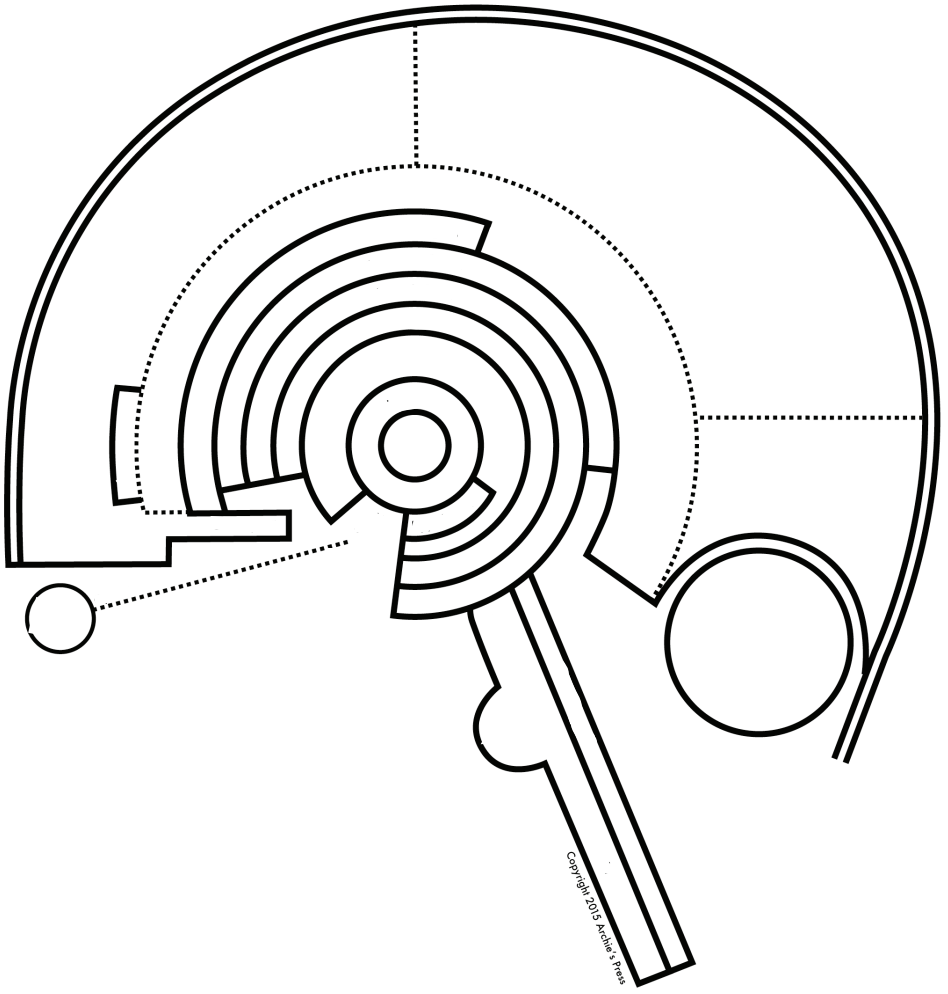

DOCTORAL THESIS

IMPULSIVITY AND COMPULSIVITY AS TRANSDIAGNOSTIC CLINICAL FEATURES IN GAMBLING AND EATING DISORDERS

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Doctors Susana Jiménez-Murcia and Fernando Fernández-Aranda certify that they have guided and supervised this doctoral thesis, entitled "Impulsivity and compulsivity as transdiagnostic clinical features in gambling and eating disorders", which is presented in order to obtain the title of Doctor (International Title) by the candidate Gemma Mestre-Bach. They thereby assert that this thesis fulfills all the required criteria.

A totes les fulles seques
To all the dry leaves

To Jordan, I am completely sure that you will be the shiniest, kindest star,
with the most shirts and most well-kept backyard to be found.

"Life should not be a journey to the grave with the intention of arriving safely in a pretty and well preserved body, but rather to skid in broadside in a cloud of smoke, thoroughly used up, totally worn out, and loudly proclaiming: Wow! What a Ride!"

Hunter S. Thompson

"A mind is like a parachute. It doesn't work if it is not open."

Frank Zappa

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"Tengo una extraña sensación. Si no es indigestión, creo que debe ser gratitud"

Benjamin Disraeli

PREFACE

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Enclosed are four peer-reviewed published journal articles and two currently under review:

1. Steward, T.*, **Mestre-Bach, G.***, Vintró-Alcaraz, C., Agüera, Z., Jiménez-Murcia, S., Granero, R., Fernández-Aranda, F., 2017. Delay Discounting of Reward and Impulsivity in Eating Disorders: From Anorexia Nervosa to Binge Eating Disorder. Eur. Eat. Disord. Rev. 25, 601–606 (IF: 3.391; Q1 in category "Psychology, clinical").

2. Steward, T.*, **Mestre-Bach, G.***, Fernández-Aranda, F., Granero, R., Perales, J.C., Navas, J.F., Soriano-Mas, C., Baño, M., Fernández-Formoso, J.A., Martín-Romera, V., Menchón, J.M., Jiménez-Murcia, S., 2017. Delay discounting and impulsivity traits in young and older gambling disorder patients. Addict. Behav. 71, 96–103 (IF: 2.944; Q1 in categories "Psychology, clinical" and "Substance abuse").

3. **Mestre-Bach, G.**, Steward, T., Granero, R., Fernández-Aranda, F., Mena-Moreno, T., Vintró-Alcaraz, C., Lozano-Madrid, M., Menchón, J.M., Potenza, M.N., Jiménez-Murcia, S., 2019. Dimensions of Impulsivity in Gambling Disorder. Under review.

4. **Mestre-Bach, G.**, Steward, T., Granero, R., Fernández-Aranda, F., Talón-Navarro, M.T., Cuquerella, À., Baño, M., Moragas, L., del Pino-Gutiérrez, A., Aymamí, N., Gómez-Peña, M., Mallorquí-Bagué, N., Vintró-Alcaraz, C., Magaña, P., Menchón, J.M., Jiménez-Murcia, S., 2018. Gambling and Impulsivity Traits: A Recipe for Criminal Behavior? Front. Psychiatry 9, 6 (IF: 3.532; Q1 in category "Psychiatry").

5. **Mestre-Bach, G.***, Steward, T.*, Granero, R., Fernández-Aranda, F., del Pino-Gutiérrez, A., Mallorquí-Bagué, N., Mena-Moreno, T., Vintró-Alcaraz, C., Moragas, L., Aymamí, N., Gómez-Peña, M., Sánchez-González, J., Agüera, Z., Lozano-Madrid, M., Menchón, J.M., Jiménez-Murcia, S., 2019. The predictive capacity of DSM-5 symptom severity and impulsivity on response to cognitive-behavioral therapy for gambling disorder: A 2-year longitudinal study. Eur. Psychiatry 55, 67–73 (IF: 4.129; Q1 in category "Psychiatry").

6. **Mestre-Bach, G.**, Steward, T., DeVito, E.E., Yip, S.W., George, T.P., Reynolds, B.A., Granero, R., Fernández-Aranda, F., Jiménez-Murcia, S., Potenza, M.N. 2019. Gambling Disorder: the Role of Impulsivity and Compulsivity. Under review.

**Shared first autorship*

LIST OF ABREVIATIONS

ACC: Anterior Cingulate Cortex
ADHD: Attention Deficit Hyperactivity Disorder
AN: Anorexia Nervosa
AN-BP: AN-Binge/Purge Subtype
ANOVA: Analysis of Variance
AN-R: AN-Restrictive
APA: American Psychiatric Association
BDD: Body Dismorphic Disorder
BED: Binge Eating Disorder
BIG-S: Berlin Inventory of Gambling behavior-Screening
BIS-11: Barratt Impulsiveness Scale
BMI: Body Mass Index
BN: Bulimia Nervosa
CAGI: Canadian Adolescent Gambling Inventory
CBT: Cognitive Behavioral Therapy
CD: Coefficient of Determination
CFI: Comparative Fit Index
CHI-T: Cambridge-Chicago Compulsivity Trait Scale
CI: Confidence interval
CPT: Continuous Performance Test
dlPFC: Dorsolateral prefrontal cortex
DSM: Diagnostic and Statistical Manual of Mental Disorders
ED: Eating Disorder
EDI-2: Eating Disorder Inventory-2
EDT: Experiential Discounting Task
GABSA: Gambling Addictive Behavior Scale for Adolescents
GD: Gambling Disorder
GFA-R: Gambling Functional Assessment-Revised
HC: Healthy Control
ICD: International Classification of Diseases
MAGS: Massachusetts Gambling Screen
mASI: Modified Addiction Severity Index
MLE: Maximum-Likelihood Estimation
mPFC: Medial Prefrontal Cortex
OCD: Obsessive-Compulsive Disorder
OCDUS: Obsessive Compulsive Drug Use Scale
OCRD: Obsessive-Compulsive Related Disorder
OFC: Orbitofrontal Cortex
OSFED: Other Specified Feeding or Eating Disorders
PCC: Posterior cingulate cortex
PEN: Psychoticism, Extraversion and Neuroticism
PG: Pathological Gambling
PGSI: Problem Gambling Severity Index
PI: Padua Inventory
PI-WSUR: Padua Inventory-Washington State University Revision
RMSEA: Root Mean Square Error of Approximation
SEM: Structural Equation Modeling
SOGS: South Oaks Gambling Screen
SOGS-RA: South Oaks Gambling Screen-Revised for Adolescents
SRMR: Standardized Root Mean Square Residual
SUD: Substance Use Disorder
TCI-R: Temperament and Character Inventory-Revised
TLI: Tucker-Lewis Index
UFED: Unspecified Feeding or Eating Disorders
UPPS-P: (negative) Urgency, (lack of) Premeditation, (lack of) Perseverance, and Sensation Seeking (UPPS) Impulsive Behavior Scale- Positive urgency
vmPFC: Ventromedial Prefrontal Cortex
WCST: Wisconsin Card Sorting Task
YBOCS: Yale-Brown Obsessive-Compulsive Scale

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1. INTRODUCTION

"Once you label me, you negate me."
S. Kierkegaard

Every branch of science attempts to assign specialized terms to phenomena from its research field and to classify them by examining their various features (1). In the specific case of psychiatry, diagnostic classifications of mental disorders have had two main objectives: to allow clinicians and researchers to exchange information about clinical diagnoses; and to obtain validity and clinical utility in the most efficient way possible (2).

However, debate continues about the best approaches for diagnosing mental disorders to deal with real clinical settings (1,3). This is not surprising due to, among other things, the complexity of mental disorders and the lack of knowledge about their etiology (1). The nosographic problem, that is, the methodological opposition between two approaches to mental pathology (the categorical and the dimensional approach), appears to be one of the main arguments for the reorganization of psychiatric classification schemes (2). While some claim that the current categorical model used to classify mental disorders (utilizing the Diagnostic and Statistical Manual of Mental Disorders [DSM] and the International Classification of Diseases [ICD]) is the most effective and exhaustive in terms of diagnosis, others advocate for a change of paradigm, proposing a dimensional model that is more sensitive in classifying symptoms along a spectrum instead of via a checklist. Although it is well known that both have strengths and weaknesses (see Table 1), a systematic, empirical understanding of which model contributes more to improving the diagnostic process in mental health is still lacking (3).

Table 1. Comparison between categorical and dimensional perspectives

	CATEGORICAL	DIMENSIONAL
PROS	- Clinical utility (easy use and communication between professionals) - High interrater reliability - Familiarity and high clinical confidence - If a new category is discovered, it can be included in the classification without invalidating the system	- Reduction of comorbidity rates - Diagnoses are faithful to clinical reality (not artificial) - Flexibility when considering interindividual differences - Not dependent on artificial cut-offs

	CATEGORICAL	DIMENSIONAL
CONS	- Poor convergent and discriminant validity - Temporary changes in symptomatology are not contemplated (the diagnosis is based on the symptoms that the person presents in a moment cut transversally in time) - Heterogeneity between patients (in terms of severity levels) is not taken into account Excessive rates of diagnostic comorbidity Arbitrary cutoffs with lack of empirical evidence - Numerous individuals do not fit into a specific category ("not otherwise specified") - Limited utility for treatment planning in cases where there are comorbidities or the individual problem does not fit in the diagnostic criteria - Labels associated with categorical models can promote stigmatization of patients - Does not provide a sufficient mechanism to record the severity of disorders - Only distinguishes between the presence and absence of the disorder, without taking into account severity	- Proposals are in nascent stages and need more empirical research - Wide variety of models - Dimensional measurements vary substantially, and there is not a consensus on which psychometrical tool is best - Tendency to be a closed system: if a new dimension is discovered, it could invalidate the theoretical spectrum - Phenomena must have a continuous distribution and vary quantitatively so that they can be measured, and not all have these characteristics - Dimensions are theoretically independent, but often co-vary - Lack of agreement on the basic categories that define the structural axes of the spectrum - An excessive use of psychotropic treatments by the mere presence of a symptom or syndrome, which occurs in a minimal way - Complex qualifying process

1.1. CATEGORICAL AND HYBRID FRAMEWORK

In order to consider a system as categorical, its categories must meet three essential criteria (4,5):

- **Be discrete:** the elements assigned to different categories do not share main characteristics. It can be expected, therefore, in the diagnostic classifications of mental disorders, that those diagnosed with different disorders do not share the same symptomatology.

- **Be mutually exclusive:** if one element fits into one category, it cannot fit into another. In the case of psychopathological classifications, if an individual suffers from a certain disorder, he or she cannot

suffer from another at the same time. This criterion is being currently disputed considering the high comorbidity rates between mental disorders.

- **Be exhaustive:** all the elements located in a category have to share the same relevant characteristics. Therefore, all people classified under the same clinical diagnosis share the same symptomatology described for a diagnostic category.

In psychiatry, the categorical approach arose previously, with the aims of establishing precise categories based on well-defined properties and of looking for natural entities of mental illnesses through the clinical observation of patients (2). The aim of grouping signs and symptoms into perfectly delimited categories is, therefore, to identify specific disorders with a known etiology, course, and response to treatment (4).

Following this categorical conception of psychopathology, which, like the medical model, classifies diseases as qualitatively discernible conditions, two main classification systems are used. The DSM, which emerged in the United States, and the ICD, which was proposed in Europe.

However, data reveal that these diagnostic classification systems do not meet the minimum criteria necessary to be considered as categorical, and serious doubts have been raised around their construct validity (4,6):

- There is a blend between diagnostic categories, and therefore, their borders seem arbitrary and subjective:

    The heterogeneity of symptoms between patients with the same diagnosis is patent (e.g., in a depression diagnosis, both agitation and psychomotor retardation are included).

    A large majority of patients present characteristics found in multiple disorders, making explicit an evident concurrence of symptoms between different diagnoses (e.g., depression and schizophrenia both share apathy as a diagnostic criterion).

Taking the DSM as a focus of attention, it has been more than 60 years since the American Psychiatric Association (APA) published its first edition (DSM-I) (7). Since then, successive revisions have been produced, through which important changes in the knowledge and classification of mental disorders have been reflected (8).

While awaiting the publication of its most recent version, many people disagreed about the level at which dimensional diagnostic features should be incorporated, which would break with the models based on the symptoms that were still present in the DSM-IV-TR (8).

Therefore, there was no consensus on whether nosology should be predominately categorical or

dimensional (9). The nosological and conceptual proposal of Thomas Insel, from the National Institute of Mental Health (NIMH), to establish the Research Domain Criteria (RDoC) should also be considered. This is a dimensional (9) approach initially oriented to mental disorders, based on brain function, genetics and neuroscience, which has had a significant impact on the scientific community and further questioned the validity of categorical classifications (10).

Finally, the DSM-5 (11) recognized the basic problems associated with categorical classifications and incorporated two types of dimensional parameters featuring in a hybrid model: spectrums or dimensional equivalents for diagnoses (psychopathological dimensions) and dimensional evaluations (measures of cross-cutting symptoms and measures of severity) (8). Specifically, the Obsessive-Compulsive Related Disorders (OCRDs) were included. The OCRD dimensional diagnosis encompasses obsessive-compulsive disorder (OCD) and other disorders that were previously classified elsewhere, such as body dismorphic disorder (BDD), which was previously listed as a somatoform disorder. This new grouping also includes disorders involving simple motor behaviors, such as trichotillomania and skinpicking disorder, previously considered as impulse-control disorders. Finally, hoarding disorder was included as a disorder among the OCRDs (12).

1.2. DIMENSIONAL FRAMEWORK

In order to face the limitations of the categorical perspective and to refine and improve existing psychiatric classification, different theoretical models, framed in a dimensional perspective, emerged towards the 1980s, in the works of authors such as Hempel (13) and Eysenck (14). From this point of view, the term "dimension" is understood as the set of magnitudes that serve to define a psychological phenomenon (4).

In general, dimensional diagnosis, one of the most important revolutionary proposals in the field of personality disorders, is opposed to a vision of mental disorders as specific biomedical entities (15). Moreover, contrary to the categorical model (which is underlied by the process of counting symptoms until reaching an arbitrary number, beyond which the presence of more symptoms loses meaning), the number of diagnostic characteristics forms an index of severity in dimensional approaches by taking into account the daily functioning of patients (4). While a categorical diagnosis, being a binary method, only contemplates the presence or absence of a disorder, a dimensional diagnosis has at least three ordinary values, which can range from a scale of three degrees to a continuous scale (2).

In addition to the dimensional models focused on personality, such as the Cloninger Temperament and Character model (16), numerous proposals have been put forward that focus on ceasing to understand psychopathology as a categorical element:

- **Internalizing vs. externalizing spectrum (17):**

This model, focused on internalizing (e.g., depression, generalized anxiety) and externalizing (e.g., substance use, antisocial personality) disorders, has suggested two presentations of psychopathology that emerge from partly distinct pathways (mainly regarding genetics and underlying brain correlates). Internalizing and externalizing symptomatology at a young age could be a predisposition for developing, later in life, different types of psychopathology.

- The "mood spectrum": depression vs. mania (18):

This model was raised to include depressive, hypomanic, and manic symptoms on the same continuum, considering major depressive disorder and bipolar disorder 1 and 2 as non-separate clinical diagnoses.

- The obsessive-compulsive and the impulsive-compulsive spectrums (19):

An obsessive-compulsive spectrum was proposed to include those disorders that have core obsessive and compulsive features, in addition to similarities in patient clinical features, comorbidities, course, neurobiology, or treatment outcome (20). These disorders vary in the extent to which they are characterized by compulsivity or impulsivity, and this difference is frequently discussed by referring to a impulsive-compulsive spectrum (20).

1.2.1. IMPULSIVE-COMPULSIVE SPECTRUM

The initial theoretical proposal suggested the presence of a continuum, with compulsivity on one pole (understood as an overexaggerated attempt to alleviate anxiety or discomfort) and impulsivity on the opposite pole (understood as an underestimated sense of harm and a desire to obtain arousal and gratification) (19). Despite being two very different constructs (see Table 2), both imply the inability to inhibit or delay repetitive behaviors, and both may be present at the same time or at different temporal moments in the same disorder (21).

Table 2. Phenomenological similarities and differences between impulsivity and compulsivity

	IMPULSIVITY	COMPULSIVITY
SIMILARITIES	Impaired ability to control, inhibit, or delay behavioral responses Behavior carried out despite adverse consequences Dysfunction in top-down inhibitory control of behavior Intrusiveness	
DIFFERENCES	Egosyntonic and pleasurable	Egodystonic and unpleasurable
	Exciting behavior	Anxious behavior
	Driving force behind the behavior: to obtain a reward (pleasure, arousal, and gratification)	Driving force behind the behavior: to reduce anxiety or discomfort
	Pseudoresistance	Resistance
	Shame associated with uncontrolled behaviors, but not with the behavior's nature	Shame associated with a ritual that the individual thinks is irrational

1.2.1.1. IMPULSIVITY

Towards a definition and categorization of impulsivity

Managing impulsivity is essential to many aspects of human cognition and behavior, such as the requirement to control interfering stimuli, thoughts, or response tendencies (22). In daily life, it is relatively easy to identify examples of impulsivity, and the term "impulsive" is used in common parlance outside of psychiatric clinical practice (23). However, numerous doubts have arisen over the years around the conceptualization of impulsivity in a wide range of fields, including neurogenetics, abnormal psychology, psychopharmacology, cognitive psychology, developmental psychology, and social psychology (22). Considering that children are, by nature, more impulsive than adults, is impulsivity an innate trait that is modified by education or merely an acquired factor? Is this always related to pathology, or is it simply a series of traits that only deserve attention if they interfere with the subjects' lives? (24).

There have been numerous attempts, particularly in the field of neuroscience, to solve these questions concerning impulsivity in order to obtain a better definition, measurement, and categorization of the construct. It would increase the validity of clinical diagnoses, as well as the effectiveness of therapeutic approaches (25). However, there are two central limitations in the study of impulsivity:

1) Blurred boundaries between normalized and problematic behaviors

There is a clear lack of consensus in the detection of the aspects that differentiate, at a social level, an acceptable impulsive behavior versus an unacceptable one (26). In this distinction, merely cultural variables intervene, which makes the study of the biological basis of the phenomenon of impulsivity even more difficult (27,28).

Currently, most existing knowledge about the impulsivity construct comes from clinical samples (29–31) or specific populations, such as adolescents (32–34) or young adults (35,36). Therefore, although data suggest a negative correlation between impulsivity and chronological age (37,38) and suggest higher impulsivity levels in males from the general population (39), few studies have focused on the prevalence of impulsivity in non-clinical populations, leaving an important gap in the research field (40).

2) Confusion and poor specificity of the impulsivity construct

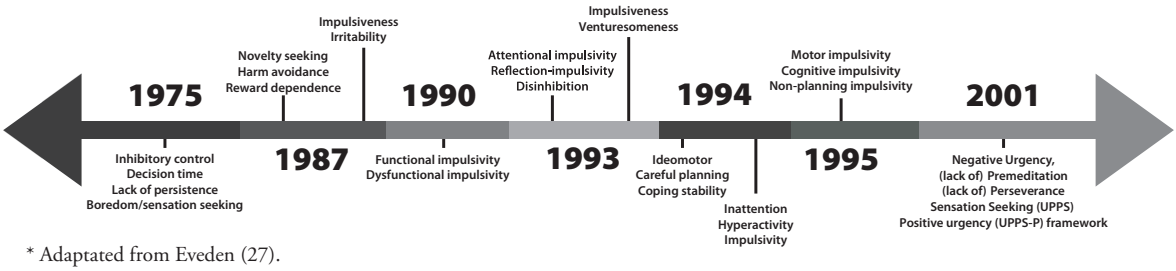
At a clinical level, the term "impulsivity" has been used to define psychopathologically disparate phenomena (23), leading to terminological and conceptual confusion, including both the "jingle" (different constructs are given the same label) and "jangle" (the same constructs are given different labels) fallacies (41,42). There is growing consensus about the multifactorial nature of impulsivity,

considering a variety of behaviors and processes instead of construing it as a unitary construct (27,43). Impulsivity may be, therefore, an umbrella construct that refers to several conceptually and empirically separable features (41,44,45).

However, in an attempt to find a comprehensive and precise definition of impulsivity and its operationalization, theorists and psychometricians found themselves in disagreement when selecting the most relevant clinical indicators associated with impulsivity, as well as when identifying the different manifestations of impulsivity (46). A debate exists about the number and types of impulsivity factors (47). Several taxonomies of the facets and components of impulsivity have been proposed (22,27), ranging from as few as two to as many as fifteen (48) (see Figure 1 and Table 3).

From a clinical perspective, impulsivity in psychiatric patients has been an issue of growing interest, as it is one of the defining characteristics of many mental disorders. Although impulsivity can exist in any individual, it is more likely to be present in those who suffer from psychiatric disorders with behavioral disinhibition, such as certain personality disorders and substance use disorders (SUDs) (49).

Figure 1. Temporal evolution of conceptualizations about impulsivity



* Adaptated from Eveden (27).

Table 3. Labels used in the impulsivity field

	COGNITIVE	BEHAVIOR (MOTOR COMPONENT)	PERSONALITY (CHARACTEROLOGICAL)
APPROACH IMPULSE (antecedents)	- Appetitive motivation - Reward-delay impulsivity - (Impaired) salience attribution - Impulsive choice - Risky choice - Delay intolerance - Reflection impulsivity		- Reward sensitivity/drive - Sensation seeking - (Agentic) extraversion
LACK OF INHIBITORY CONTROL (RESPONSE INHIBITION) (consequences)		- (Poor) self-regulation - Motor (dis)inhibition - Impulsive action - Rapid-response impulsivity - (Impaired) response inhibition - Response impulsivity	- Rash impulsiveness - (Low) constraint

Adaptated from Gullo et al (50).

Current theoretical definitions and models of impulsivity

The theoretical heterogeneity evidences the need for an impulsivity model to help identify biomarkers related to different kinds of disorders (22,51).

From a biopsychosocial perspective, understanding impulsivity as a "predisposition toward rapid, unplanned reactions to internal or external stimuli without regard to the negative consequences of these reactions to the impulsive individual or to others" has been widely recognized in the scientific community (51). "Predisposition" considers impulsivity as a pattern of behavior rather than as an isolated and independent behavior. Itt is essential to take into account rapid, unplanned reactions without prior assessment of the associated consequences. Contrary to compulsive behaviors or impaired judgment, where planning happens before the behavior, in impulsivity the action arises before the opportunity to intentionally weigh the risks and consequences of these behaviors (51).

IMPULSIVITY HAS BEEN STUDIED IN TERMS OF:

A) Associations with diverse forms of psychopathology:

Impulsivity is mediated by linked, but functionally distinct, neural circuitry related to motivational and decisional processes (52). From them, core laboratory-based research has focused mainly on two impulsivity subtypes (43). Both are separate in terms of underlying neurobiology and contribute uniquely to specific phases of mental disorders such as addictions (47):

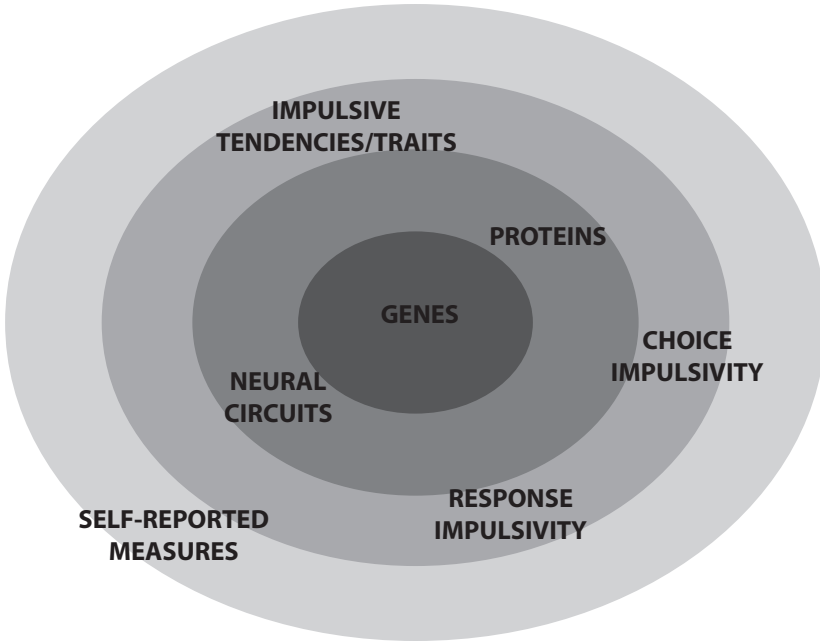
1) Choice impulsivity (cognitive factors): decision-making styles condition goal selection and decisions on when and how to act. Choice impulsivity refers, more concretely, to lack of planning and lack of regard for future consequences, showing a propensity to approach stimuli.

2) Response impulsivity (behavioral factors): a failure to inhibit approach behaviors.

B) Personality dimensions:

3) It has been suggested to contemplate a trait measure of impulsive tendencies when defining impulsivity in order to obtain a richer picture of this construct (53,54) (see Figure 2 and Table 5).

Figure 2. Impulsivity as a multifactorial construct



Adaptated from Bevilacqua & Goldman (55).

1) Choice impulsivity

Conceptualization

Individuals are recurrently confronted with choices that differ in quality, amount, delay, likelihood, valence, and effort (56). Within behavioral research, choice impulsivity has been defined via two broad categories: the inability to inhibit responses and the inability to delay gratification (27,57,58), although the latter has received more attention in empirical research.

When facing a choice, people prefer to receive rewards sooner rather than later and to have more of a reward rather than less. However, when these dimensions are in tension (less now or more later), choices become less straightforward and more complex (59). It is well known that delaying a reinforcer's delivery reduces its reinforcing power (60,61). Choice impulsivity is focused on this process, and it refers to a tendency to preferentially choose small, immediate rewards (the impulsive choice) rather than larger-later rewards (the self-controlled choice), to the detriment of long-term outcomes, even when the larger reward is objectively optimal when taking reward-earning potential into account (59,62,63). This temporal myopia is related to the devaluation of a reward because it is delayed (64).

Within choice impulsivity, the integration of reward amount and delay and the incorporation of a probable role for temporal processing in determining impulsive choice behavior have been considered as a separate descriptive model named "delay discounting" (57). It has received much interest across many fields, including psychology, marketing, economics, and behavioral ecology (56). In psychology, the hyperbolic discounting equation (65) was created to describe the indifference points as a function of delay. Therefore, it has been used to operationalize the discounting behavior, predicting the subjective value of a reward of a particular amount and delay (66):

$$V = \frac{A}{1 + kD}$$

V	Subjective value of reward.
A	Amount of reward.
K	Discounting rate. It has been used in impulsive choice behavior to identify individual differences.
D	Time delay to reward which, as delay increases, decreases the value of a reward, thus leading to the discounting of reward value with delay.

Although the hyperbolic model is the most widely used, different models of discounting have been proposed in an attempt to more adequately describe the discounting of delayed rewards (67).

Assessment

Delay discounting assessment procedures are focused on finding the point at which two rewards, one immediate and the other delayed, have roughly the same value (59). Following this perspective, a wide variety of techniques have been used.

Empirical researchers generally ask participants to make a series of choices between hypothetical options instead of conditioning them with the consequences of each choice, as is done in animal research (59). In human paradigms, the indifference point, understood as the average amount of reward at which the participant switched preference, is usually the main variable of interest. This point can also be determined by moving through a fixed list of options (68), whereas studies adjust amounts of the immediate outcome based on the participant's choice (69). As the delay to the larger amount increases (the money becomes more remote), the value of the reward is degraded systematically (the indifference point is decreased) (59). Other delay discounting paradigms have focused on framing (e.g., temporal reference points or outcome salience), due to the fact that the context in which the decision is presented strongly influences the decision-making process (70).

Within this framework, Kirby et al. (71) developed a brief questionnaire based on the findings of Kirby and Marakovic (72). The monetary-choice questionnaire includes 27 choices between smaller, sooner rewards and larger, delayed rewards (such as: "Would you prefer $54 today or $55 in 117 days?"). It has been shown to have sound psychometric properties for reliability and stability.

However, some researchers have expressed skepticism about these kinds of tasks and their validity, arguing that asking people to imagine what they think they would prefer is not the same as having them make a choice and face the consequences of their actions (59). New proposals of assessment have been made to cope with this limitation, such as the Experiential Discounting Task (EDT) (73), in which individuals experience the delays and receive the amounts of money that they choose.

Neurobiology

Due to, among other things, the complexity of choice impulsivity assessment, it remains unclear how neural regions and neurochemical systems contribute to this impulsivity dimension (57). Choice impulsivity can be understood as the manifestation of an imbalance between neurobiological systems subserving motivation and control (74). The data implicate the differential functioning of brain regions which underlie reward-related decision making, namely the limbic and prefrontal regions (75,76). Specifically, mesocorticolimbic dopamine pathways within the medial prefrontal cortex (mPFC), the orbitofrontal cortex (OFC), and ventral striatal projections have been implicated in impulsive choice (77). Some studies suggest that the nucleus accumbens is sensitive to the magnitude of future rewards, while lateral cortical regions are sensitive to the delay of future rewards (57). The subjective value of monetary rewards has also been related to activation of the ventral striatum, mPFC, and posterior cingulate cortex (PCC) (77).

2) Response impulsivity

Conceptualization

The ability to inhibit inappropriate behaviors is an important aspect of human functioning, as it allows individuals to evaluate the consequences of their actions and to make adaptative responses (78).

Response impulsivity, also termed "impulsive action" or "motor impulsivity," refers to impulsivity in action and involves impairments in delaying, withholding, interrupting, or inhibiting inappropriate behavioral responses (43,47). Therefore, it is focused on the tendency to prepotent motor disinhibition, responding with an inadequate assessment of context (78,79). In other words, it refers to a lack of top-down control governing behavioral response tendencies, principally when there are changes in the environment (80).

Assessment

Response impulsivity has been mainly assessed in two ways: self-report and behavioral measures. Nevertheless, correlations have been found to be inconsistent or lacking between assessment options, suggesting that motor impulsivity itself requires a multi-dimensional conceptualization (81).

Differences between both kinds of assessment are listed in Table 4, below (82–85).

Table 4. Differences between self-report and behavioral measures

SELF-REPORT MEASURES	BEHAVIORAL MEASURES
Focused on impulsivity tendencies or traits (a stable personality feature)	Laboratory tasks are measuring state (a transitory feature specific to a context or situation) impulsivity
Subjective and explicit	Objective and implicit
Instruct participants to be honest	Instruct participants to do their best
May be monotonous, principally for individuals with high impulsivity levels, achieving different motivation levels across participants	May be more engaging and related to greater participant motivation (except in the case of some Go/No-go tasks)
The same items are administered to all participants. Moreover, on some tools, the "yes" or "no" response type forces the participant to make a choice between the two options. Participants might have difficulties accurately describing their responses in nuanced situations	Adaptive, computer-based measures administer different item sets based on participants' performance
Aim to identify a normal level on a given construct	Aim to identify the peak level on a given construct

- Self-report measures

From all the self-report measures which assess response impulsivity, the Barratt Impulsiveness Scale (BIS-11) (86) has been the most used. This tool has been found to factor into several domains, including motor, non-planning (related to delay discounting tasks), and inattention (ability to stay focused on daily activities) (86,87). Regarding response impulsivity, the motor subscale measures the tendency to respond without preceding thought, reflecting a concept similar to inhibitory control (82,88,89). Concerns have been raised regarding the lack of a rigorous psychometric evaluation of the tool and inconsistencies in the BIS-11 factor structure across studies, which raise doubts on the three constructs proposed by Barratt (90).

- Behavioral measures

Go/No-go tasks

In Go/No-go tasks, "go" and "no-go" trials are mixed (91). During "go" trials, the individual is required to make a quick behavioral response (e.g., pressing a key when a letter appears on the screen).

During "no-go" trials, the participant suppresses a not-already-triggered response when it is presented with certain cues (e.g., withholding a response when a number appears on the screen) (80).

Both kinds of trials are used to quantify impulsivity through "commission errors" (80). This key dependent measure is reflective of response impulsivity and takes inappropriate motor responses to no-go stimuli into account by representing the capacity to inhibit an inappropriate response. Other dependent measures related to impulsivity include perseveration errors (random, repetitive, or anticipatory responses) and the reaction time on go trials, on which it is thought that impulsivity leads to faster (or rash) responses (81).

The Continuous Performance Test (CPT) is a Go/No-go task with unique attributes that involve the maintenance of focus throughout the duration of a repetitive task. Participants are instructed to respond to target stimuli and to inhibit responses to specific stimuli, which are similar to the target. Responses to incorrect stimuli, or commission errors, index response impulsivity (47).

Stop-Signal tasks

Stop-Signal tasks are similar to Go/No-go tasks, although they require the cancellation of an already cued response. In the middle of "go" trials, there are some "stop cues" after a certain interval called "stop signal delays," where participants have to suppress their already initiated prepotent response (81). Utilizing this task, the stop-signal reaction time (understood as an estimate of the time taken for the individual's brain to stop prepotent behavior) can be determined (80). Participants considered as impulsive tend to make more errors on these tasks or have increased latency in action cancellation (77).

Neurobiology

The OFC, anterior cingulate cortex (ACC), and striatum are the brain regions implicated directly in response impulsivity (77,92). During a Go/No-go task, connectivity between the dorsolateral prefrontal cortex (dlPFC) and gray matter around the bilateral intraparietal sulcus positively modulates mean go-reaction times, whereas connectivity between the mPFC and PCC negatively modulates mean go-reaction times (93). During response inhibition, regions particularly implicated in successfully inhibiting response includes fronto-parietal regions, specifically the bilateral ACC and insula, right OFC, right dlPFC, and right supplementary motor areas (93).

3) Impulsive tendencies/traits

Conceptualization and assessment

Impulsivity is included in every major model of personality, such as the Five-Factor Model, Eysenck's

PEN Model of Personality (psychoticism, extraversion, and neuroticism), and Tellegen's three-factor model (94). The first contains four traits which reflect different pathways to impulsive behavior (impulsiveness, excitement seeking, self-discipline, and deliberation) (95,96). The second is one of the most influential models and considers that impulsive traits are found in the extroversion dimension, and encompass personality characteristics related to sociability, openness and personal interaction (49).

The Cloninger Temperament and Character model, based on two historical components of personality (temperament and character), has also been related to impulsivity (16). According to this model, impulsive behavior is related to four inheritable temperamental traits: high novelty-seeking, reduced harm avoidance, reduced persistence and, rarely, low reward dependence. Among them, novelty seeking would be closely associated with impulsivity, since it refers to the excitement and exploration of new stimuli and signs of reward (49).However, these constructs are theoretically slightly different (temperament is more stable across time and emphasizes motivational tendencies instead of degree of control over these tendencies, as happens with impulsivity traits) (97).

The (negative) Urgency, (lack of) Premeditation, (lack of) Perseverance, and Sensation Seeking (UPPS) Impulsive Behavior Scale- Positive urgency (UPPS-P) framework

The UPPS-P model did not adopt a specific theoretical posture on the nature of impulsivity, but was an attempt to capture diverse etiological "pathways" to impulsivity, taking the Five-Factor Model into account (41,96). These types of impulsive behaviors are associated with different domains of the Five-Factor Model of personality: Conscientiousness (Premeditation and Perseverance), Extraversion (Sensation Seeking), and Neuroticism (Urgency) (94,98).

It was derived through the factor analysis of twenty scales drawn from nine well-validated self-report measures (41). This widely used model proposes five factors of impulsivity (94) that were collected via a questionnaire composed of 59 items, which was subsequently validated in numerous languages, including Spanish (99):

- (Lack of) perseverance:

This factor focuses on an inability to remain focused on a task that may be long, difficult, or boring. High lack of perseverance levels suggests a difficulty working under conditions that require resistance to distracting stimuli and finishing projects (96,99). This impulsivity dimension, like urgency, is not well represented in other measures of impulsivity (50). Lack of perseverance is positively associated with sensitivity to punishment (another impulsivity conceptualization) and, therefore, individuals with higher sensitivity to punishment show a greater tendency to avoid undesired stimuli (99).

- (Lack of) premeditation:

This factor measures difficulty in reflecting on the consequences of a behavior before engaging in it. This definition has been used to conceptualize impulse control problems, and it is related to the choice impulsivity dimension (94). It is also similar to the non-planning impulsivity dimension included in the Barratt model (99,100).

- Positive and negative urgency:

Urgency determines the association between affect and impulsivity, and this dimension is used to describe the difficulty in coping with urges to act in response to negative emotions (94,99). In other words, it refers to the tendency to engage in impulsive behaviors when experiencing negative affect even though the potentially harmful long-term consequences may appear (94). High levels of this dimension are associated with difficulties resisting cravings and temptations (94).

More recently, a fifth factor (positive urgency) was added to the UPPS model and scale, defined as the tendency toward rash action in response to positive moods (96,99).

- Sensation seeking:

This impulsivity facet encompasses two aspects: the tendency to enjoy exciting activities and the openness to trying new experiences that may or may not be risky and dangerous (94,99). It is commonly placed in different personality models, such as the dimension "novelty seeking" included in the Cloninger Temperament and Character model. Sensation seeking has also shown a correlation with sensitivity to reward (another impulsivity conceptualization), with both dimensions being related to the approach behavior associated with the prospect of reward or novel stimuli (99).

Data support the sound psychometric properties of UPPS-P scores, accepting it as a reliable measure in terms of construct validity (101). High scores obtained on the UPPS-P correlate with a wide range of behavioral manifestations of impulsivity (102,103).

The UPPS-P model also highlights the importance of emotional vs. non-emotional (or "cool") ingredients of impulsivity in all behavior varieties (104,105). Sensation seeking and urgency are strongly associated with emotional factors (106). More specifically, both positive and negative urgency depend on inadequate appraisal of emotions preceding the decision-making process; and sensation seeking is linked to the anticipation of reward and a lack of foresight regarding the risks involved. On the other hand, lack of premeditation and lack of perseverance are less dependent on emotions (107).

Neurobiology

Data suggest that gray- and white-matter volumes correlate with self-reported impulsivity scores (77). Trait impulsivity has also been related to alterations during reward processing, with highly impulsive individuals presenting higher sensitivity towards immediate rewards (108). In this line, a positive relationship between trait impulsivity and ventral striatum BOLD signal during reward processing and anticipation in healthy participants has been suggested (109) (see Table 5).

Table 5. Neural mechanisms and bases of each UPPS-P domain

UPPS-P DOMAINS	NEURAL MECHANISMS	NEURAL BASES
(Lack of) perseverance	Resistance to proactive interference (impaired ability to inhibit irrelevant thoughts or memories)	Left lateral prefrontal cortex, left anterior prefrontal cortex
(Lack of) premeditation + urgency	Poor decision-making process and risk taking	Insula, ventromedial prefrontal cortex, amygdala, dorsolateral prefrontal cortex, ventral striatum, supplementary motor area, median orbitofrontal cortex
Urgency	Emotional stimuli interfere with the ability to inhibit prepotent responses	Right inferior frontal gyrus, anterior cingulate, anterior insula, amygdala, orbitofrontal cortex, ventromedial prefrontal cortex
Sensation seeking	Reward drive/sensitivity (associated with motivational system)	Prefrontal cortex, basal ganglia, insula, posterior medial orbitofrontal cortex

Adapted from Rochat et al. (110).

1.2.1.2. COMPULSIVITY

Conceptualization

Compulsivity is less understood than impulsivity (79) (see Table 5). The study of compulsivity is of some interest to different fields, albeit it is mainly of interest to psychiatry, since it is related to over a dozen clinical conditions (111). Clarity on how to measure compulsivity is essential for guaranteeing adequate communication between clinicians and researchers. However, this construct is still too

ambiguous, and there are differences in conceptualization depending on the disorder (111). Therefore, there is not a clear definition of this construct; some doubts have arisen around its categorization (112):

- The existence of different kinds of compulsivity, and whether it is correct to label them with a single term

- The core components of compulsivity

Currently, in an attempt to combat such doubts and the heterogeneity of definitions, some authors have framed compulsivity as an endophenotype characterized by "the performance of repetitive and functionally impairing overt or covert behavior without adaptive function, performed in a habitual or stereotyped fashion, either according to rigid rules or as a means of avoiding perceived negative consequences" (6,12,92,113). The experience of compulsivity usually generates shame, guilt, lack of self-confidence, and anxiety (112).

The individual "has to" perform that particular thought or behavior, with compulsivity driving the urge to carry out an act or, conversely, the impossibility of stopping or not carrying out a particular thought or behavior (112). Compulsivity represents, therefore, the result of an internal struggle associated with the lack of control over one's own behavior (112).

More specifically, some deficits associated with cognitive inflexibility have been found in compulsivity (79,92):

- **Failures in contingency-related cognitive flexibility, also understood as reversal learning:** the ability to modify a behavior after receiving negative feedback. It involves, therefore, learning a rule and the consequent adaptation of the behavior, using trial-by-trial feedback, after rule changes.

- **Failures in task/attentional set-shifting, also labeled as extra-dimensional attentional set-shifting:** it is understood as the ability to frequently switch attention between a set of stimuli. It comprises visual discrimination and attentional maintenance and shifting.

- **Attentional bias/disengagement:** defined as impaired shifting of attentional resources away from disorder-relevant stimuli. It is, therefore, the failure to inhibit a prepotent response, in other words, the inability to respond to certain environmental stimuli while others are ignored.

- **Failures in habit learning:** it refers to the lack of foresight to the outcomes of actions. It explains, therefore, the impairment in the tendency of actions to become automatic and insensitive to the outcome when they are frequently repeated.

Assessment

- Self-report measures

Psychometrical tools or behavioral tasks for assessing compulsivity are almost non-existent, and those available are disorder-specific, usually based on classic OCD conceptualizations and therefore not completely appropriate for conceptualizations understanding compulsivity as a transdiagnostic construct (111).

Some of the current questionnaires used to assess compulsivity are the Padua Inventory (PI) (114) and the Yale-Brown Obsessive-Compulsive Scale (YBOCS) (6), both measuring OCD symptomatology. From them, some adaptations have been proposed, such as the Padua Inventory-Washington State University Revision (PI-WSUR) (115), an adaptation of the PI, and the Obsessive Compulsive Drug Use Scale (OCDUS) (116), created from the YBOCS (6) (see Table 6).

Table 6. Main characteristics of the different compulsivity self-report measures.

	PI	**PI-WSUR**	**YBOCS**	**OCDUS**
Frequency of thoughts associated with obsession	X	X	X	X
Level of anxiety due to these thoughts	X	X	X	X
Frequency of urges to perform behavior	X	X		X
Distress over being unable to perform urge				X
Time spent resisting these thoughts/behaviors			X	X
Time spent performing compulsive behaviors	X	X	X	
Life interference due to thoughts/behaviors			X	X
Control over thoughts/behavior			X	X

Adapted from Robbins et al. (6). Note. PI: the Padua Inventory; PI-WSUR: the Padua Inventory-Washington State University Revision; YBOCS: the Yale-Brown Obsessive-Compulsive Scale; OCDUS: the Obsessive Compulsive Drug Use Scale.

Due to the lack of transdiagnostic psychometric tools that do not focus only on a specific disorder, mainly OCD, some authors have used a measure of temperament from the Temperament and Character Inventory-Revised (TCI-R) (117) to measure compulsivity: Harm Avoidance 2 – Fear of Uncertainty vs. Confidence (118,119). In this line, the Cambridge-Chicago Compulsivity Trait Scale (CHI-T) has recently been developed to deal with these limitations (120). However, more empirical efforts are needed to optimize self-report instruments for assessing compulsivity.

- Behavioral measures

Different laboratory tasks have been proposed to assess the compulsivity domains (see Table 7).

Table 7. Behavioral assessment of the different neurocognitive domains of compulsivity

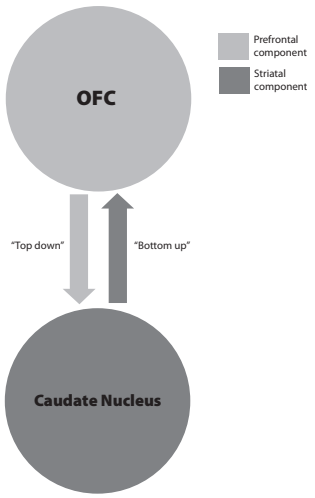
NEUROCOGNITIVE DOMAIN	BEHAVIORAL MEASURES
Contingency-related cognitive flexibility	Probabilistic Reversal Learning Task (121) Card Playing Task (122) Deterministic Reversal Learning Task (123) Contingency Learning Task (124)
Task/attentional set-shifting	Wisconsin Card Sorting Task (WCST) (125) Intra-Extra Dimensional Set Shift (126) Switch Task (127)
Attentional bias/disengagement	Stroop Task (128) Trail Making Test (part B) (129)
Habit learning	Fabulous Fruit Game (130) Two Step Task (131)

Adapted from van Timmeren et al (132).

Neurobiology

Regarding the compulsive brain circuit, compulsive behaviors are driven by a striatal component (caudate nucleus), while a prefrontal component (OFC) may apply inhibitory control over them (79). Specifically, the dlPFC, the lateral OFC, and the caudate nucleus are related to reversal learning. The supplementary motor area, the premotor cortex, and the putamen are associated with the habit learning process (133) (see Figure 3).

Figure 3. Neurocircuitry of compulsivity



Adapted from Godier & Park (134)

Table 8. Summary of main clinical features of impulsivity and compulsivity

	CHOICE IMPULSIVITY	RESPONSE IMPULSIVITY	IMPULSIVE TENDENCIES	COMPULSIVITY
CONCEPTUALIZATION	Difficulty in delaying gratification	Capacity to inhibit a prepotent motor response	UPPS-P theoretical model: positive urgency, negative urgency, lack of premeditation, lack of perseverance, sensation seeking	Repetitive and functionally impairing overt or covert behavior
ASSESSMENT	Delay discounting paradigms, such as: - EDT - Delay discounting task from Kirby	Self-report measures, e.g.: BIS-11 Behavioral measures, e.g.: Go/No-go tasks Stop signal tasks	UPPS-P questionnaire	Self-report measures, e.g.: - PI - YBOCS Behavioral measures, e.g.: - WCST

Note. EDT: the Experiential Discounting Task; BIS-11: the Barratt Impulsiveness Scale; PI: the Padua Inventory; YBOCS: the Yale-Brown Obsessive-Compulsive Scale; WCST: Wisconsin Card Sorting Test.

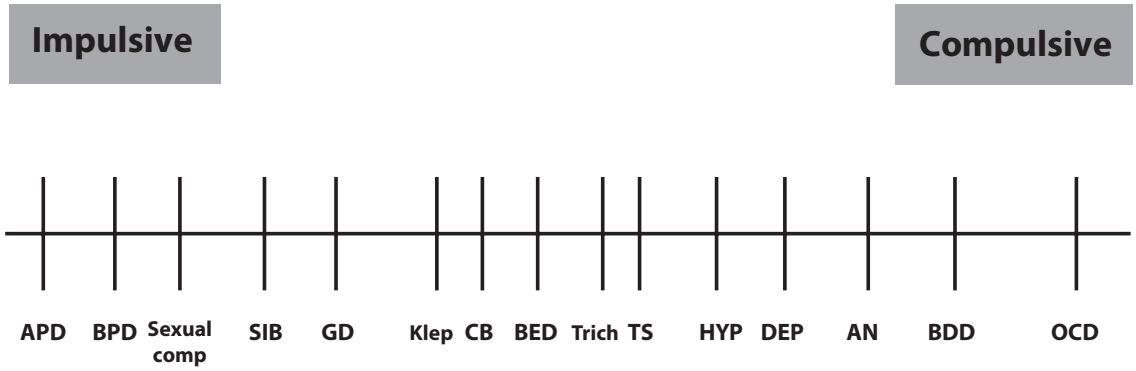
1.2.1.3. IMPULSIVITY, COMPULSIVITY, AND MENTAL DISORDERS

On phenotypic grounds, certain mental disorders present impulsive and compulsive behaviors (79). As broad constructs, both have been understood from three theoretical perspectives (12):

Impulsive-compulsive continuum

Disorders such as OCD, BDD, and anorexia nervosa (AN) are placed on the compulsive extreme. In all three disorders, individuals use compulsive behaviors as a strategy to reduce anxiety or a perceived threat. On the other extreme, the impulsive pole, one could find mental disorders such as gambling disorder (GD), compulsive buying, and binge eating disorder (BED). Here, individuals are characterized by prioritizing gratification, immediate or short-term pleasure activation, and underestimating the negative consequences of their conduct (135) (see Figure 4).

Figure 4. Impulsive-compulsive continuum

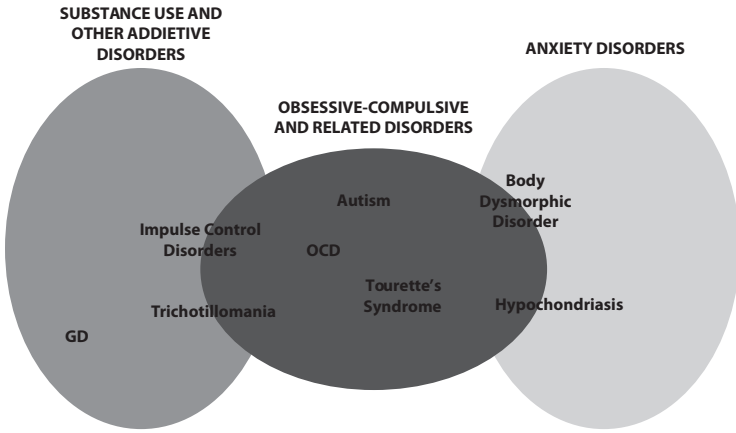


Adapted from Hollander & Rosen (21). Note. APD: antisocial personality disorder; BPD: borderline personality disorder; Sexual comp: sexual compulsions; SIB: self-injurious behavior; GD: gambling disorder; Klep: kleptomania; CB: compulsive buying; BED: binge eating disorder; Trich: trichotillomania; TS: Tourette's syndrome; HYP: hypochondriasis; DEP: depersonalization disorder; AN: anorexia nervosa; BDD: body dysmorphic disorder; OCD: obsessive-compulsive disorder.

Impulsive-compulsive spectrum

Impulsivity and compulsivity can be understood as individual symptom domains; they can co-occur in the same person and, thus, they must be understood together in terms of severity (12,136). Therefore, a spectrum model was proposed to group mental disorders into three main categories—anxiety disorders, SUDs, and behavioral addictions— with OCRD in the middle acting as a bridge. Some conditions can be considered anxiety-like, while others are closer to SUDs (12) (see Figure 5).

Figure 5. Impulsive-compulsive spectrum

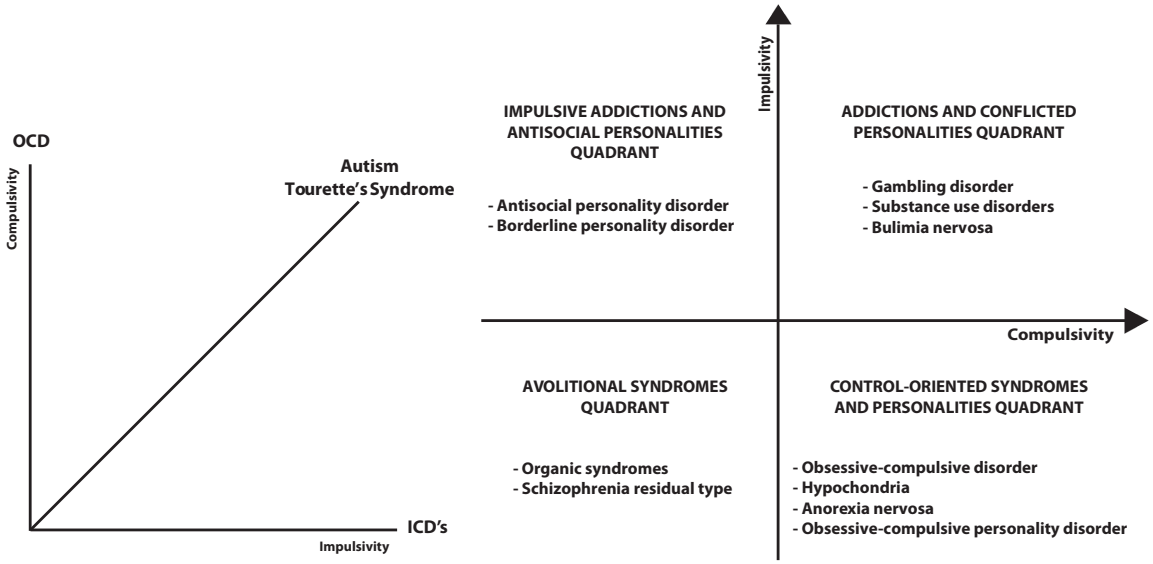


Adapted from Berlin & Hollander (12). Note. GD: gambling disorder; OCD: obsessive-compulsive disorder.

Compulsivity and impulsivity as orthogonal dimensions

A theoretical current suggests common neurobiological processes between both compulsivity and impulsivity, such as a lack of top-down executive control (or "disinhibition"), throwing into question the validity of the continuum and other theoretical models (137). Consequently, some authors suggested splitting the continuum into two orthogonal dimensions, which would comprise three psychopathological domains: one with impulsive predominance (including disorders such as borderline personality disorder), another with compulsive predominance (including OCD, AN, and hypochondria), and the last with impulsive-compulsive predominance (including GD and bulimia nervosa [BN]) (118) (see Figure 6).

Figure 6. Impulsivity and compulsivity as orthogonal dimensions



Adapted from Berlin & Hollander (12) and from Tavares & Gentil. (118) Note. OCD: obsessive-compulsive disorder; ICD: impulse control disorders.

Although this theoretical proposal has received wide acceptance, some studies highlight that impulsivity and compulsivity may not be totally orthogonal and that a more complex relationship between both components might exist (119). Therefore, a systematic understanding of how impulsivity and compulsivity constructs contribute to each mental disorder is still lacking.

Mental disorders with both impulsive and compulsive features: a focus on eating disorders (EDs) and GD

At first glance, EDs and GD may seem very disparate, mainly because GD is more prevalent in

men, while EDs are more prevalent in women (11). However, both mental disorders share numerous clinical features:

It has been proposed that both mental disorders lie on the impulsive-compulsive spectrum (138,139):

- Regarding impulsivity, EDs (mainly those related to binge eating episodes) and GD involve impulsive personality characteristics (45,140,141) and a recurrent failure of impulse control, particularly with reference to eating and gambling behaviors (142). Data in this line have reported evidence of transdiagnostic and disorder-specific predictors for both disorders, with negative urgency being a common predictor of BED and GD (143). These findings coincide with earlier studies which suggested that individuals with both disorders exhibit similar patterns of affective illness, reporting eating or gambling behaviors for similar reasons, such as a way to relieve depression, anxiety, or boredom (144–146).

- With respect to compulsivity, EDs and GD involve similar compulsive repetitive actions (e.g., gambling and bingeing and purging) (138,147).

- Concerning the impulsive to compulsive shift, similarities between the addiction model and EDs such as AN have been stressed. Both tend to show a primary stage of reward seeking (e.g., weight loss in AN), which is experienced as pleasurable and egosyntonic (positive reinforcement) (148–150). This phase is usually succeeded by a narrowing of the behavioral repertoire and the inability to cease behaviors, which become progressively compulsive and egodystonic, despite their negative consequences (negative reinforcement) (134,151,152).

In addition to the similarities in impulsivity and compulsivity between these disorders, another relevant similarity between both is comorbidity with other disorders. EDs and GD share many features with SUDs and mood disorders (139,153), and high rates of SUDs have been observed in patients with EDs (from 22% to 50%) (154,155) and GD (57.5%) (156). In this regard, patients with comorbidity between GD and EDs have shown a worse clinical profile, with lower self-esteem (157) and higher scores in novelty seeking (158).

Finally, both disorders have been hypothesized to share neurological pathways (140) as well, although the two phenotypically different behavioral patterns have been shown to be dissociable as a function of brain opioid and dopamine neurotransmission (153).

1.3. EATING DISORDERS

1.3.1. FROM A CATEGORICAL AND HYBRID FRAMEWORK: DSM DIAGNOSTIC CRITERIA

The DSM-5 (11) included a section on EDs, labeled as "Feeding and Eating Disorders," encompassing (159,160):

- **AN:** it is mainly characterized by a low body weight due to a persistent restriction of food intake, a fear of gaining weight, and a body image distortion. Two subtypes of AN have been proposed: AN-restrictive (AN-R) subtype and AN-binge/purge subtype (AN-BP).

- **BN:** it is characterized by recurrent episodes of binge eating, understood as the consumption, in a discrete period of time, of an objectively large amount food with a sense of loss of control during the episode. These episodes are accompanied by extreme, inappropriate weight-control behaviors (such as self-induced vomiting, excessive exercise, misuse of laxatives or diuretics, or extreme dietary restriction).

- **BED:** it is characterized by regular episodes of binge eating, although without the presence of compensatory weight-control behaviors. These clinical features would explain why individuals with BED tend to be overweight, in contrast to individuals with BN, who tend to be in a normal weight range.

- **Other Specified Feeding or Eating Disorders (OSFED):** includes atypical anorexia nervosa, low frequency/ limited duration bulimia nervosa, and purging disorder.

- **Unspecified Feeding or Eating Disorders (UFED):** category used when the criteria for a specific ED are not met.

Although AN may be the most well-known ED, bulimic-type EDs, including mainly BN and BED, occur among individuals of normal or above average body weight and are more common and prevalent (159).

1.3.2. FROM A DIMENSIONAL FRAMEWORK

Certain ED symptoms have been viewed as compulsive, driven, and compelled (e.g., restriction behavior, self-induced vomiting, and over-exercise), while others have been described as more impulsive (e.g., binge eating behavior) and commonly associated with bulimic-spectrum disorders, namelly AN-BP, BN, and BED (161,162). Although data on EDs support the relevance of both constructs, the degree to which they are linked with ED symptomatology remains unclear (163).

1.3.2.1. EDS AND IMPULSIVITY

Data suggest that EDs are associated with impulsivity, especially those in which bingeing features are present. Impulsivity may underlie the commonly reported feelings of loss of control that are

characteristic of binge-eating episodes (45,141,164,165). Higher impulsivity in individuals with an ED diagnosis has been associated with ED severity (141,166), higher levels of psychopathology, and poor treatment outcome (141,167) as well.

EDs and choice impulsivity

Regarding choice impulsivity, those EDs characterized by greater impulsivity levels, namely BN and BED, show a higher preference for immediate monetary (168,169) or food rewards (170). This inability to resist the temptation of immediate rewards (i.e., unhealthy and palatable foods) may be an unfavorable influence on adherence to the common dietary guidelines included in BED treatment programs (171). Conversely, individuals with AN are characterized by being overly cautious (with an unusually elevated level of self-control) and by focusing on delayed gratification and long term goals more than is expected (172–174). Therefore, the behavioral habit of not discounting rewards has been understood to be a potential maintenance factor for AN (175). Starvation in AN may be a positive reinforcer and produce an immediately rewarding sense of control (176), and the long-term goal of weight loss may become irrationally overvalued in this ED, even with the associated adverse consequences (134,177,178).

EDs and response impulsivity

Concerning motor impulsivity, EDs are related to difficulties in response inhibition, especially binge groups, showing more commission errors and faster reaction times in Go/No-go tasks (141,179,180).

EDs and impulsive tendencies/traits

Taking impulsive tendencies/traits into account, in the case of EDs, an interaction between negative urgency, lack of premeditation, and bingeing and purging behaviors has been recognized (181,182). Significant differences have been found among the ED diagnostic subtypes with respect to all personality traits of the UPPS-P model (141,183), with negative urgency and sensation seeking being the dimensions most related to bulimic symptomatology (141,184). Other findings in this line have highlighted that patients with ED binge-eating/purging showed a significantly higher lack of premeditation and lack of perseverance levels compared to HC and restrictive ED patients (185).

All these results suggest that the different EDs may be distinguished by the presence or absence of impulsive features and that restricting and bingeing behaviors may be understood as opposite poles of an impulsive behaviors spectrum (141).

Two probable models have been proposed to elucidate the association between EDs and impulsivity (141):

- The first model posits impulsivity as a predisposing causal factor in the development of an ED, specifically those with bingeing/purging behaviors.

- The second model suggests that impulsivity may be a moderator that influences the expression of ED symptomatology and that different biological, psychological, and social factors lead to the development of each ED.

1.3.2.2. EDS AND COMPULSIVITY

The theoretical model referring to the compulsive-impulsive spectrum considered AN as one of the disorders with the most compulsive characteristics (21,118). AN is characterized by persistent, intrusive thoughts regarding food and weight gain that can lead to the development of compulsive, ritualized behaviors with the aim of reducing or eliminating the anxiety associated with these thoughts (186). Such thoughts lead to extreme control of eating and dietariy restriction, which tend to take on a driven and compulsive nature (178,187,188). Moreover, compulsive over-exercising is another clinical feature common in this ED, and it is more prevalent in restrictive AN (80%), in comparison to the binge/purging subtype (43%) (189,190). In those individuals who cannot sustain this eating and extreme weight control, AN can be complicated by the development of binge eating and compensatory purging behaviors, which also appear to have an element of compulsivity (134). On the other hand, individuals with an AN diagnosis have shown cognitive inflexibility (191–196), namely a rigid cognitive style closely associated with compulsivity (79).

1.3.3. OTHER RISK FACTORS

From a biopsychosocial model perspective, in addition to impulsivity and compulsivity, three types of risk factors have been suggested:

1.3.3.1. BIOLOGICAL FACTORS

It has been suggested that eating behaviors and disorders characterized by under-eating and overeating are associated with brain reward systems (197) and abnormalities in the neuropeptide and hormone system (198,199). In particular, palatable foods activate reward systems (200–202). Some brain regions are active in representing reward in response to food stimuli, such as the insula, striatum, anterior cingulate cortex, and midbrain regions (203,204). Dopamine has been described as being involved in the reward response to consumption of certain kinds of food as well (205,206). Moreover, EDs are strongly familial, and interest in heritability, molecular genetic factors and epigenetic mechanisms has increased in recent years (207, 208).

1.3.3.2. PSYCHOLOGICAL FACTORS

EDs are also associated with psychological etiopathogenic factors, such as emotional dysregulation (145,209), dysfunctional cognitive processes (e.g., attention biases, impaired decision making, or lack of inhibitory control) (210,211), and dysfunctional personality traits (such as high harm avoidance and perfectionism levels) (158,212).

In patients with EDs, the most usual comorbidities are mood disorders, anxiety disorders, and SUDs (213–215).

1.3.3.3. SOCIAL FACTORS

Family and peer environment have been the two social factors most emphasized in the ED field. Both have a powerful influence in the development of dieting behavior and body-dissatisfaction (215,216). Negative social comparison and social and parental pressure are some of the environmental risk and maintaining factors identified among EDs (217-219).

1.4. GAMBLING DISORDER

1.4.1. FROM A CATEGORICAL AND HYBRID FRAMEWORK: DSM DIAGNOSTIC CRITERIA

GD is a behavioral addiction characterized by a maladaptive pattern of gambling behavior that persists despite negative consequences in different contexts of life functioning. Having an accurate GD diagnosis is essential for detecting a precise prevalence of the disorder in the general population for a proper management of public health efforts and for an effective clinical practice, especially in terms of clinical assessment and treatment outcome (220).

Pursuing these objectives, the DSM-III (221) was the first version to consider GD, conceptualized then as pathological gambling (PG), as a mental disorder. For the preparation of the DSM-IV (222), there was still not much empirical evidence about the disorder, which explains why it does not contain an exhaustive list of symptoms, although the symptoms listed are sufficient to provide a clinical diagnosis (223).

The latest version, the DSM-5 (11), includes the following changes:

A) Changes in labeling

The name of the condition was modified to GD, as some considered the term PG to be stigmatizing and pejorative (11,224).

B) Specifying that symptoms occur within a 12-month time period

The new DSM version (11) includes a temporal reference.

C) Reclassifying from impulse control disorders to substance-related and addictive disorders

PG was classified in the DSM-IV-TR (225) as an Impulse Control Disorder (ICD) Not Elsewhere Classified. Repeated engagement in impulsive behaviors and a diminished ability to inhibit these behaviors despite negative consequences are the main features of these disorders (225,226). However, besides the fact that high co-occurrence rates between GD and substance addictions have been observed (227), it was recognized that gambling behaviors resemble some components of alcohol and drug dependence, such as (228,229):

- Continuously engaging in a behavior despite negative consequences
- Reduced self-control over engaging in the behavior
- Compulsive engagement in the behavior
- Appetitive urges or cravings prior to engagement in the behavior

In addition to these core components, GD shares comorbidities, antecedent factors, and neurobiological mechanisms (mainly reward processing) with the other addictions (230,231). Because of all these clinical similarities, GD was classified as a substance-related disorder in the DSM-5 (11).

D) Including three levels of severity

Numerous indicators have been proposed as a potential measure of GD severity, such as money lost to gambling as a percentage of earnings, impairment, or comorbidity (232,233). However, the DSM-5 (11) proposed a summation of the diagnostic criteria for this disorder:

- Mild: 4 to 5 criteria
- Moderate: 6 to 7 criteria
- Severe: 8 to 9 criteria

This decision led to a controversy that has not yet been resolved. Certain groups have refused to approve of this summation of the criteria, since they consider not all the criteria to have the same contribution to the severity of this disorder and therefore should not all be weighted equally (233,234). While criteria such as chasing losses or being preoccupied with gambling have been less associated with GD severity, jeopardizing important matters, experiencing withdrawal, and needing financial assistance have been understood as more severe criteria (234). However, only some studies in this line have examined the clinical utility of the inclusion of a GD severity measure, finding differences between cases of mild severity and moderate and severe severity (233) and suggesting that gamblers are not a homogenous group (235), as already postulated in multiple previous studies

(236,237). Moreover, to date, few studies have investigated the association between severity and treatment outcome, despite the notable implications that these results could have in clinical practice. In this vein, it has been suggested that the improvement from severe to moderate GD regarding DSM-5 criteria may not always match with changes in gambling behavior severity in the reality of clinical practice (233).

E) Elimination of the illegal acts criterion

A functional, complex association between GD and gambling-related criminal behaviors, usually non-violent and income-producing offences, has been demonstrated (238). The desire to obtain funds, both to gamble and to relieve financial hardships, has been reported to directly motivate a proportion of crimes (239). Moreover, some risk factors, such as the co-occurrence of substance abuse (240), GD severity (241,242), sociodemographic features, (239,240), and personality features (242,243) have been highlighted.

Consequently, from the DSM-III (221) to the DSM-IV-TR (225), a criterion valuing the commission of illegal acts in order to support gambling behavior was included. Specifically, it was raised in the following way: "Has committed illegal acts such as forgery, fraud, theft or embezzlement to finance gambling" (225). However, after much debate in the scientific community, this criterion was finally removed from the GD diagnostic set in the latest version of the DSM (11), in parallel with the elimination of an analogous criterion in the alcohol and drug use disorders diagnostic sets (244). Many researchers and clinicians highlighted its minimal contribution to diagnostic accuracy, since few gamblers endorsed that item (244,245). It was, therefore, considered as an indicator of disorder severity instead of as an independent diagnostic criterion (246,247). Relatedly, it has been argued that GD-related criminal behaviors seldom take place in the absence of other GD criteria (248). The removal of this criterion has not had a great impact on diagnosis since most individuals who met this criterion also reached the DSM-5 threshold for GD diagnosis (220,245,249).

This change has been received with skepticism from some professionals who consider the illegal acts criterion to be essential for clinical diagnosis (250). They highlight that the underreporting of criminal behaviors in a clinical assessment, probably related to the social desirability bias, may partially explain the low prevalence rates of this criterion, which was one of the motives for eliminating this criterion in the DSM-5 (244). Moreover, they foreground the higher frequencies of gamblers who report illegal acts among gambling subpopulations (i.e., clinical samples or offenders), with criminal behaviors related to GD reflecting the desperation related to this disorder (245). Since gamblers who commit illegal acts present a heterogeneous profile another complaint is the loss of clinical heterogeneity in GD with its removal (251). Finally, this group emphasizes, therefore, the need to continue evaluating this aspect in clinical practice because it may have utility as an indicator of severity and for treatment recommendations (252). However, this criterion requires clarification during the diagnostic process in order to determine whether an act, such as writing a bad check, has to be considered an illegal act

(244).

F) Reducing the threshold for diagnosis from five criteria to four criteria

With the diagnostic threshold proposed by the DSM-IV (222), numerous false negatives were detected just below the standard threshold of five criteria (220,253). Therefore, in the latest version of the DSM (11), the diagnostic threshold was reduced from five to four criteria in order to obtain a more accurate diagnostic process. With this modification, numerous criticisms arose regarding this modification, as it created a consequent diagnostic inflation that would increase the prevalence of people diagnosed with GD (254,255). The GD prevalence described so far in psychiatric populations ranged from 3% to 12% (256,257) and up to 39% in cases of comorbidity with SUDs (258,259). Data highlighted a slight improvement in diagnostic accuracy (220), coupled with a modest increase in prevalence rates (247), which would allow diagnosis and treatment of more individuals with some degree of problematic gambling behaviors (244).

With these modifications, the final criteria mainly encompass: repeated, unsuccessful attempts to stop gambling behavior; irritability when attempting to resist it; and tolerance and escalation over time, in frequency or "amount." These criteria have been classified into three clusters (260) (see Table 9):

- Loss of control
- Craving/withdrawal
- Neglect of other areas in life

Table 9. DSM-5 diagnostic criteria for GD, grouped in symptom clusters

A. Persistent and recurrent problematic gambling behavior leading to clinically significant impairment or distress, as indicated by the individual exhibiting four (or more) of the following in a 12-month period:	
1. Needs to gamble with increasing amounts of money in order to achieve the desired excitement	Loss of control (tolerance development)
2. Is restless or irritable when attempting to cut down or stop gambling	Craving/withdrawal
3. Has made repeated unsuccessful efforts to control, cut back, or stop gambling	Loss of control
4. Is often preoccupied with gambling (e.g., having persistent thoughts of reliving past gambling experiences, handicapping or planning the next venture, thinking of ways to get money with which to gamble)	Neglect of other areas in life
5. Often gambles when feeling distressed (e.g., helpless, guilty, anxious, depressed)	Craving/withdrawal
6. After losing money gambling, often returns another day to get even ("chasing" one's losses)	Neglect of other areas in life

7. Lies to conceal the extent of involvement with gambling	Neglect of other areas in life
8. Has jeopardized or lost a significant relationship, job, or educational or career opportunity because of gambling	Neglect of other areas in life
9. Relies on others to provide money to relieve desperate financial situations caused by gambling	Neglect of other areas in life
B. The gambling is not better explained by a maniac episode.	

Adapted from Romanczuk-Seiferth et al. (260).

1.4.1.1. OTHER GD ASSESSMENTS

Several screening tools are available to monitor GD in different development stages, and they are usually based on the DSM criteria, such as the Problem Gambling Severity Index (PGSI) (261), the South Oaks Gambling Screen (SOGS) (262), the South Oaks Gambling Screen-Revised for Adolescents (SOGS-RA) (263), the Massachusetts Gambling Screen (MAGS) (264), the modified Addiction Severity Index (mASI), the Gambling Functional Assessment-Revised (GFA-R) (265), the Berlin Inventory of Gambling behavior-Screening (BIG-S) (266), the Gambling Addictive Behavior Scale for Adolescents (GABSA) (267), or the Canadian Adolescent Gambling Inventory (CAGI) (268). Despite the wide range of screening options, the South Oaks Gambling Screen (SOGS) has become the dominant instrument for measuring GD in both research and clinical settings due to, among other things, its convenience and efficiency (269).

1.4.2. FROM A DIMENSIONAL FRAMEWORK

Since GD comprises features of both impulsivity and compulsivity, the impulsive-compulsive spectrum framework offers an appropriate theoretical background for its characteristic phenomenology (270,271). These characteristics may occur at the same time or at different time points within the same individual (272,273).

1.4.2.1. GD AND IMPULSIVITY

Even though GD diagnostic criteria do not take impulsivity into account, it is one of the strongest etiological contributors to the disorder (274–276).

GD and choice impulsivity

Gambling is itself a risk-taking activity because it involves choices with a smaller probability of winning (277). Gambling implies the risk of losing something of value (usually money) with the hope of gaining something with a greater financial value (278). However, the way to evaluate the associated risk varies across people (278). In the case of individuals with GD, they usually show

several cognitive factors, such as illusion of control, the gambler's fallacy, the failure to understand mutual independence of chance events, or superstitions while gambling (279). For this reason, individuals with GD, after a sequence of losing bets, usually continue betting, irrationally expecting gains to follow losses (280). These cognitive tendencies have important implications in the ability of this clinical population to make decisions (279,281).

Regarding delay discounting tasks, decision options differ in the absolute amounts, delays, probabilities, and reward features (if they are real or hypothetical), hindering the comparability of studies (282). Despite these limitations in evaluation, impulsive choice has been found to be associated with GD in a large part of the studies in this field (282–284). It has been found in both adults (282) and adolescents (278,285). Specifically, cognitive disturbances related to risk-reward decision making have been reported (228,286), and individuals with GD show a tendency to discount rewards more steeply than non-problem gamblers (287–290).

Therefore, some inconsistencies have been found between studies (291). While some studies suggest that choice impulsivity cannot discriminate between problematic gambling and GD (292,293), others highlight that GD severity and age may be the best statistical predictors of individual differences in delay discounting rates (294,295). Further, some theoretically-related constructs (e.g., learning to make advantageous choices during a risk/reward decision-making task) have found GD to be associated with disadvantageous decision making, whereas others have not (296).

GD and response impulsivity

GD has been found to be related to high levels of response impulsivity (275), with GD subjects demonstrating significant differences in response impulsivity in comparison to healthy controls (HCs) (297), including within treatment-seeking samples (298). However, the association between this impulsivity dimension and GD severity has not been studied in depth (81), although some studies suggest a relationship between both (292,299).

GD and impulsive tendencies/traits

Some studies have also reported an association between impulsive tendencies/traits and GD (300-302). Specifically, positive and negative urgency levels and a higher lack of perseverance are the features that best distinguish between patients with GD and HCs (303,304). Moreover, lack of premeditation has been found to be positively related, in most cases, with poor decision making, a relevant feature in patients with GD (305,306).

Impulsivity has been associated with the severity of the gambling behavior (307,308). Specifically, data highlight the link between urgency levels and GD severity (309–311) because this trait makes it possible to differentiate more effectively between individuals with GD and HCs (300,312). Urgency may be relevant in GD due to, among other things, its relationship with affective and executive

mechanisms, (300,313–315), two essential components in this disorder.

1.4.2.2. GD AND COMPULSIVITY

Phenomenological models in the GD field have proposed a changing nature of GD, highlighting a motivational shift from impulsivity (gambling behavior carried out to obtain immediate reinforcement) to compulsivity (gambling behavior induced by aversive and stressful stimuli) as the course of the disorder advances (132,270,316,317). Therefore, it has been suggested that compulsivity plays a crucial role in understanding the pathology of GD (132,318). Notwithstanding, data concerning compulsivity in GD are scarce, contrary to what occurs in impulsivity. This could be due, among other things, to the multifaceted nature of this construct and the lack of questionnaires to assess it (132).

The few existing studies in this field suggest that GD is related to performance deficits in a broad range of compulsivity-related neuropsychological functions (132) (see Table 10). More specifically, there is a growing body of literature that recognizes gambling behavior as being related to clinical alterations in cognitive flexibility, performance on inhibition, working memory, time estimation, decision making, and planning tasks (136,319). In this line, some of the clinical features of GD are analogous to those of OCD (320). More specifically, the persistent and repetitive thoughts about gambling are similar to the intrusive thoughts characteristic of OCD, being perceived as egodystonic. Moreover, the behaviors of both disorders, gambling and compulsions, may be understood in some cases as maladaptative strategies to cope with negative affect. Finally, similar to OCD, ritualistic behaviors are presented by many individuals with GD, such as prayers or the need of "lucky" numbers or superstitious objects to favorably influence an outcome (321).

Table 10. Synthesis of the most relevant findings in compulsivity and GD

FACETS OF COMPULSIVITY	FINDINGS
Contingency-related cognitive flexibility	The results concerning this facet of compulsivity are contradictory. While some studies have found an evident perseverative tendency in individuals with GD (322,323), others are unable to find significant differences with HCs (324,325).
Task attentional set-shifting	Studies of individuals with GD using the WCST reported significantly worse performance (compared to HCs) on at least one test parameter (236,326,327).

Attentional bias/disengagement	Results about this compulsivity dimension seem to be disparate as well. While some researches highlight worse performance in individuals with GD (using Stroop or TMT) (328,329), others do not observe differences with HCs (330,331).
Habit learning	Although habit learning is hypothesized to have a relevant role in the transition from goal-directed to compulsive behavior, there is a lack of data assessing this compulsivity dimension in GD (132).

Information obtained from van Timmeren et al. (123).

Some studies have also identified several significant positive correlations between the number of errors that an individual with GD makes in tasks assessing compulsivity and distinct measures of gambling severity, such as the number of DSM-5 criteria, gambling frequency, gambling urge/behavior severity, and the amount of money lost in the past year (332). These errors on behavioral tasks also have shown a positive correlation with self-reported measures, specifically the total PI score, suggesting that some cognitive flexibility aspects may be related to certain facets of compulsivity (332).

A general tendency of individuals with GD to show compulsive behaviors that are not directly related to the gambling behavior itself has been suggested (132). The different performance deficits identified in this clinical population may be associated with both (132):

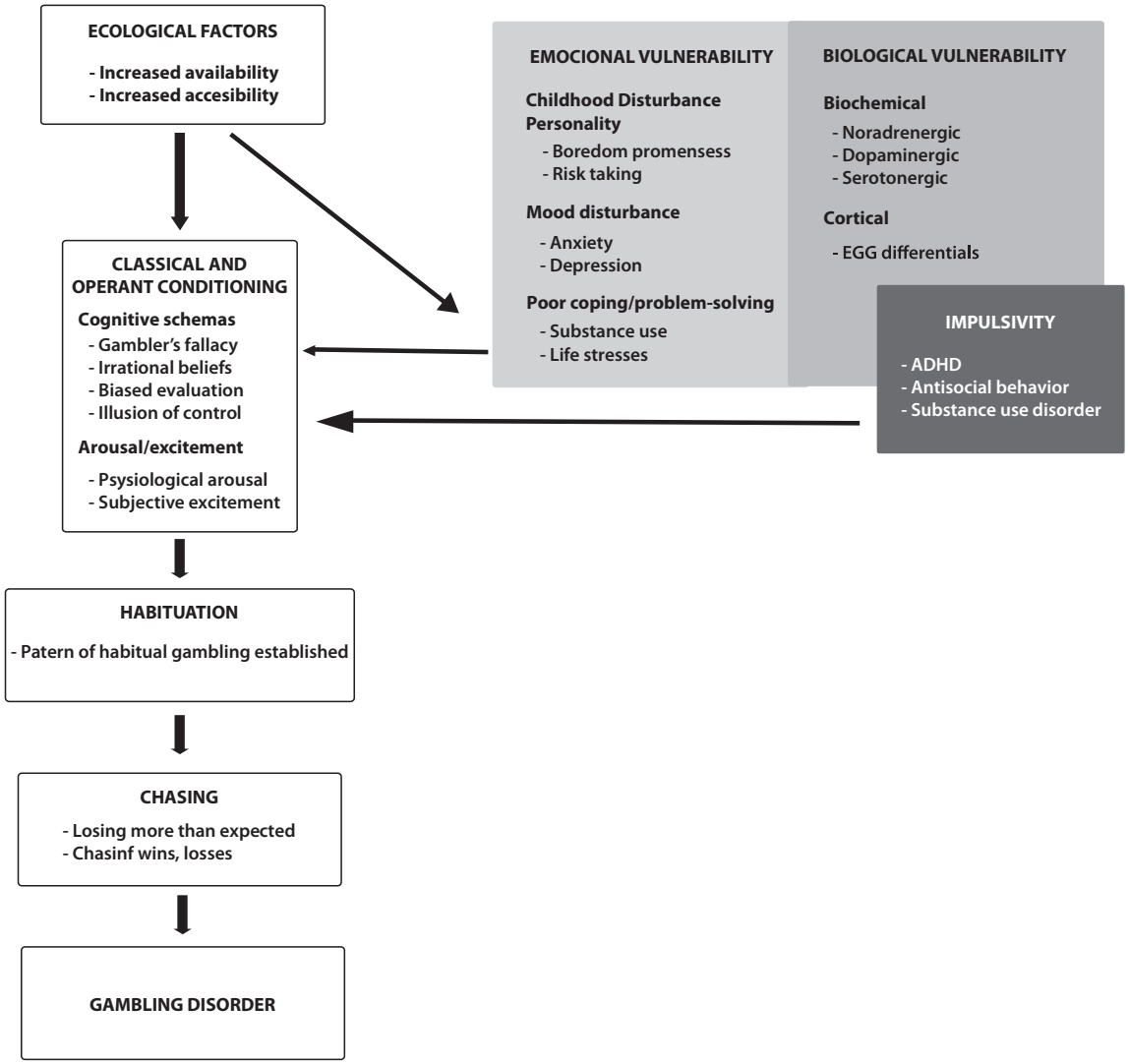
- **The development of the disorder symptomatology:** for instance, the tendency to perseverate on a behavior when it has been learned, or the general inability to switch attention in a flexible way, may increase the risk for developing compulsive gambling behavior.

- **GD maintenance:** these performance deficits may be a consequence of disordered gambling behavior and increase the difficulties in quitting this maladaptative behavior.

1.4.3. OTHER RISK FACTORS

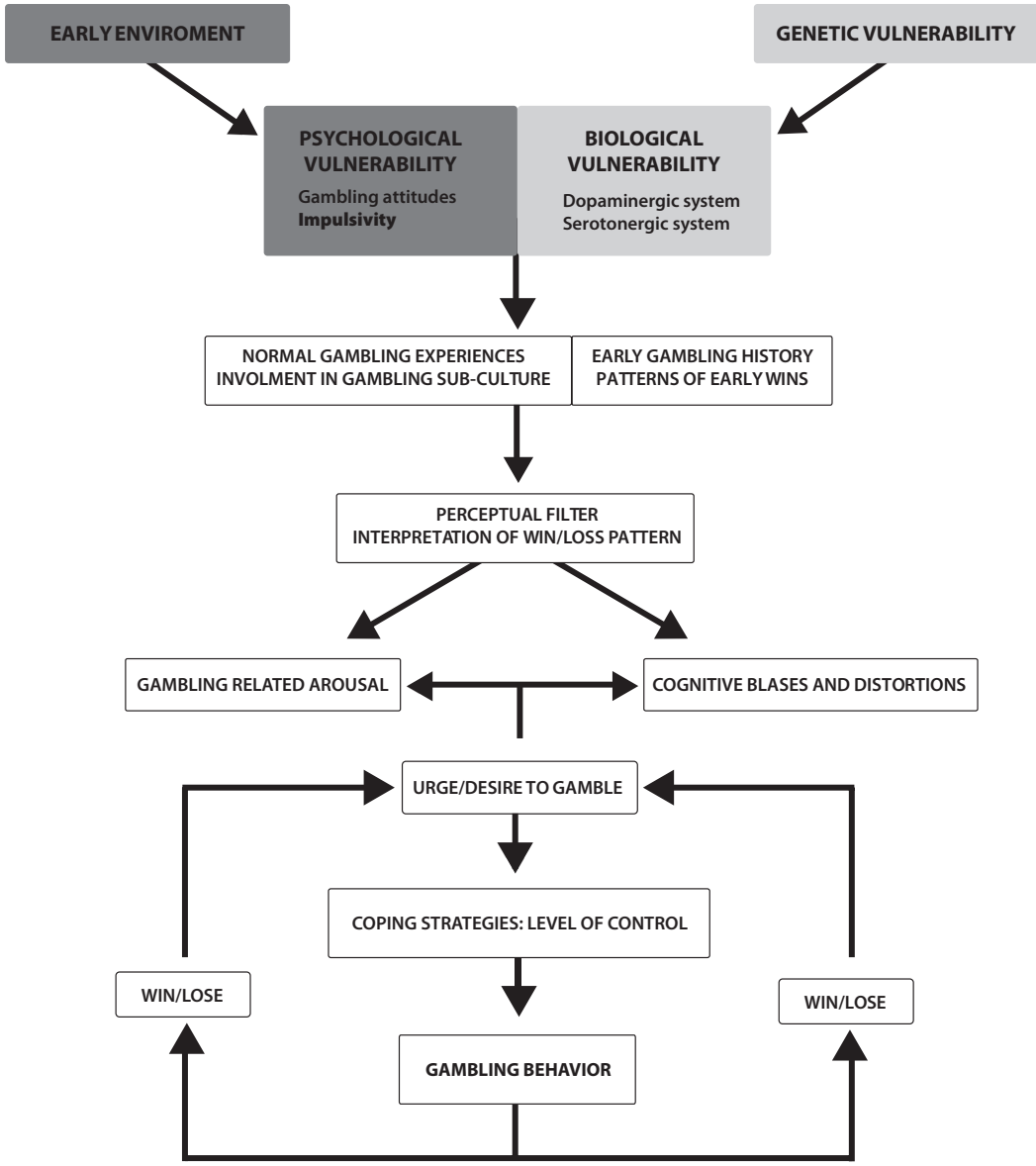
A biopsychosocial perspective has been proposed to classify the different risk factors that explain the heterogeneity of profiles showed by individuals with GD, in addition to impulsivity and compulsivity (237,333). Figures 7, 8 and 9 show different models from this perspective.

Figure 7. A pathways model of gambling disorder



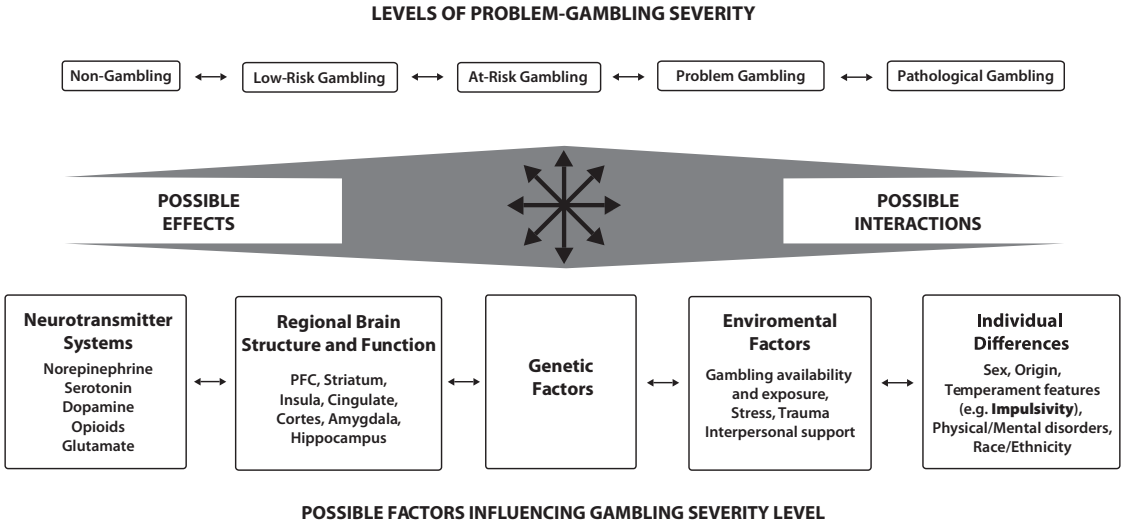
Adaptated from Blaszczynski & Nower (237). Note. EEG: electroencefalograma; ADHD: attention deficit hyperactivity disorder.

Figure 8. A cognitive-behavioral model of gambling disorder



Adapted from Sharpe (333).

Figure 9. Factors influencing gambling disorder



Adapted from Potenza (224). Note. PFC: prefrontal cortex.

1.4.3.1. SOCIODEMOGRAPHIC FACTORS

GD is more frequent in men than in women (334,335), and the course of GD differs between both sexes (336). Men usually start to present problems with the gambling behavior at an earlier age than women (337–339). However, data suggest that the time between the initial engagement in gambling and the development of GD (the addiction course) is shorter in women, which has been labeled the "telescoping effect" (340,341).

This disorder usually begins in adolescence or in young adulthood, but in some individuals it manifests in middle adulthood or at a more advanced age (342). Complex psychosocial, neurobiological, and genetic features influence the age of GD onset, such as sex, GD severity, personality traits, and psychopathological features (343,344). Taking personality into account, impulsivity and negative affectivity have been the two main temperament dimensions associated with age of onset (345,346). In this regard, life events perceived as negative and stressful have an impact on the development of GD psychopathology (347,348).

The increasing availability of gambling opportunities has been associated with an increase in the prevalence of GD in the general population (349). Another complex social risk factor is the level of exposure to betting advertisements and promotions (350), although its relationship with GD has not been established (351,352). Finally, early family exposure to gambling has an essential role in gambling initiation (353).

1.4.3.2. BIOLOGICAL FACTORS

In terms of neurotransmitter systems, numerous neurochemical systems have been complexly implicated in GD: adrenergic systems, especially noradrenaline, have been suggested to contribute to excitement and arousal; dopamine to reinforcing and rewarding features; serotonin to impulse control and behavioral initiation and cessation; opioids to pleasure and urges; cortisol to stress responsiveness; and glutamate to cognitive functioning, including cognitive flexibility (224,354). Regarding neural systems, multiple studies have observed diminished activation in the ventromedial prefrontal cortex (vmPFC) in individuals with GD during anticipation phases of reward processing (227,354). Finally, genetic risk factors are beginning to be studied as essential in GD development (355).

1.4.3.3. PSYCHOLOGICAL FACTORS

This disorder is often characterized by impulsive behavior (236,356); cognitive distortions, such as illusions of control (357,358); emotional dysregulation (359,360); and specific personality traits, e.g., high novelty seeking and low self-directedness (361–363). In addition, copying styles, especially emotion-focused coping strategies, are a relevant risk factor for the acquisition of gambling problems (364).

A high percentage of individuals with a GD diagnosis meet criteria for another psychiatric disorder, with SUDs, mood disorders, anxiety disorder, attention deficit hyperactivity disorder (ADHD), and personality disorders being the most common comorbidities in this clinical population (355,365,366).

1.4.4. GD AND TREATMENT

1.4.4.1. TREATMENT OPTIONS

It has been suggested that GD treatments may be divided into three different phases (228):

- During the first stage, it is essential to obtain sustained abstinence by reducing immediate withdrawal symptoms (e.g., irritability, anxiety, and emotional instability).

- The second stage attempts to promote sustained motivation to avoid relapse, learning different strategies in order to cope with cravings, and implementing new and healthy behavioral patterns to replace addictive gambling behavior.

- Finally, the relapse prevention phase aims to sustain abstinence in the long term.

GD treatment options include two main options (367,368):

- **Non-pharmacological approaches:** to reduce distinct GD clinical features, such as cognitive distortions, comorbidities, cravings, impairments in inhibitory control, and social vulnerability (369,370). From these options, cognitive behavioral therapy (CBT) has been shown to be especially effective for GD (371–373), particularly when it includes cognitive restructuration (374,375) and motivational components (372). These approaches mainly weaken factors associated with gambling, such as perseveration patterns, irrational beliefs, and magical thinking, and they promote patients' understanding of cognitive distortions related to gambling behavior (368,376).

- **Pharmacological therapies:** to restore impairments in the neuronal circuits responsible for the GD endophenotype (377–379). Although studies with different drugs have been carried out, currently only naltrexone seems to be effective for pure GD without clear comorbidities (368,380).

1.4.4.2. TREATMENT OUTCOME

Data show that re-establishing control over gambling behavior is envisioned as conceivable for some patients (381,382). However, although abstinence has been traditionally established as the primary goal of GD treatment (381,383), complete abstinence seems to be a rather exceptional phenomenon in this disorder (384,385). It could be, among other things, due to the intermittent nature of symptom experience in GD, with a chronic, relapsing pattern of behaviors (119). Likewise, despite all these treatment options, research has highlighted high relapse rates during or after treatment (385,386).

Furthermore, an additional problem is the difficulty of retaining patients with GD in treatment. During treatment, patients frequently cancel, re-schedule, or fail to attend clinical sessions, and up to 50% drop out of treatment (387–389). For this reason, it is an ongoing challenge to disentangle which factors actually contribute to real improvement in outcome (390) and which interfere with treatment. Sociodemographic features (391,392), personality (367), impulsivity (393,394), and other clinical variables (391) have been suggested as interfering factors.

Although there are few studies focused on how impulsivity affects the treatment outcome (395), some authors have suggested that individuals with GD who show high levels of impulsivity are more likely to finish their treatment prematurely (393,396) due to impulsivity being related to greater psychopathological comorbidity (309, 397) and greater severity (311), among other aspects.

1.5. RATIONALE FOR THE FEATURED STUDIES

It is well known that there is a growing interest in the field of psychiatry to approach disorders from a dimensional perspective, as a means of solving the main limitations of categorical approaches. From this dimensional perspective and, specifically, considering the impulsive-compulsive spectrum, it has been suggested that both impulsivity and compulsivity have an essential role in disorders such as GD and EDs.

Impulsivity has been associated with GD and EDs, especially bulimic-type EDs. However, although there seems to be consensus about its multifactorial nature, most empirical studies have rarely evaluated its different dimensions at once in clinical populations. This leads to a poor characterization of what could be common risk factors on a transdiagnostic level.

In reference to compulsivity, although interest in this construct has increased and it has been suggested that it may have a direct effect on different mental disorders, few studies evaluate it in conjunction with impulsivity using different evaluation tools to explore separate domains.

It is essential, therefore, to decipher how these constructs are associated with each other and with the clinical correlates of mental disorders.

2. AIMS AND HYPOTHESES

2.1. GENERAL AIMS

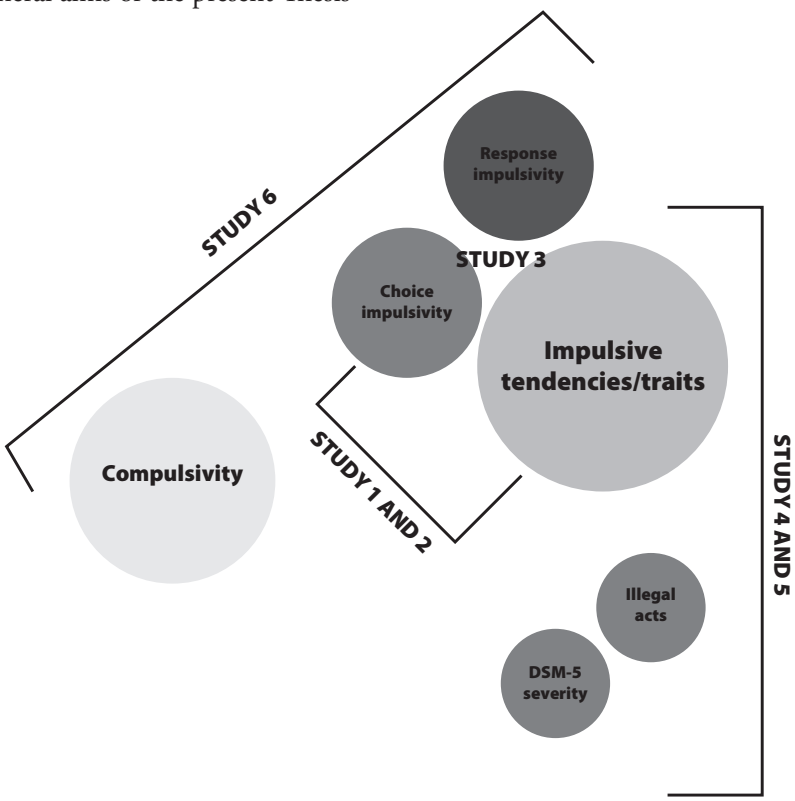
EDs and GD, at first glance, could seem fairly disparate in nature. However, theoretical dimensional models suggest a common link binds them together as outcomes of two main risk factors: impulsivity and compulsivity. In order to prove this fact, the main aims of the present thesis were:

A) To study in depth the interaction between the different types of impulsivity in two of the disorders included along the impulsive-compulsive spectrum (GD and EDs) **(Study 1, 2, 3, 4, 5 and 6)**.

B) To assess the association between impulsivity and the controversial DSM-5 criteria for GD, specifically the illegal acts criterion and the inclusion of three severity levels **(Study 4 and 5)**.

C) To examine compulsivity dimensions and the interaction between them and impulsivity levels in GD **(Study 6)**.

Figure 10. General aims of the present Thesis



2.2. SPECIFIC AIMS AND HYPOTHESES

A) INTERACTION BETWEEN IMPULSIVITY DIMENSIONS AND EDs / GD

Study 1: Delay discounting of reward and impulsivity in eating disorders: from anorexia nervosa to binge eating disorder

AIMS

- To assess delayed discounting and impulsive tendencies/traits in extreme-eating/weight conditions, in comparison with healthy controls (HCs).

- To examine whether delay discounting differed between AN-BP and AN-R subtype patients.

HYPOTHESIS

- We hypothesized that increased delay discounting and impulsive tendencies/traits levels would be associated with bulimic-spectrum disorders (AN-BP and BED), whereas these tendencies would be reduced in AN-R patients.

Study 2: Delay discounting and impulsivity traits in young and older gambling disorder patients

AIMS

- To examine whether the associations between delay discounting and impulsive tendencies/traits varied between younger and older treatment-seeking GD patients.

- To identify the mediating role of impulsivity factors between age and GD severity levels by means of path analysis.

HYPOTHESIS

- We hypothesized that it is possible to build a tentative model of the relationships between age, choice impulsivity, urgency, and gambling severity. Specifically, we expect choice impulsivity to predict severity only through its shared variability with urgency, and this path (particularly its positive urgency component) to be more evident in younger gamblers.

Study 3: Dimensions of impulsivity in gambling disorder

AIMS

- To examine whether the associations between three facets of impulsivity (response impulsivity, choice impulsivity and impulsive tendencies/traits) varied between GD patients and HCs.

- To evaluate the intercorrelatedness of these three types of impulsivity in GD, as proposed by theoretical models of impulsivity, and their association with GD severity.

HYPOTHESIS

- We hypothesized that GD, as compared to HC participants, would exhibit greater impulsivity in all three domains, and that response impulsivity, choice impulsivity, and impulsive tendency would correlate with one another to varying degrees in the GD group, and GD severity would relate to impulsivity in the GD group.

B) IMPULSIVITY AND DSM-5 GD CRITERIA

Study 4: Gambling and impulsivity traits: a recipe for criminal behavior?

AIMS

- To compare impulsive tendencies/traits in a sample of treatment-seeking GD patients who committed illegal acts to those who did not.

- To explore differences between these groups in terms of sociodemographic and psychological variables, and the type of illegal act committed in order to ascertain which variable(s) best predicted the presence of a history of criminal behavior.

HYPOTHESES

We hypothesized that:

- GD patients with a history of criminal behavior would present higher levels of debt than those without a criminal record.

- GD patients with a history of criminal behavior would be characterized by greater levels of GD severity, impulsive tendencies/traits, and overall psychopathology.
Those gamblers with a history of committing multiple offenses would present increased

psychopathology, GD severity and levels of accumulated debt.

Study 5: The predictive capacity of DSM-5 symptom severity and impulsivity on response to cognitive-behavioral therapy for gambling disorder: a 2-year longitudinal study

AIMS

- To explore the association between gambling-related variables and impulsive tendencies/traits in a sample of adult men who met criteria for GD.

- To estimate the predictive capacity of the impulsivity measures on GD treatment outcome (after 4 months of CBT treatment and at a two-year follow-up), namely considering relapse and dropout as outcome measures.

- To examine the associations between DSM-5 severity categories on treatment outcome.

C) INTERACTION BETWEEN IMPULSIVITY AND COMPULSIVITY IN GD

Study 6: Gambling Disorder: the Role of Impulsivity and Compulsivity

AIMS

- To examined the interplay between self-reported and behavioral measures of impulsivity and compulsivity and GD severity in adults with GD.

- Structural Equation Modeling (SEM) was used to explore associations between age and these clinical factors.

HYPOTHESES

- We hypothesized that GD severity levels would positively relate to both self-reported and behavioral measures of impulsivity and compulsivity.

- We also hypothesized that age would be associated with compulsivity, as suggested by previous studies (398,399), and that impulsivity would show a direct association with GD severity, as observed previously (400).

3. METHODOLOGY

3.1. PARTICIPANTS AND PROCEDURE

The different samples included in this thesis consisted of patients with a diagnosis of ED or GD according to DSM criteria (11,225). Those who were treatment-seeking patients were derived to the Department of Psychiatry of the Bellvitge University Hospital through general practitioners, via another healthcare professional or from prison health services, though their treatment was not compulsory. In the case of HCs, the main exclusion criteria were to report a lifetime history of ED or GD (depending on the clinical sample of each study). Some participants were recruited at Yale University in the Problem Gambling Clinic through advertisements. Individuals 18 years or older with a diagnosis of DSM-IV pathological gambling as determined by structured interview were included (401). The main characteristics of the participants and procedure of the studies are included in Table 11.

Table 11. Summary of the main characteristics of the different studies.

	Sample composition								Inclusion-Exclusion criteria	
Study	**Design**	**Size**	**# groups**	**GD**	**EDs**	**HCs**	**Gender**	**Country of the study**	**Inclusion**	**Exclusion**
1	Cross-sectional	160	4	---	37 AN-R (TS) 19 AN-BP (TS) 24 BED (TS)	80	Female	Spain	Age over 18	Organic mental disorder Intellectual disability HCs: ED history
2	Cross-sectional	335	2	67 Young (TS) 261 Old (TS)	...	---	Female (36) Male (292)	Spain	GD TS	Organic mental disorder Intellectual disability Neurodegenerative condition Active psychotic disorder
3	Cross-sectional	129	2	97 (TS)	---	32	Male	Spain	Age between 18-50	Comorbid mental disorder HCs: lifetime GD history
4	Cross-sectional	382	2	Illegal acts (279) Non illegal (103)	---	---	Male	Spain	GD-TS (met DSM criteria	Organic mental disorder Intellectual disability Neurodegenerative condition Active psychotic disorder
5	Longitudinal	398	3	65 Mild (TS) 133 Moderate (TS) 200 severe (TS)	---	---	Male	Spain	Patients undergone GD treatment	Mental disorder Intellectual disability
6	Cross-sectional	236	1	Non-TS	---	---	Female (36) Male (292)	The US	Age over 18	No GD diagnosis

Note. GD: gambling disorder. EDs: eating disorders. HCs: healthy controls. AN-R: anorexia nervosa restrictive. AN-BP: anorexia nervosa bulimic purgative. BED: binge eating disorder. TS: treatment seeking.

3.2. ASSESSMENT

The instruments used in the empirical works that make up this thesis are part of the assessment battery (see Table 12). Data was collected through behavioral measures and self-report using validated instruments that have demonstrated appropriate psychometric properties. The socio-demographic information and part of the clinical information was obtained by means of a semi-structured clinical interview.

Table 12. Assessment batery

Construct		Instrument	Study 1	2	3	4	5	6
GD diagnosis and severity		SOGS		✓	✓	✓	✓	✓
		DSM-5		✓	✓	✓	✓	
		Clinical interview		✓	✓	✓	✓	
ED diagnosis and severity		EDI-2	✓					
		DSM-5	✓					
		Clinical interview	✓					
Impulsivity	Self-report	UPPS-P	✓	✓	✓	✓	✓	
		Delay discounting task	✓	✓	✓			
		BIS-11						✓
	Behavioral	EDT						✓
		CPT-II			✓			
Compulsivity	Self-report	PI						✓
	Behavioral	WCST						✓
Psychopathology		SCL-90-R				✓		
Personality		TCI-R				✓		
Substances	Alcohol	AUDIT		✓		✓		
	Drugs	DUDIT				✓		
Sociodemographics		Clinical interview	✓	✓	✓	✓	✓	✓

Note. GD: gambling disorder; ED: eating disorder; SOGS: South Oaks Gambling Screen; DSM-5: Diagnostic and Statistical Manual of Mental Disorders-5; BIS-11: Barratt Impulsiveness Scale; EDT: Experiential Discounting Task; CPT-II: Continuous Performance Test; PI: Padua Inventory; WCST: Wisconsin Card Sorting Task; SCL-90-R: Symptom Checklist-Revised; TCI-R: Temperament and Character Inventory-Revised; AUDIT: Alcohol Use Disorders Identification Test; DUDIT: Drug use Disorders Identification Test.

3.2.1. GAMBLING DISORDER

3.2.1.1. DSM-5 CRITERIA FOR GD (11)

Through a clinical interview, patients were diagnosed with pathological gambling if they met

DSM-IV-TR criteria (225). It should be noted that with the release of the DSM-5 (11), the term pathological gambling was replaced with GD. All clinical diagnoses were reassessed and recodified post hoc and only those patients who met DSM-5 criteria for GD were included in the analysis of this thesis (Studies 2,4 and 5).

In the study 3, patients were directly diagnosed with gambling disorder if they met DSM-5 criteria (11), which consist of nine different criteria and the presence of the disorder is set at a cut-off point of 4 or more, in a 12-month period.

3.2.1.2. SOGS (262)

This self-report 20-item screening questionnaire assesses GD and is scored by summing the number of items endorsed out of 20. A cut score of 5 or more indicates that the respondent is a probable pathological gambler.

It includes both subjective (such as "do you feel you have a problem with gambling?" or "have you felt guilty about the way you gamble or what happens when you gamble?") and behavioral ítems (such as "have you ever hidden betting slips, lottery tickets, gambling money, or other signs of gambling from your spouse, children, or other important people in your life?").

The DSM diagnostic criteria for GD and the SOGS may represent different gambling problem severity levels. The SOGS represents some of the early and less severe GD symptoms, while the DSM represents the later stage of the disorder (or the more severe level). Therefore, someone who on the SOGS scores a 5, particularly endorsing subjective items, may not necessarily meet DSM criteria (248).

The Spanish validation used in this work showed excellent internal consistency ($\alpha = 0.94$) and test-retest reliability ($r = 0.98$) (402).

3.2.2. EATING DISORDERS

3.2.2.1. EATING DISORDER INVENTORY-2 (EDI-2) (403)

The EDI-2 is a reliable and valid 91-item multidimensional self-report questionnaire which assesses different cognitive and behavioral characteristics, that are typical in ED. The items are grouped into eleven scales: drive for thinness, body dissatisfaction, bulimia, ineffectiveness, perfectionism, interpersonal distrust, interoceptive awareness, maturity fears, asceticism, impulse regulation and social insecurity. All the scales are answered on a six-point Likert scale and provide standardized subscale scores. In the current thesis, only the total score was used (as a measure of ED severity). When this instrument was validated in a Spanish population, a mean internal consistency of 0.63

(coefficient alpha) was found (404).

3.2.2.2. DSM-5 CRITERIA FOR EDS (11)

Patients were originally diagnosed according to DSM-IV-TR criteria (225). All the clinical diagnoses were, however, re-analyzed post hoc by using DSM-5 criteria (11).

3.2.3. IMPULSIVITY

3.2.3.1. SELF-REPORT MEASURES

Impulsive Behavior Scale UPPS-P (94)

The UPPS-P assesses five facets of impulsive behavior through 59 self-report items: positive urgency, negative urgency, lack of perseverance, lack of premeditation and sensation seeking. Acts/incidents during the last 6 months are considered when participants rating their behavior and attitudes (See Table 13).

Table 13. Description of each dimension included in the UPPS-P

DIMENSIONS	DESCRIPTION
Positive Urgency	Tendency of the subject to carry out hasty actions due to a positive mood.
Negative Urgency	Tendency to carry out impulsive behaviors under conditions of negative affect, that is, when the subject experiences moods which interprets as negative.
Lack of premeditation	Tendency to think and reflect on the consequences of an act before getting involved in it.
Lack of perseverance	It refers to the subject's ability to remain focused on a task that may be long, boring or difficult.
Sensation seeking	It covers two central aspects. On the one hand, the tendency to seek and enjoy exciting activities and, on the other, a tendency to openness, that is, to the interest to try new experiences, which may or may not be dangerous.

The Spanish- language adaptation shows good reliability (Cronbach's α between 0.79 and 0.93) and external validity (99).

Delay discounting task (71)

This task is a 27-item self-administered tool applied to detect individual inter-temporal discount rates (k), providing a set of alternative choices between a smaller, immediate monetary reward and a larger, delayed monetary reward. Each of the items was designed to correspond to a different k-value, which constitutes the measure of discounting rate and represents the amount of discounting of the later reward that renders it equal to the smaller reward. The protocol is scored by calculating where the respondent's answers lie amid reference discounting curves, where placement amid steeper curves is indicative of higher levels of impulsivity. Point single k parameter-estimates may be obtained to represent the overall rate of discounting, but also for ítems with small, medium and large monetary rewards (71). k-values can range from 0 (selection of the delayed reward option for all items, or no discounting) to 0.25 (selection of the immediate reward option for all items, or always discounting). According to many studies using the Delay Discounting Task, the distributions of k-values were approximately normalized using the natural log transformation (n log kvalues) for statistical analyses. In addition, according to previous results showing a magnitude effect on discount rates (k-values decrease as the amount of the rewards increase), delay discounting was estimated for overall questionnaire and separately for three magnitude categories (405): small delayed rewards (€25–35), medium delayed rewards (€50–60) and large delayed rewards (€75–85).

The Barratt Impulsiveness Scale (BIS-11) (86)

The BIS-11 (86) is a 30-item, self-report questionnaire consisting of three subscales: (1) attentional, (2) motor, and (3) non-planning impulsivity. Item responses range from 1 to 4 (Rarely/Never, Occasionally, Often, Almost Always/Always). The BIS-11 has displayed adequate satisfactory test-retest reliability (Spearman's rho .83) and internal consistency (.83), with a cut-off score of 72 indicative of high levels of impulsivity.

3.2.3.2. BEHAVIORAL MEASURES

EDT (73)

The EDT is a computerized task in which participants experienced chosen rewards at specified time points during the assessment (73). Subjects completed four sessions (blocks) associated with different time delays, three of which involved choices between an adjusting amount (initially, $0.15) that was given immediately, or a standard amount ($0.30) that was delayed and probabilistic (35%). In another session, there was no delay (0 s), and the reward ($0.30; probability 35%) was immediately delivered. Choice options were indicated by illuminating light bulbs on the screen. The immediate amount (right side of screen) was adjusted in value; it increased by a set percentage following a delayed standard choice but decreased following an immediate choice. The delayed standard amount (left side of screen) was not adjustable. The standard option choice resulted in a specified delay (0, 7, 14, and

28 s). If money was delivered, it could be transferred to the "bank" by clicking on an illuminated bank image, resulting in coin delivery from a coin dispenser. For each choice block, subjects made choices until an indifference point was reached, defined as choosing each option (i.e., immediate and delayed options) three times within six consecutive choice trials, thus keeping the adjusting amount constant over those six choices. After an indifference point had been reached or the delayed option had been chosen 15 times (reflecting minimal discounting), the session ended. The remaining sessions (i.e., 7, 14, and 28 s) were completed in ascending order.

The plot of indifference curves (normalized indifference point plotted for each delay interval) for each individual were fit with either an exponential (VS = VAe –kd) or a hyperbolic (VS = VA/ 1+Kd; Mazur 1987) function, where the subjective value (VS) was a modification of the actual value (VA) by the delay (d) and a discount constant (K). K represented the steepness of the delay discounting curve and was used as the measure of choice impulsivity. A higher K represents higher choice impulsivity. The curve fitting was conducted using Prism 5 (GraphPad software). We assessed the proportion of choices for each delay interval (delayed choice ratio = delayed choice/total choice) and compared impulsive and non-impulsive subjects (dichotomized by median K).

CPT-II (406)

The CPT-II is a computer-based task in which participants press the space bar in response to visual cues (i.e., letters on a computer screen) that are presented over a span of 14 min. Participants' omission and commission error rates, reaction time, and response variability represent measures of sustained attention and inhibitory control. Higher scores on the CPT-II indicate worse performance.

3.2.4. COMPULSIVITY

3.2.4.1. SELF-REPORT MEASURES

PI (114,407)

The PI is a 60-item tool examining obsessive and compulsive tendencies that factors into domains of impaired mental control, contamination, checking, and urges and worries. The PI comprises five subscales: i) aggressive thoughts concerning the self and others; ii) aggressive impulses concerning the self and others; iii) contamination; iv) checking; v) symmetry/order.

3.2.4.2. BEHAVIORAL MEASURES

WCST (408)

The WCST is a set-shifting task assessing cognitive flexibility. It examines the ability to shift cognitive

strategies in response to changing experimental conditions on the basis of strategic planning and the ability to adapt cognitive sets in response to feedback. The WCST consists of 128 cards that vary according to number, color, and shape of their elements.

Participants are asked to sort these cards in piles beneath four reference cards that vary with regard to the above mentioned same dimensions. Feedback of "wrong" or "right" is given to participants. Initially, color is the correct sorting category, and positive feedback is given only if the card is placed in the same color pile. Categorization criteria change following ten sequential correct answers. Thus, participants are required to learn to adapt to new sorting criteria according to feedback. The test ends when all cards are sorted, or when six full categories have been completed. The number of complete categories, the percentage of perseverative errors (i.e., failures to change the sorting strategy in response to negative feedback) and the percentage of non-perseverative errors are recorded.

3.2.5. PSYCHOPATHOLOGY

3.2.5.1. SYMPTOM CHECKLIST-REVISED (SCL-90-R) (409)

This is a 90-item questionnaire measuring psychological distress and psychopathology. Especifically, this instrument allows to carry out a valid evaluation of the level of psychological distress of the individual through global, dimensional and discrete symptoms information. It is not a global assessment of the experience of mental suffering, it is limited to a recent time frame, that is, the week before the application of the questionnaire.

The SCL-90-R items assess nine symptom dimensions: somatization, obsessive-compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, and psychoticism. Moreover, it contains 3 global index: Global Severity Index (GSI), Positive Symptom Total (PST) and Positive Symptom Distress Index (PSDI). The former is a widely used index of psychopathological distress. It combines the number of symptoms present with the intensity of perceived distress. It is calculated by adding the scores obtained in the nine dimensions of symptoms and in the additional items, and dividing that number by the total of answers given (90 if the person answered all of them). The GSI was the only variable from this questionnaire used in this thesis.

The Spanish validation scale obtained good psychometrical indexes, with a mean internal consistency of 0.75 (Cronbach's alpha) (410).

3.2.6. PERSONALITY TRAITS

3.2.6.1. TCI-R (117)

The TCI-R evaluates personality traits based on 240 items rated on a 5-point Likert scale and is a

reliable and valid questionnaire. There are seven primary personality dimensions: four temperamental (novelty seeking, harm avoidance, reward dependence, and persistence) and three character dimensions (self-directedness, cooperativeness, and self transcendence) (see Table 14). The Spanish revised version used (411) showed adequate internal consistency (Cronbach's alpha mean value of 0.87).

Table 14. TCI-R dimensions

		↓ levels	↑ levels
Temperament	novelty seeking	control, analytical ability, reflexivity	excitability, impulsivity, thoughtlessness
	harm avoidance	carelessness, security, optimism	anxiety, insecurity, worry and fear
	reward dependence	independence, individualism, tendency to loneliness	sociability, warmth, sentimentality
	persistence	self-demand, frustration, ambition	self-demand, hard work, overcoming
Character	self-directedness	immaturity, lack of personal goals, inefficiency	self-sufficiency, responsibility, effectiveness
	cooperativeness	intolerance, mistrust, opportunism	empathy, compassion, benevolence
	self transcendence	self-consciousness, materialism, rationality	spirituality, idealism, mysticism

3.2.7. SUBSTANCE USE

3.2.7.1. ALCOHOL USE DISORDERS IDENTIFICATION TEST (AUDIT) (412)

The AUDIT is an easy-to-use screening tool for alcohol abuse. Internal consistency has been found to be high, and test-retest data have shown high reliability (0.86) and sensitivity (0.90). Specificity in different settings is above 0.80 (413). In this work, cutoff points of 8 and 20 were used to identify individuals with alcohol abuse and alcohol dependence, respectively (414).

3.2.7.2. DRUG USE DISORDERS IDENTIFICATION TEST (DUDIT) (415)

The 11-item questionnaire DUDIT has been developed to screen for non-alcohol drug use and drug-related problems in the general public as well as in individuals in clinical settings who are likely to meet criteria for substance dependence (415). The first nine items are scored on a 5-point Likert scale ranging from 0 to 4, and the last two are scored on 3-point scales (values of 0, 2, 4). Total scores may range from 0 to 44, with higher scores associated with more severe drug abuse. The following risk levels have been suggested for DUDIT scores: no drug-related problems (total scores 0–5/1); possible drug-related problems (i.e., risky or harmful drug habits that might be diagnosed as substance abuse/ harmful use or dependence) (6/2–24); likely severe drug dependence (scores ≥ 25) (415).

3.2.8. OTHER SOCIODEMOGRAPHIC AND CLINICAL VARIABLES

Additional sociodemographic and clinical variables related to ED and GD were measured using a semi-structured face-to-face clinical interview (see Table 15).

Table 15. Sociodemographic and clinical variables assessed

SOCIODEMOGRAPHIC	ED	GD
- Age (years-old) - Nationality - Education level - Civil status - Socioeconomic status	- Onset of ED (years-old) - Duration of ED (years) - Binges/weekly - Purges/weekly - BMI present (Kg/m^2) - BMI maxim (Kg/m^2) - BMI minim (Kg/m^2)	- Onset of GD (years-old) - Duration of GD (years) - Maximum bets per episode (€) - Mean bets per episode (€) - Cumulate debts (€) - Monthly income (€) - Lifetime criminal activity related to GD - Treatment outcome: relapse and dropout

3.3. COGNITIVE BEHAVIORAL THERAPY

The CBT group therapy intervention consisted of 16 weekly outpatient sessions at Bellvitge University Hospital lasting 90 minutes each and a follow-up period. To ensure treatment fidelity, therapists were instructed to adhere closely to the treatment manual. The goal of the treatment was to train patients

to implement CBT strategies in order to minimize all types of gambling behavior and to eventually arrive at full abstinence. The general topics addressed in the therapies included: psychoeducation regarding the disorder (its course, vulnerability factors, diagnostic criteria, bio-psychosocial models of GD, phases, etc.), stimulus control (money management, avoidance of potential triggers, self-exclusion programs, etc.), response prevention (alternative and compensatory behaviors), cognitive restructuring focused on illusions of control over gambling, and magical thinking, reinforcement and self-reinforcement, skills training, and relapse prevention techniques. This treatment program has already been described elsewhere (416).

3.4. STATISTICAL ANALYSIS

Stata and SPSS for Windows were used. The procedures used depended on the objectives of the analyses and the scale of measurement of the criteria variables of each study. In general terms, the choice of each technique was made according to the following table (the particularities with which each procedure has been used in each study can be found in the corresponding article).

Table 16. Statistical procedures used in the articles

Criterion variable	Statistical procedure
Categorical-binary	Chi-square tests (χ^2)
	Binary logistic regression *(general procedure)*
Categorical-multilevel	Chi-square tests (χ^2)
	Multinomial regression *(general procedure)*
Quantitative	Two mean comparison: t-test
	Multiple mean comparison: Analysis of variance (ANOVA)
	Pearson's correlation
	Partial correlation
	Linear regression *(general procedure)*
Censored data	Survival function estimate (Kaplan-Meier)
	Comparison of survival curves (Mantel-Haenszel, Cox, Log-Rank)
	Cox's regression *(general procedure)*
Mediational analysis	Path-analysis (structural equation modeling, SEM)

Chi-square tests (χ^2): to compare categorical variables (binary and multilevel) between groups (categorical data, exposure and response). In the case of large samples (expected frequencies equal to or greater than 5), χ^2 Pearson's statistic was used, and with small samples (expected frequencies less than 5) exact non-parametric statistics (such as Fisher's test) were used.

Logistic regression: the general model for binary criterion variables. It allows for the inclusion of categorical (binary and multilevel) and quantitative explanatory-predictor variables. The goodness of fit of models were evaluated with the Hosmer-Lemeshow test (good fit was considered non-

significant results in the test, p>0.05). The global predictive capacity of the model was estimated with the pseudo-coefficient of correlation of Nagelkerke and the discriminative capacity with the area under the ROC curve made on the predictions of the model considering as criterion variable the dependent variable of the model.

Multinomial regression: is an extension of the logistic regression model for multilevel criterion variables (with more than two values). As with logistic regression, it allows the inclusion of categorical (binary and multilevel) and quantitative explanatory-predictor variables. The global predictive capacity of the model has been evaluated with Mc-Fadden's pseudo correlation coefficient.

T-Test: allows the comparison of two means obtained in independent groups.

ANOVA: to compare more than two averages obtained in independent groups. The identification of the possible differences between groups has been based on multiple comparisons with contrasts in pairs, with estimates based on Scheffé's methods or that of the minimum significant difference.

Pearson's correlation: to estimate the degree of linear association between quantitative variables. Due to the strong association between statistical significance for the R-coefficients and sample size, effect size was considered using low-poor |R|>0.10, moderate-medium |R|>0.24 and large-high |R|>0.37 (these thresholds correspond to Cohen's-d of 0.20, 0.50 and 0.80, respectively (417).

Partial correlation: to estimate the degree of linear association between two quantitative variables controlling the possible effect of a set of factors. In this way, it is possible to obtain an estimation of the correlation coefficient adjusted to potential confounding variables.

Linear regression: the general model for quantitative criterion variables. It allows for the inclusion of explanatory-predictor variables of categorical type (binary and multilevel) and also quantitative type.

Censored data (survival analysis): These models are used for modeled censored data, which occurs if patients withdraw from the study (arrive alive to the end of the follow-up or lost in the follow-up without event occurrence at the last measurement time). In this project, the Kaplan-Meier (product-limit) estimator was used to estimate the cumulative survival function, based the comparison of survival curves in the Mantel-Haenszel, Cox and Log-Rank tests, and used the Cox's regression to estimate the contribution of a set of independent variables on the survival time. As a whole, the survival function is a method used to measure the probability of patients "living" (surviving without the presence of the outcome, for example without dropout or without the presence of relapse episodes) for a certain amount of time after the intervention (418,419).

Path-analysis: Path analysis procedures constitute a straightforward extension of multiple regression

modeling, which can be used with the aim to estimate the magnitude and significance of hypothesized associations in a set of variables, including mediational links (direct and indirect effects) (420). It can be used for both exploratory and confirmatory modeling, and therefore it allows for theory testing and theory development (421,422). Path analysis has been used in this project as a case of structural equation modeling (SEM), using the maximum-likelihood estimation (MLE) method of parameter estimation and valuing the goodness-of-fit through the standard statistical measures: χ^2 tests, root mean square error of approximation (RMSEA), Bentler's Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and standardized root mean square residual (SRMR). Adequate model fit was considered non-significant by χ^2 tests and if the following criteria were met (423,424): RMSEA<.08, TLI>.9, CFI>.9 and SRMR<.1. The global predictive capacity of the model was measured by the coefficient of determination (CD). Regarding the sample size for SEM, in some studies groups were not large. While SEMs have been largely used in behavioral science research, considerations about the sample size requirements for these models seems rely on outdated rules-of-thumb, recent studies have analyzed the sample size requirements for some common types of these procedures through Monte-Carlo procedures, including variation by the number of factors, number of indicators, strength of the indicator loadings and the regressive paths and the amount of missing data per indicator (425), and results have revealed that the sample requirements were in a very broad range (from 30 to 460) depending on the analysis characteristics. And most interesting: overall, solutions that met fitting at a given sample size, were stable relative to the results of the analysis at the next largest sample sizes.

In the present thesis, the analyses have been based on Fisher's tests of significance, used to obtain the degree of significance as a tool to assess the level of plausibility of the null hypothesis formulated in each statistical test, and also in the estimation of the effect sizes that assess the degree of intensity of the relationships under study. The effect sizes have been estimated from the confidence intervals of the coefficients/parameters obtained in each model and through the Cohen's-d coefficient (this last coefficient has been obtained to obtain a standardised measure of the difference in proportions and means). For Cohen's-d coefficient, effect size was considered low-poor $|d|>0.20$, moderate-medium for $|d|>0.5$ and large-high for $|d|>0.8$ (426).

General models (such as logistic regression and linear regression) have been used for different purposes, according to the particular objectives of each study: descriptive, explanatory and predictive. Likewise, due to the fact that the studies presented have been carried out using a non-experimental methodology (non-randomised groups), in order to guarantee the absence of spuriousness in the relationships obtained, the analyses have been adjusted/controlled for possible confusing variables (such as, for example, sex and age).

Finally, Finner's correction was used in the different studies to avoid increases in Type I error due to multiple statistical comparisons (427). This is a method included in the family-wise-error-rate stepwise systems, which offers more powerful test than Bonferroni correction.

3.5. ETHICS

All the studies were carried out in accordance with the latest version of the Declaration of Helsinki. The University of Bellvitge Ethics Committee of Clinical Research and the Yale Human Investigation Committee approved them and written informed consent was obtained from all participants.

4. RESULTS

STUDY 1

DELAY DISCOUNTING OF REWARD AND IMPULSIVITY IN EATING DISORDERS: FROM ANOREXIA NERVOSA TO BINGE EATING DISORDER

Steward, T.*, Mestre-Bach, G.*, Vintró-Alcaraz, C., Agüera, Z., Jiménez-Murcia, S., Granero, R., Fernández-Aranda, F., 2017. Delay Discounting of Reward and Impulsivity in Eating Disorders: From Anorexia Nervosa to Binge Eating Disorder. Eur. Eat. Disord. Rev. 25, 601–606 (IF: 3.391; Q1 in category "Psychology, clinical").

EUROPEAN EATING DISORDERS REVIEW

DELAY DISCOUNTING OF REWARD AND IMPULSIVITY IN EATING DISORDERS: FROM ANOREXIA NERVOSA TO BINGE EATING DISORDER

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ABSTRACT

Evidence points to eating disorder patients displaying altered rates of delay discounting (one's degree of preference for immediate rewards over larger delayed rewards). Anorexia nervosa (AN) patients are believed to have an increased capacity to delay reward, which reflects their ability to override the drive to eat. Contrarily, binge eating disorder (BED) patients are associated with a reduced predisposition to delay gratification. Here, we investigated monetary delay discounting and impulsivity in 80 adult women with EDs (56 AN and 24 BED), diagnosed according to Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition criteria, and 80 healthy controls. AN-restrictive (AN-R) subtype patients showed less steep discounting rates than BED and AN-bingeing/purging subtype patients. Compared with healthy controls and AN-R patients, BED and AN-bingeing/purging patients presented higher delay discounting and positive and negative urgency levels. Our findings suggest that restriction in AN-R patients is associated with disproportionate self-control, whereas bingeing behaviours could be more driven by emotional states and impulsivity traits.

Keywords
Eating disorders; delay discounting; impulsivity; anorexia nervosa; binge eating disorder.

INTRODUCTION

Certain personality characteristics, such as rigidity or perfectionism, are often related to anorexia nervosa-restricting subtype (AN-R; National Institute for Clinical Excellence, 2004), whereas other features, such as impulsivity and emotion dysregulation, are commonly associated to bulimic-spectrum disorders, encompassing AN-bingeing/purging subtype (AN-BP), bulimia nervosa (BN) and binge eating disorder (BED; Atiye, Miettunen, & Raevuori-Helkamaa, 2015; Claes, Vandereycken, & Vertommen, 2002; Lavender & Mitchell, 2015; Waxman, 2009). Likewise, the extent to which an individual chooses immediate gratification over larger, delayed rewards varies across psychiatric disorders (Amlung, Vedelago, Acker, Balodis, & MacKillop, 2017; Story, Moutoussis, & Dolan, 2015) and contexts (Kaplan, Reed, & Jarmolowicz, 2016; Lempert & Phelps, 2016). This tendency to disproportionately value immediate rewards during decision making is known as delay discounting or temporal discounting and is normally measured by having subjects choose between a smaller-immediate reward and a larger-delayed reward (e.g. 'Would you prefer € 45 now or € 88 in 7 days?'; Madden & Bickel, 2009). As opposed to delayed gratification, or deferred gratification, which is the ability to resist the temptation for an immediate reward and wait for a later reward, delay discounting is a sign of one's preference for smaller immediate rewards over larger but delayed rewards (Odum, 2011). Being more prone to choosing immediate rewards has been associated with clinical conditions, such as gambling disorder (Steward et al., 2017), substance abuse (Grant & Chamberlain, 2014) and obesity (Caleza, Yañez-Vico, Mendoza, & Iglesias-Linares, 2016; Epstein, Salvy, Carr, Dearing, & Bickel, 2010).

In the case of EDs, evidence points to a phenotypic overlap across disorders with respect to delay discounting (Bartholdy et al., 2017; Stojek & MacKillop, 2017). EDs characterized by higher levels of impulsivity, namely, BN and BED, are associated with a preference for immediate rewards, regardless of whether the reward is monetary (Davis, Patte, Curtis, & Reid, 2010; Kekic et al., 2016) or a food reward (Manwaring, Green, Myerson, Strube, & Wilfley, 2011). On the other hand, being overly cautious and choosing delayed rewards more than is expected has been linked to AN (Decker, Figner, & Steinglass, 2015; Steinglass et al., 2012, 2017). This tendency is thought to reflect the unusually elevated level of self-control found in AN patients and possibly reflects a vulnerability marker for the disorder (Kanakam, Krug, Collier, & Treasure, 2017; Stojek & MacKillop, 2017). By regularly forgoing the immediate rewards provided by food in favour of the longer term goal of reducing body weight, the behavioural habit of not discounting rewards is increasingly understood to be a potential maintenance factor for AN (Walsh, 2013). Likewise, in the case of EDs associated with excess weight, the inability to resist the temptation of immediate rewards (i.e. unhealthy and palatable foods) is believed to be a detrimental influence on adherence to the dietary guidelines that commonly form part of BED treatment programs (Citrome, 2015).

Impulsivity factors, such as a lack of premeditation and acting out rashly in response to extreme moods, have also been linked to heightened delay discounting (Stojek, Fischer, Murphy, &

MacKillop, 2014; VanderBroek-Stice, Stojek, Beach, vanDellen, & MacKillop, 2017). The UPPS-P model contemplates impulsivity as a multidimensional construct and utilizes five separate subscales to assess impulsive behaviour and traits. Positive urgency refers to the tendency to act impulsively when undergoing positive affect; negative urgency reflects the propensity to act impulsively when experiencing negative affect; lack of perseverance shows the tendency to not persist in an activity that can be arduous or boring; lack of premeditation refers to the tendency to act without considering the consequences of an action; and sensation seeking indicates one's disposition to seek exciting experiences (Verdejo-García, Lozano, Moya, Alcázar, & Pérez-García, 2010).

In the EDs, an interaction among lack of premeditation, negative urgency and bingeing and purging behaviours has been identified (Anestis, Smith, Fink, & Joiner, 2009; Bardone-Cone, Butler, Balk, & Koller, 2016), with these maladaptive behaviours often being carried out in negative mood states (Fischer, Smith, & Anderson, 2003). Contrarily, AN-R patients tend to present reduced levels of impulsivity-related traits on the UPPS-P (Claes, Vandereycken, & Vertommen, 2005). It must be highlighted, however, that there is a dearth of studies evaluating both trait and choice (i.e. delay discounting) impulsivity across EDs when taking AN subtypes into account.

AIMS

As such, in this study, we sought to assess delayed discounting and impulsivity in extreme-eating/weight conditions, in comparison with healthy controls (HCs). Given the aforementioned differences in impulsivity features, we also sought to examine whether delay discounting tendencies differed between AN-BP and AN-R subtype patients. We hypothesized that increased delay discounting and impulsivity levels would be associated with bulimic-spectrum disorders (AN-BP and BED), whereas these tendencies would be reduced in AN-R patients.

METHODS

SAMPLE AND PROCEDURE

Our sample was made up of 80 ED female patients (37 AN-R, 19 AN-BP and 24 BED patients), who were recruited as consecutive referrals to the ED Unit within the Department of Psychiatry at Bellvitge University Hospital (Spain). These patients were compared with 80 matched HCs. Patients were originally diagnosed according to Diagnostic and Statistical Manual of Mental Disorders (DSM), Fourth Edition text revision (APA, 2000) criteria by means of the Structured Clinical Interview for DSM Disorders I (First, Gibbon, Spitzer, & Williams, 1996). However, DSM Fourth Edition text revision diagnoses were reanalyzed post hoc by using DSM-5 criteria (APA, 2013). Study inclusion criteria were the following: being female and being over the age of 18. The study exclusion criteria were the following: the presence of an organic mental disorder and an intellectual disability and, in the case of HCs, a history of EDs or any other psychiatric condition. For this purpose, prior to

assessment, the participants were asked about lifetime or current ED symptomatology and diagnosis, and they reported minimum and maximum BMI. HCs who had high levels of ED symptomatology and high scores of psychopathology were excluded from the sample.

Unit staff psychologists and psychiatrists carried out clinical evaluations during two structured face-to-face interviews. The first was conducted to provide information on current ED symptoms, antecedents and other psychopathological data of interest. The second interview consisted of a psychometrical assessment and eating behaviour monitoring through daily reports. HCs were provided with the study questionnaire following screening.

The present study was carried out in accordance with the latest version of the Declaration of Helsinki. The Bellvitge University Hospital Clinical Research Ethics Committee approved the study, and signed informed consent was obtained from all participants.

MEASURES

Eating disorder symptomatology was assessed via the validated Spanish version of the Eating Disorders Inventory 2 (Garner, 1998; internal consistency measured by Cronbach alpha for the total score in the study sample was excellent, $\alpha = .921$). The UPPS-P Impulsive Behaviour Scale-UPPS (Verdejo-García et al., 2010) was used to measure impulsivity-related traits (internal consistency in the study sample was good, ranging from .789 in lack of perseverance to .923 in positive urgency). On the UPPS-P, individuals are asked to consider acts/incidents during the last 6 months when rating their behaviour and attitudes.

Delay discounting was assessed by using a validated paper-and-pencil monetary choice task (Kirby, Petry, & Bickel, 1999). This task elicits individual intertemporal discount rates (k) by providing a set of alternative choices between a smaller, immediate monetary reward and a larger, delayed monetary reward. Each of these questions was designed to correspond to a different k value, which represents the amount of discounting of the later reward that renders it equal to the smaller reward. The task is scored by calculating where the respondent's answers place him/her amid reference discounting curves, with placement on steeper curves indicating higher levels of choice impulsivity. Point single k parameter estimates can be obtained to represent not only the overall rate of discounting but also for items with small, medium and large monetary rewards (Kirby et al., 1999). Overall k values can range from 0 (selection of the delayed reward option on all items or no discounting) to 0.25 (selection of the immediate reward option on all items). As previous studies have shown a magnitude effect on discounting rates (k-values decrease as the amount of the rewards increase), k values were separately estimated by using three magnitude categories (Kirby & Petry, 2004): small (€25–35), medium (€50–60) and large (€75–85) delayed rewards. The distributions of k values were normalized by using square root transformation.

STATISTICAL ANALYSES

Analyses were conducted with STATA15 for Windows. Comparison of discounting rates (k index) and impulsivity levels (UPPS-P) between groups was carried out by using analysis of variance (ANOVA, including post hoc pairwise comparisons through Scheffé's procedure). The effect size for pairwise comparisons in the ANOVA analyses was estimated through the Cohen's d coefficient (|d|>0.50 was considered moderate effect size, and |d|>0.80 was considered large effect size). To avoid increases in type I error due to multiple comparisons, Finner's procedure was used (a method included in familywise error rate methods, which offers a more powerful test than Bonferroni correction).

RESULTS

SAMPLE CHARACTERISTICS

Table 1 includes a description of the sociodemographic and ED-related variables of the sample groups. Significant differences were found with respect to age, with AN-BP and BED patients being older than HCs and AN-R patients. For this reason, all pairwise comparisons controlled for this variable. As is to be expected, Eating Disorders Inventory 2 total scores were higher in the ED groups than in HCs.

Table 1 Sample description

		HC $n=80$		AN-R $n=37$		AN-BP $n=19$		BED $n=24$				
		Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*	*F*	*df*	*p*
Age (years old)		23.0	4.43	24.3	7.22	28.6	6.56	33.6	8.59	20.35	3/156	<.001
ED related measures		Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*	*F*	*df*	*p*
EDI-2: total score	α = .921	28.2	17.2	59.2	34.8	104.7	43.1	112.0	42.6	66.75	3/156	<.001
Onset of ED (years old)		—	—	18.35	6.07	18.21	4.58	20.27	8.21	0.73	3/77	.488
Duration of ED (years)		—	—	5.35	6.00	10.53	8.86	12.80	8.81	6.77	3/77	.002
Binges/weekly		—	—	—	—	1.79	3.22	5.08	5.46	5.40	1/41	.025
Purges/weekly		—	—	—	—	4.94	5.34	—	—	—	—	—
BMI present (kg/m^2)		21.62	3.22	16.15	1.83	16.65	0.88	38.86	9.70	141.5	3/156	<.001
BMI maxim (kg/m^2)		23.09	3.94	21.95	3.80	21.40	2.87	39.75	9.35	77.16	3/157	<.001
BMI minim (kg/m^2)		19.77	2.22	15.19	1.85	15.44	1.78	25.65	5.17	77.94	3/156	<.001

Note. HC, healthy controls; AN-R, anorexia restrictive subtype; AN-BP, anorexia bingeing-purging subtype; BED, binge eating disorder; *SD*, standard deviation. *df*, degrees of freedom; EDI-2, Eating Disorder Inventory 2; BMI, body mass index.

COMPARISON OF DELAY DISCOUNTING AND IMPULSIVITY LEVELS BETWEEN GROUPS

Table 2 contains the results of the ANOVA comparing k-index values (for small, medium, large and overall rewards) between groups. Compared with the other ED groups, k values for patients with AN-R were significantly lower, indicating lower levels of delayed discounting. In comparison with HCs and AN-R patients, both BED and AN-BP patients presented significantly higher levels of delay discounting. No significant differences were obtained between BED and AN-BP patients in

terms of k-values.

Table 2 Comparison of delayed discounting and UPPS-P impulsivity traits between groups: ANOVA

	Means and standard deviation								Pairwise comparisons											
	HC $n = 80$		AN-R $n = 37$		AN-BP $n = 19$		BED $n = 24$		HC vs AN-R		HC vs AN-BP		HC vs BED		AN-R vs AN-BP		AN-R vs BED		AN-BP vs BED	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*p*	|*d*|	*p*	|*d*|	*p*	|*d*|	*p*	|*d*|	*p*	|*d*|	*p*	|*d*|
k-small	0.179	0.116	0.147	0.109	0.249	0.136	0.248	0.160	.205	0.28	.029*	0.55†	.017*	0.52†	.004*	0.82†	.002*	0.74†	.995	0.01
k-medium	0.148	0.114	0.097	0.056	0.214	0.142	0.195	0.163	.031*	0.56†	.027*	0.51†	.079	0.34	.001*	1.08†	.002*	0.81†	.607	0.12
k-large	0.107	0.096	0.075	0.055	0.187	0.174	0.161	0.124	.129	0.41	.003*	0.57†	.030*	0.55†	.001*	0.87†	.002*	0.89†	.419	0.17
k-overall	0.139	0.100	0.101	0.065	0.218	0.149	0.194	0.139	.076	0.45	.005*	0.62†	.028*	0.51†	.001*	1.02†	.001*	0.86†	.476	0.16
Premedit	21.1	4.57	19.9	5.19	21.0	7.09	23.7	5.86	.225	0.26	.919	0.02	.037*	0.52†	.446	0.18	.006*	0.70†	.096	0.42
Persever	18.9	3.67	18.9	5.21	21.4	5.69	25.0	5.05	.958	0.01	.035*	0.51†	.001*	1.38†	.050*	0.51†	.001*	1.20†	.010*	0.67†
Sensation S	28.0	7.16	24.1	6.47	24.4	7.69	21.8	7.74	.008*	0.56†	.049*	0.54†	.001*	0.83†	.888	0.04	.214	0.33	.234	0.34
P.urgency	26.1	6.13	27.2	7.99	34.3	4.83	34.0	5.27	.363	0.16	.001*	1.48†	.001*	1.39†	.001*	1.06†	.001*	1.00†	.910	0.04
N.urgency	21.3	7.28	21.7	6.58	28.9	9.45	28.6	9.42	.800	0.06	.001*	0.90†	.001*	0.87†	.002*	0.88†	.002*	0.85†	.911	0.03

Note. HC, healthy control; AN-R, anorexia restrictive; AN-BP, anorexia bingeing-purging; BED, binge eating disorder.
M, mean; SD, standard deviation.
k-square root transformation index. Premedit, lack of premeditation; Persever, lack of perseverance; sensation S, sensation seeking; P.urgency, positive urgency; N.urgency, negative urgency.
*Bold: significant pairwise comparison.
†Bold: moderate ($|d| > 0.50$) to large effect size ($|d| > 0.80$).

The first panel of Figure 1 displays the group means of the k indexes measuring delay discounting for small, medium and large rewards. The second panel includes boxplots for overall k indexes separated by group.

In terms of UPPS-P, we found significant differences between groups in multiple dimensions. Compared with HCs, lack of premeditation scores were found to be higher in BED patients. Lack of perseverance scores were also higher in AN-BP and BED patients compared with HCs. The same pattern held true for both positive and negative urgency. Finally, all ED groups obtained lower scores on sensation seeking compared with HCs.

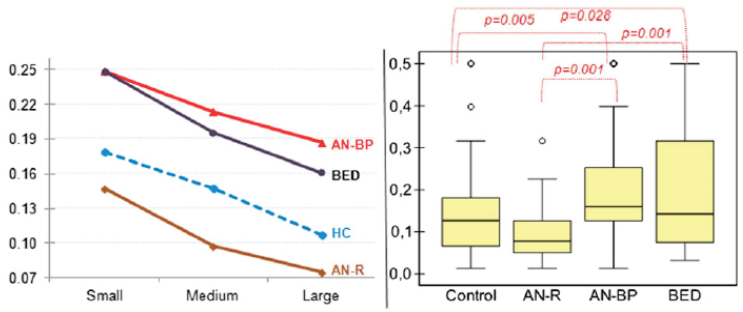

Figure 1. First panel: mean discount rate (*y*-axis) as a function of delayed reward magnitude (*x*-axis); second panel: boxplot for overall *k* values. *Note*. HC, healthy control; AN-R, anorexia restrictive; AN-BP, anorexia bingeing-purging; BED, binge eating disorder *k*-value expressed in square root. [Colour figure can be viewed at wileyonlinelibrary.com]

DISCUSSION

In this study, we aimed to compare delay discounting and impulsivity in HCs and in patients in extreme-weight conditions, namely, AN and BED, emphasizing the differences between bulimic-spectrum disorders and AN-R.

Anorexia nervosa-bingeing/purging subtype patients reported greater ED severity in comparison with AN-R patients, as is consistent with other studies (DeJong et al., 2013; Edler, Haedt, & Keel, 2007; Lavender et al., 2017). Likewise, as is commonly observed in clinical populations, the mean age of patients with AN was lower than BED patients. For this reason, we chose to control for this variable when making group comparisons.

The findings of the present study dovetail with previous reports of altered monetary delay discounting in patients with EDs and uphold the utility of employing spectrum models to order to understand ED behaviour (Jiménez-Murcia et al., 2015; Wierenga et al., 2014). Similar to other research (Lavagnino, Arnone, Cao, Soares, & Selvaraj, 2016; Mole et al., 2015), we found that patients with BED discounted rewards more steeply than HCs. This tendency may reflect alterations in the neural subprocesses underpinning choice impulsivity such as enhanced salience of immediate reward and/or diminished prospection (Bari & Robbins, 2013). In addition, we found that patients with AN-BP subtype, though not AN-R subtype, had greater discounting than HCs. As such, increased rates of delay discounting may contribute to some of the core symptoms in bulimic spectrum disorders and could therefore represent a relevant target for intervention (Kekic et al., 2016).

Contrastingly, AN-R patients presented less steep discounting rates than the other ED groups. This result coincides with past studies identifying more conservative decision making in AN patients (Decker et al., 2015; Steinglass et al., 2012, 2017). Clinically, patients with AN-R are often described as being more prone to excessive self-control than their AN-BP counterparts, who are characterized as being more undercontrolled (Lavender et al., 2017; Wildes et al., 2011). Our results indicate that these differences may also be relevant in the realm of delay discounting. Steinglass et al. (2012) found that the significant difference in discounting in their AN sample, in comparison with controls, was largely attributable to individuals with AN-R subtype. Although our current findings require replication, they highlight the importance of separating AN subjects by subtype in future studies.

Regarding impulsivity-related traits, patients with bulimic spectrum disorders (AN-BP and BED) showed greater levels of positive and negative urgency, as we hypothesized. This is in line with other research that found that urgency, especially negative urgency, was associated with bingeing and purging behaviours, as well as subjective loss of control of food intake (Claes et al., 2015, Claes et al., 2002; Fischer et al., 2003; Racine et al., 2015; Wolz et al., 2015). Being that neuroimaging evidence has suggested that negative affect increases the rewarding value of food (Bohon & Stice, 2012) and that emotion dysregulation is associated with excess weight (Steward et al., 2016), our

results lend support to the notion that bingeing behaviours could mainly be negatively reinforcing (Berner et al., 2017). Other researchers have found the tendency to act rashly when experiencing strong emotions (i.e. urgency) and greater discounting of delayed monetary rewards to be associated with higher score food addiction (VanderBroek-Stice et al., 2017). In addition, the authors of this study found, via mediation analyses, indirect effects among urgency, delay discounting and obesity by way of food addiction. Taken the study mentioned in the preceding texts into account, these domains may represent an etiological pathway contributing to bingeing behaviours, although longitudinal studies would be needed to validate this hypothesis. It is worth noting that we failed to identify any differences between reported positive and negative urgency between HCs and AN-R patients. These findings raise the question whether the persistent choice of inadequate caloric intake may be linked to disproportionate self-control for AN-R patients and more emotionally driven for AN-BP patients (Steinglass & Walsh, 2016). Empirical studies on the effectiveness of treatment approaches focused on these features, such as overcontrol in the case of AN-R patients (Lynch et al., 2013; Lynch, Hempel, & Dunkley, 2015) or impulsivity for patients with bulimic-spectrum disorders (Giner-Bartolomé et al., 2016; McClelland et al., 2016; Val-Laillet et al., 2015).

LIMITATIONS AND FUTURE RESEARCH

Although this study has its strengths, there are limitations that should be considered when interpreting its results. First, age is a significant factor in determining delay discounting and impulsivity levels. Even though we controlled for this variable in our statistical analyses, future studies should ideally aim to match control and patients as much as is practically possible. Second, delay discounting was measured through a monetary reward task. However, taking ED features into account, it would be of interest to assess delay discounting effects by using other types of reward (e.g. food). Third, context and emotional state are understood to influence decision making and delay discounting (Kaplan et al., 2016; Lempert & Phelps, 2016), although our study did not assess the present mood or economic situation of the subjects while they completed the study measures. Fourth, in the present study, only AN and BED were included in our sample, being that the prime focus of this study was on extreme-weight conditions. Future research should also examine other EDs (i.e. BN and other specified feeding or eating disorders). Finally, more longitudinal studies with larger samples are needed to estimate the predictive capacity of decision making and impulsivity dimensions on ED treatment outcome (Steward, Mestre-Bach, et al., 2016).

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STUDY 2

DELAY DISCOUNTING AND IMPULSIVITY TRAITS IN YOUNG AND OLDER GAMBLING DISORDER PATIENTS

Steward, T.*, Mestre-Bach, G.*, Fernández-Aranda, F., Granero, R., Perales, J.C., Navas, J.F., Soriano-Mas, C., Baño, M., Fernández-Formoso, J.A., Martín-Romera, V., Menchón, J.M., Jiménez-Murcia, S., 2017. Delay discounting and impulsivity traits in young and older gambling disorder patients. Addict. Behav. 71, 96–103 (IF: 2.944; Q1 in categories "Psychology, clinical" and "Substance abuse").

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DELAY DISCOUNTING AND IMPULSIVITY TRAITS IN YOUNG AND OLDER GAMBLING DISORDER PATIENTS

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ABSTRACT

Background: Impulsivity is understood to be a multidimensional construct involving aspects such as impulsive choice and impulsive traits. Delay discounting, the tendency to place greater value in immediate rewards over larger, long-term rewards, has been associated with maladaptive choices in gambling disorder (GD). Delay discounting is known to evolve with age; though no study to date has evaluated the interactions between impulsivity, GD severity and age in treatment-seeking patients. **Objectives:** We aimed to examine whether associations between delay discounting and impulsivity traits differed between younger and older-aged GD patients. Secondly, we sought to untangle the mediating role of impulsivity in determining gambling behavior in these two age groups. **Methods:** GD patients (N = 335) were evaluated using the UPPS-P Impulsive Behavior Scale and a delay discounting task. Structural Equation Modeling (SEM) was used to explore associations between impulsivity measures and gambling severity in young (18–30 years) and old (31–70) GD patients. **Results:** No differences in delay discounting were found between young and old GD patients. Significant correlations between delay discounting and urgency levels (the tendency to act rashly under emotional states) were identified only in the young GD group. Path analyses also revealed both positive and negative urgency to be a mediator of GD severity levels in young GD patients. **Discussion and conclusions:** Significant associations between impulsive choice and positive urgency are only present in young gamblers, suggesting that positive urgency influence choice behavior to a greater degree at younger ages. Implications for targeted interventions are discussed.

Keywords
Delay discounting, gambling disorder, impulsivity, age, urgency.

HIGHLIGHTS

• Delay discounting has been linked with gambling severity in previous research.

• We assessed the association between delay discounting, impulsivity and age in patients with gambling disorder.

• No significant differences in delay discounting were identified between younger and older gambling patients.

• Positive correlations between impulsivity traits and delay discounting were found in younger patients.

• Our findings uphold the existence of differing impulsivity mechanisms in younger and older gamblers.

1. INTRODUCTION

Gambling disorder (GD) is strongly linked with dysfunction across multiple cognitive domains, many of which can be considered in terms of impulsivity (Del Prete et al., 2017; Grant, Odlaug, & Chamberlain, 2016;Mackillop et al., 2014). However, due to the numerous ways by which it can be measured, impulsivity is increasingly understood to be a multidimensional construct (Evenden, 1999; Mackillop et al., 2016).Motor impulsivity is thought to reflect a dysregulation of outward behavior due to decreased inhibitory control. Contrastingly, impulsive choice is characterized as an individual's motivational and decision-making style (e.g. choosing immediate gratification over larger, delayed rewards) (Grant & Chamberlain, 2014). Lastly, impulsive personality traits are thought to be indicative of individual's ability to self-regulate dominant preferences (e.g., to act without deliberation, to give up on tasks) (Cyders & Smith, 2008b).

In recent years, given the heterogeneity of impulsivity models, attempts at developing more inclusive models have been made. For example, the UPPS-P framework identifies five separate impulsivity related traits. These subscales are: (lack of) premeditation and perseverance, positive and negative urgency, and sensation seeking (Berg, Latzman, Bliwise, & Lilienfeld, 2015). Urgency (emotion-laden impulsivity) has specifically been found to distinguish between treatment-seeking pathological gamblers and controls, and to be linked to affective mechanisms related to problem gambling. This approach allows for a more comprehensive assessment of the associations between impulsive traits and GD (Canale, Vieno, Bowden-Jones, & Billieux, 2017; Canale, Vieno, Griffiths, Rubaltelli, & Santinello, 2015a) than general personality constructs.

Impulsive choice and urgency have been found to be strongly linked to gambling severity, though results on the existence of associations between motor impulsivity and GD severity levels are inconsistent (Brevers et al., 2012; Torres et al., 2013). This three-factor model of impulsivity has been tested in large samples and has been found to properly reflect meaningful and quantitatively discrete domains of impulsivity (Mackillop et al., 2016). Few studies to date, however, have conducted a within-subject comparison of these aspects of impulsivity in GD patients while taking factors such as age into account. Epidemiological research suggests a negative correlation between chronological age and impulsivity in non-clinical populations (Galvan, Hare, Voss, Glover, & Casey, 2007; Steinberg et al., 2008). As a majority of GD patients report first engaging in gambling behavior at a young age (Granero et al., 2013), empirical studies would be useful to gain a better understanding of whether this association between age and choice impulsivity is also present in the GD phenotype.

One of the most widely utilized indices of choice impulsivity is delay discounting (i.e. temporal discounting) (Amlung, Vedelago, Acker, Balodis, & Mackillop, 2017). Delay discounting refers to the subjective devaluation of rewards according to the temporal delay of their receipt, and is

commonly measured by presenting subjects with questions in which a choice must be made between a smaller-immediate or a larger-delayed reward (e.g. 'Would you prefer € 31 now or € 85 in 7 days?') (Madden & Bickel, 2009). At each delay, indifference points are plotted and a delay discounting curve is modeled using a hyperbolic function. This function yields the derived parameter, k, which corresponds to an individual's discount rate. Larger k values indicate steeper discounting and thus, increased choice impulsivity (Kirby, Petry, & Bickel, 1999).

Multiple studies have found that GD patients present higher levels of delay discounting than control subjects (Albein-Urios, Martinez-González, Lozano, & Verdejo-Garcia, 2014; Amlung et al., 2017; Dixon, Marley, & Jacobs, 2003; Krmpotich et al., 2015; Petry, 2001), and that gamblers with steeper delay discounting show greater risk taking, poorer decision making and higher levels of bet chasing (Kräplin et al., 2014b). Alterations in delay discounting are believed to be underpinned by a hypoactive reward system, which modify reward representations and consequently influence behavior (Madden & Bickel, 2009). Other research, however, has not found a direct association between impulsive choice and GD severity levels, though GD severity has been found to highly correlate with other impulsive traits, such as acting without proper planning (Brevers et al., 2012; Secades-Villa, Martínez-Loredo, Grande-Gosende, & Fernández-Hermida, 2016).

The neural areas associated with impulsivity continue to develop into the young adulthood (Giedd, 2004); therefore, the relationship between delay discounting and impulsive action, such as gambling behavior, could very well be distinct in younger versus older adults. Indeed, studies in young men at increased risk of engaging in HIV risk behaviors and in adolescents with bipolar disorders have identified increased monetary delay discounting to be linked to age-specific risky behavior and improvements in delay tolerance, respectively (Jones & Sullivan, 2016; Urošević, Youngstrom, Collins, Jensen, & Luciana, 2016). Another study specifically examining the mediating effects of decision making in trait urgency and gambling problems in young adults found age-related differences, with young people tending to act rashly in response to extreme moods and having lower levels of deliberative decision making (Canale, Vieno, Griffiths, Rubaltelli, & Santinello, 2015b). The sample in this study however only consisted of students aged 16–25 and did not explore how associations between delay discounting and gambling behavior evolved into older adulthood. Moreover, as opposed to the present study, the community-based nature of Canale et al. (2015b), does not allow for determining whether such associations hold true in a clinical setting in which GD severity levels are higher.

With excessive delay discounting identified as a process underlying a wide variety of clinical conditions, increased attention has been given to understanding how individuals' discount rates change with age. Developmental studies point to deliberative decision-making abilities maturing over time, and to emotionally-charged impulsivity (i.e. urgency) being heightened during adolescence compared to adulthood (Cyders & Smith, 2008a). Relatedly, urgency and lack of premeditation significantly correlate with each other in adolescents (Tomko, Prisciandaro, Falls, & Magid, 2016).

Studies have found that relying upon decision-making processes largely based on emotion appraisal decreases adolescents ability to delay gratification, and is linked to participation delinquent behaviors including, substance use and risky sex (Wardell, Strang, & Hendershot, 2016; Wolff & Crockett, 2011).

More specifically, changes in discount rates can be interpreted from the perspective of the competing neurobehavioral decision systems theory, which describes a combination of developmental neurological and behavioral processes that account for delay discounting (Koffarnus, Jarmolowicz, Mueller, & Bickel, 2013). Younger gamblers could be less able to successfully inhibit impulsive choices that they would be unlikely to engage in if not for their vulnerability to their particular emotional state (i.e. positive and/or negative urgency). As such, disentangling the decision-making components of GD in the context of age could potentially allow for the development of targeted intervention strategies that focus on emotion regulation and impulsive control strategies (Jiménez-Murcia et al., 2013; Jiménez-Murcia et al., 2015; Kräplin et al., 2014b; Lobo et al., 2014). Recent research has highlighted the possible existence of a GD patient subgroup characterized by young age, early problem gambling onset and more dysfunctional personality traits (Granero et al., 2013); yet little is known on how choice impulsivity factors into the these age-divided subgroups.

The purpose of this research was two-fold. Our first aim was to examine whether the associations between delay discounting and impulsivity varied between younger and older treatment-seeking GD patients. Our second aim was to identify the mediating role of impulsivity factors between age and GD severity levels by means of path analysis. Being that empirically derived k values from delay-discounting tasks are context sensitive and are not constant across various settings (Dixon, Jacobs, & Sanders, 2006), we did not hypothesize that significant differences in choice impulsivity would exist between younger and older GD patients. Integrating the abovementioned evidence about (1) age dependent overlapping between decision-making styles –including choice impulsivity- and affect regulation (Berns, Laibson, & Loewenstein, 2007), (2) the heightened sensitivity of young people with gambling and other self-regulation problems to positive emotions and motives (Littlefield, Sher, & Wood, 2010; Navas et al., 2017), and (3) the prominent prognostic and diagnostic value of urgency with regard to GD (Canale et al., 2017), it is possible to build a tentative model of the relationships between age, choice impulsivity, urgency, and gambling severity. Specifically, we expect choice impulsivity to predict severity only through its shared variability with urgency, and this path –particularly its positive urgency component- to be more evident in younger gamblers.

2. MATERIALS AND METHODS

2.1. PARTICIPANTS

The sample consisted of 335 patients with a diagnosis of GD who were being treated at the Gambling Disorder Unit within the Department of Psychiatry at Bellvitge University Hospital (Barcelona,

Spain). This public hospital is certified as a tertiary care center for the treatment of addictive behaviors and oversees the treatment of very complex cases. Patients were derived to the Bellvitge University Hospital Gambling Disorder Unit through general practitioners or via another healthcare professional; some patients were derived from prison health services, though their treatment was not compulsory. All the patients were consecutive referrals for assessment and treatment from July 2013 to December 2014. Experienced psychologists and psychiatrists conducted two face-to-face clinical interviews before a diagnosis was given and only patients who met DSM-5 criteria for GD (APA, 2013) were included in our sample. Sociodemographic and additional clinical information was taken, and patients individually completed all the questionnaires required for this study (requiring approximately 2 h) before initiating outpatient treatment. Only patients who sought treatment for GD as their primary health concern were admitted to this study. Exclusion criteria were: the presence of an organic mental disorder, intellectual disability, a neurodegenerative condition, such as Parkinson's disease, or an active psychotic disorder.

Participants were classified in two groups according to their chronological age: young gamblers (between 18 and 30 years-old, n = 67, 20.4%) versus older gamblers (31 to 70 years-old, n = 261, 79.6%). The reasons for selecting 30 years of age as a cut-off were: a) other studies in addiction research have used this age to divide younger and older samples (Fidler, Ferguson, Brown, Stapleton, & West, 2013); and b) neurodevelopment is generally understood to reach adulthood at the age of 30 (Mukherjee et al., 2016).

The present study was carried out in accordance with the latest version of the Declaration of Helsinki. The University Hospital of Bellvitge Ethics Committee of Clinical Research approved the study, and written informed consent was obtained from all participants.

2.2. INSTRUMENTS

2.2.1. DSM-5 CRITERIA (APA, 2013)

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

2.2.2. SOUTH OAKS GAMBLING SCREEN (SOGS) (LESIEUR & BLUME, 1987)

This self-report 20-item screening questionnaire discriminates between probable pathological, problem and non-problem gamblers. The Spanish validation used in this work showed excellent internal consistency ($\alpha = 0.94$) and test-retest reliability ($r = 0.98$) (Echeburúa, Báez, Fernández, & Páez, 1994).

2.2.3. ALCOHOL USE DISORDERS IDENTIFICATION TEST (AUDIT) (SAUNDERS, AASLAND, BABOR, DE LA FUENTE, & GRANT, 1993)

This test was developed as a simple screening method for excessive alcohol consumption. Internal consistency has been found to be high, and rest-retest data have suggested a high reliability (0.86) and a sensitivity of around 0.90. Specificity in different settings and for different criteria averages 0.80 or more (Martínez, 1999). In this work, cut-off points of 8 and 20 were used to identify individuals with alcohol abuse and alcohol dependence, respectively (Reinert & Allen, 2002).

2.2.4. IMPULSIVE BEHAVIOR SCALE (UPPS-P) (WHITESIDE, LYNAM, MILLER, & REYNOLDS, 2001)

The UPPS-P measures five facets of impulsive behavior through self-report on 59 items: negative urgency; positive urgency; lack of premeditation; lack of perseverance; and sensation seeking. Individuals are asked to consider acts/incidents during the last 6 months when rating their behavior and attitudes. The Spanish-language adaptation shows good reliability (Cronbach's α between 0.79 and 0.93) and external validity (Verdejo-García, Lozano, Moya, Alcázar, & Pérez-García, 2010). Consistency in the study sample was between good (α=0.75 for lack of perseverance scale) to excellent (α = 0.92 for positive urgency).

2.2.5. DELAY DISCOUNTING TASK (KIRBY ET AL., 1999)

This task is a 27-item self-administered tool used to elicit individual inter-temporal discount rates (k), providing a set of alternative choices between a smaller, immediate monetary reward and a larger, delayed monetary reward. Each of these questions was designed to correspond to a different k-value, which constitutes the measure of discounting rate and represents the amount of discounting of the later reward that renders it equal to the smaller reward. The protocol is scored by calculating where the respondent's answers place him/her amid reference discounting curves, where placement amid steeper curves indicates higher levels of impulsivity. Point single k parameter-estimates can be obtained to represent the overall rate of discounting, but also for items with small, medium and large monetary rewards (Kirby et al., 1999). k-values can range from 0 (selection of the delayed reward option for all items, or no discounting) to 0.25 (selection of the immediate reward option for all items, or always discounting). According to many studies using the Delay Discounting Task, the distributions of k-values were approximately normalized using the natural log transformation (n log k values) for the statistical significance tests in this work. In addition, according to previous results showing a magnitude effect on discount rates (k-values decrease as the amount of the rewards increase), delay discounting was estimated for overall questionnaire and separately for three magnitude categories (Kirby, Petry, & Kirby, 2004): small delayed rewards (€25–35), medium delayed rewards (€50–60) and large delayed rewards (€75–85).

2.2.6. OTHER SOCIODEMOGRAPHIC AND CLINICAL VARIABLES

Additional demographic, clinical, and social/family variables related to gambling were measured using a semi-structured face-to-face clinical interview described elsewhere (Jiménez-Murcia, Aymamí-Sanromà, Gómez-Peña, Álvarez-Moya, & Vallejo, 2006).

2.3. STATISTICAL ANALYSIS

Statistical analysis was carried out using Stata13.1 for Windows. Due the strong association between sex with impulsivity measures and age, all the analyses were controlled including the participants' sex as a covariate to avoid biases due to this potential confounding factor.

First, partial correlations (R) estimated the association between positive urgency, negative urgency, and delayed discounting measures. Since significance levels for correlations coefficients are strongly related to sample size, only coefficients with moderate (|R| N 0.24) to good (|R| N 0.30) effect size were considered as relevant in this study (Kelley & Preacher, 2012).

Second, Structural Equation Modeling (SEM) tested the hypothesized meditational model. The Maximum Likelihood method of parameter estimation was used and adequate goodness-of-fit was considered via the following criteria (Barrett, 2007): chi-square test ($\chi 2$) with non-significant result being p N 0.05, Root Mean Square Error of Approximation (RMSEA) being b0.08, Bentler's Comparative Fit Index (CFI) being N0.90, Tucker-Lewis Index (TLI) being N0.90, and Standardized Root Mean Square Residual (SRMR) being b0.1. The global predictive capacity of the model was measured with the Coefficient of Determination (CD). An initial model for the total sample was estimated, and next a multiple-group model assessed the potential invariance of the participants' age group (18 to 30 versus 31 to 70).

3. RESULTS

3.1. SAMPLE DESCRIPTION

Table 1 contains the frequency distribution of all the variables in the study for the total sample (n = 328) and a comparison of the two age groups. Significantly higher values appeared in the older age group with respect to the prevalence of previous consultation for gambling problems, gambling duration, personal income, and accumulated gambling debts. Higher mean scores in the three primary UPPS-P scales (lack of premeditation, lack of perseverance and sensation seeking) were found in the younger age group.

Table 1
Descriptive for sample.

	Total		Age: 18 to 30		Age: 31 to 70		p-Value
	(n = 328)		(n = 67)		(n = 261)		
Gender; *n*-%							
Males	292	89.0%	63	94.0%	229	87.7%	0.142
Origin; *n*-%							
Spain	320	97.6%	64	95.5%	256	98.1%	0.225
Education level; *n*-%							
Primary	183	55.8%	31	46.3%	152	58.2%	0.208
Secondary	111	33.8%	28	41.8%	83	31.8%	
University	34	10.4%	8	11.9%	26	10.0%	
Civil status; *n*-%							
Single	120	36.6%	50	74.6%	70	26.8%	**<0.001**
Married - with partner	175	53.4%	16	23.9%	159	60.9%	
Divorced - separated	33	10.1%	1	1.5%	32	12.3%	
Employment; *n*-%							
Employed	151	46.0%	30	44.8%	121	46.4%	0.816
Smoker; *n*-%	182	55.5%	34	50.7%	148	56.7%	0.381
Alcohol (AUDIT); *n*-%							
Null-low	281	85.7%	57	85.1%	224	85.8%	0.130
Risk	44	13.4%	8	11.9%	36	13.8%	
Dependence	3	0.9%	2	3.0%	1	0.4%	
Other drugs use-abuse; *n*-%	37	11.3%	8	11.9%	29	11.1%	0.848
Previous consultation for GD; *n*-%	61	18.6%	3	4.5%	58	22.2%	**0.001**
Age (years-old); Mean-SD	42.24	13.73	23.91	4.64	46.94	11.08	**<0.001**
Age of onset (years-old); Mean-SD	36.98	13.99	21.30	5.12	41.01	12.64	**<0.001**
Duration of gambling (years); Mean-SD	14.10	10.37	5.97	3.42	16.19	10.53	**<0.001**
Own incomes (euros); Mean-SD	1144.8	857.3	753.0	508.0	1245.4	899.6	**<0.001**
Family incomes (euros); Mean-SD	1966.8	1108.1	2021.7	1171.8	1952.7	1093.0	0.650
Bets: maximum-episode (euros); Mean-SD	1146.3	4005.3	1296.6	3925.9	1107.7	4032.0	0.731
Bets: mean-episode (euros); Mean-SD	121.3	390.9	105.2	284.3	125.4	414.2	0.705
Cumulate debs (euros); Mean-SD	12,941.9	50,211.5	2011.5	5365.6	15,747.8	55,900.8	**0.046**
UPPS-P: lack premeditation	23.95	6.32	26.12	6.13	23.40	6.26	**0.002**
UPPS-P: lack perseverance	22.29	5.36	23.76	5.50	21.91	5.27	**0.012**
UPPS-P: sensation seeking	26.88	8.44	31.88	7.84	25.60	8.12	**<0.001**
UPPS-P: positive UR	32.13	10.43	30.94	9.83	32.44	10.58	0.294
UPPS-P: negative UR	33.25	7.20	32.70	7.37	33.39	7.17	0.488
Delay discounting: k-index small	0.0941	0.0892	0.0821	0.0796	0.0971	0.0913	0.219
Delay discounting: k-index medium	0.0770	0.0916	0.0671	0.0804	0.0795	0.0943	0.323
Delay discounting: k-index large	0.0613	0.0864	0.0591	0.0778	0.0619	0.0887	0.813
Delay discounting: k-index overall	0.0727	0.0886	0.0637	0.0756	0.0750	0.0916	0.352

Note. SD: standard deviation. p-Value obtained with χ^2 test for categorical variables and *t*-test for quantitative variables.
Bold: significant comparison (0.05 level).

3.2. DISTRIBUTION OF DISCOUNTING-RATE MEASURES

In this study, discounting-rate parameters (k-index) ranged from 0.00016 to 0.25 for the three rewards sizes (small-medium-large) (Table 1). 57 (17.4%) patients always chose the immediate reward for items with small reward, 58 (17.7%) for items with medium reward and 44 (13.4%) for items with large reward (for the overall questionnaire, immediate reward was always chosen by 42 patients, 12.8%). Around 15% of k-indexes represented participants who discounted very little (the percentage of responses choosing the later reward was 50% or higher), while around 60% represented patients who discounted high (the percentage of responses choosing the later reward was 30% or lower). Seven patients (2.09%) from the candidate sample were excluded due to inconsistent results (consistency indexes lower than 75% were considered inconsistent (Kaplan et al., 2016a)). Fig. S1 (supplementary) shows the mean discount rate (k-index) for the three different reward sizes considered (small, medium and large). The mean trends in the line-graph concurred with other studies using real rewards: a magnitude effect emerged reflecting a decrease in discount rates as the reward amount increased.

3.3. ASSOCIATION BETWEEN DELAYED DISCOUNTING WITH IMPULSIVITY

Table 2
Partial correlations (adjusted for sex) between delayed discounting measures with impulsivity.

	Age: 18 to 30 years-old ($n = 67$)				Age: 31 to 70 years-old ($n = 261$)			
	k-Small	k-Medium	k-Large	k-Overall	k-Small	k-Medium	k-Large	k-Overall
UPPS-P: lack premeditation	0.22	0.23	**0.32**††	**0.30**††	0.07	0.09	0.05	0.08
UPPS-P: lack perseverance	0.09	0.09	0.22	0.16	0.09	0.10	0.07	0.09
UPPS-P: sensation seeking	0.03	−0.02	−0.03	0.01	−0.01	−0.02	−0.02	−0.02
UPPS-P: positive UR	**0.28**†	0.18	**0.27**†	0.24	0.10	0.10	0.11	0.12
UPPS-P: negative UR	**0.47**††	**0.38**††	**0.42**††	**0.44**††	0.13	0.11	0.11	0.12

Note. Bold: †moderate ($|r| > 0.24$) to ††good effect size ($|r| > 0.30$).
Natural log transformation for k-index is analyzed (*n*log k).

Table 2 contains the partial correlations (adjusted for sex) between delayed discounting and the UPPS-P. No relevant associations were found in patients in the older GD patient group. However, in the younger GD group, significant positive correlations emerged between lack of premeditation with k-large and k-overall measures, positive urgency with k-small and k-large scores, and negative urgency with all discounting scores) (Table 3).

Table 3
Partial correlations (adjusted for participants' sex) between impulsivity and delayed discounting with clinical measures.

	Impulsive behavior scale (UPPS-P)					Monetary change questionnaire			
	Pre-medit.	Per-sever.	Sens. seek.	Posit. UR	Negat. UR	k-Index small	k-Index medium	k-Index large	k-Index overall
Age: 18 to 30 ($n = 67$)									
Onset GD (years-old)	−0.24	**−0.41**††	−0.20	**−0.29**†	−0.09	−0.08	−0.06	−0.06	−0.08
Duration GD (years)	0.20	0.10	0.08	0.24	0.16	**0.26**†	**0.34**††	**0.25**†	**0.28**†
Maximum bets (€)	0.23	0.13	0.08	0.11	−0.04	0.17	0.20	**0.27**†	0.21
Mean bets (€)	**0.33**††	0.02	0.18	0.01	−0.04	0.09	0.16	0.16	0.17
Cumulate debts (€)	0.11	−0.05	0.05	−0.12	−0.05	0.15	0.15	0.19	0.20
SOGS: total	0.15	0.17	0.02	0.24	**0.30**††	0.09	0.10	0.14	0.11
DSM-IV criteria: total	0.12	0.09	0.05	**0.33**††	**0.34**††	0.15	0.08	0.18	0.13
Alcohol level: AUDIT total score	−0.06	0.00	**0.31**†	0.14	0.13	0.21	0.14	0.19	0.23
Age: 31 to 70 ($n = 261$)									
Onset GD (years-old)	−0.19	−0.12	−0.19	0.01	−0.08	−0.12	−0.09	−0.07	−0.09
Duration GD (years)	0.10	0.14	0.14	0.07	0.08	0.11	0.12	0.12	0.12
Maximum bets (€)	0.00	0.02	0.06	0.02	−0.05	−0.06	−0.06	−0.08	−0.07
Mean bets (€)	0.03	0.02	0.12	0.11	0.03	0.03	0.01	−0.07	−0.01
Cumulate debts (€) m	0.01	0.01	0.02	0.04	−0.06	−0.06	−0.08	−0.10	−0.07
SOGS: total	0.18	0.08	**0.29**†	0.22	**0.27**†	0.17	0.13	0.14	0.16
DSM-IV criteria: total	0.21	0.12	0.16	**0.27**†	**0.34**†	0.10	0.06	0.06	0.08
Alcohol level: AUDIT total score	0.02	0.00	−0.02	0.10	0.07	0.13	0.13	0.13	0.13

Note. Bold: †moderate ($|r| > 0.24$) to ††good effect size ($|r| > 0.30$).
Natural log transformation for k-index is analyzed (*n*log k).
UPPS-P scales: lack of premeditation, lack of perseverance, sensation seeking, positive UR, negative UR.

3.4. SEM ANALYSIS

The first panel in Fig. 1 contains the path-diagram (standardized coefficients and fitting indexes) obtained in the SEM estimated for the total sample, measuring the contribution of the patients' age, delay discounting (the k-overall index) and urgency levels with gambling severity (number of DSM-5 total criteria). As one of the objectives of the current study was to determine age differences between associations of impulsivity and gambling severity, invariance by the participants' age was measured (see Table S1, supplementary). The second panel in Fig. 1 includes the results of the two-group SEM, which obtained adequate goodness-of-fit indexes and moderate global predictive capacity (CD around 0.16).

For the younger group, higher GD severity was directly associated with higher impulsivity levels (in both positive and negative urgency). Delay discounting scores did not directly contribute to GD

severity, but indirect effects emerged through mediational paths via impulsivity: high delay discounting predicted higher positive and negative urgency levels, which also contributed to increased GD severity. For the older group, a lower number of significant paths emerged. As in the younger group, delay discounting significantly contributed to urgency levels in the older GD group; however, GD severity was only directly related to negative urgency levels. Table S2 (supplementary) contains the complete parameters for the two-group SEM, and Table S3 (supplementary), the decomposition of effects for the mediating variables of the diagram-paths in direct, indirect and total effects.

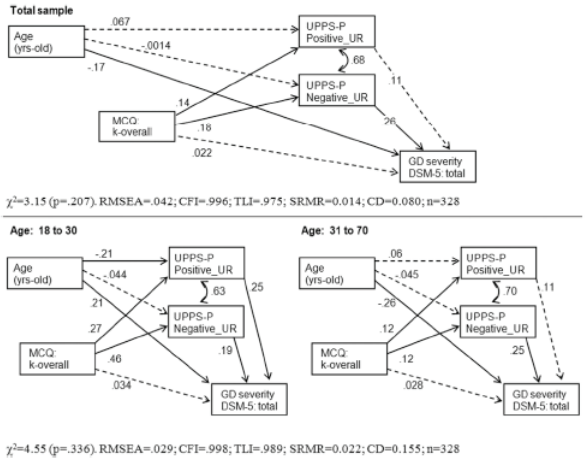

Fig. 1. SEM, standardized coefficients and goodness-of-fit indexes (results adjusted by sex). Continuous line = significant coefficient. Discontinuous line: non-significant coefficient.

4. DISCUSSION

This study analyzed whether there were variations in impulsivity domains between younger and older-aged treatment-seeking GD patients. More specifically, we sought to examine the interplay between GD severity, impulsive traits and delay discounting in two age groups. Keeping with our first hypothesis, no significant differences in choice impulsivity were found between younger and older-aged GD patients. Suitable reasons as to why these two groups obtained similar results in delay discounting can be explained by taking GD severity into account. Both groups had similar GD severity levels and previous studies have reported higher levels of impulsivity choice in GD patients, suggesting that this association scales to GD severity levels (Amlung et al., 2017; Petry, 2001).

Moreover, in accordance with previous research (Mackillop et al., 2016; Michalczuk, Bowden-Jones, Verdejo-Garcia, & Clark, 2011), our findings uphold that there were positive correlations between impulsive traits and choice impulsivity in younger gamblers. Namely, the traits that showed a greater association with choice impulsivity were lack of premeditation, positive urgency and negative urgency. This is in line with other epidemiological research suggesting that negative urgency is positively associated with GD severity (Billieux et al., 2012).

This leads us to postulate that impulsive choice behavior is frequently linked to negative affective states

and those with high levels of urgency are more likely to make poor choices. Relatedly, taking the arousing effects of gambling activity into account, other research supports that younger people who engage in impulsive behaviors in response to intense positive emotions are more likely to present gambling problems (Canale et al., 2015b). Other possible reasons for the positive correlation with urgency and delay discounting in young people could be related to increased emotional reactivity and reduced ability to regulate emotional experiences. These two factors are characteristic of the early stages of development and are observed in young populations (Henry, Castellini, Moses, & Scott, 2016).

Given that other research has identified noteworthy differences related to gambling motives (Clarke, 2008), action impulsivity (Kräplin et al., 2014a; Odlaug, Chamberlain, Kim, Schreiber, & Grant, 2011) and overall gambling behavior (Bischof et al., 2014; Black et al., 2015; Edgerton, Melnyk, & Roberts, 2014) in younger populations compared to older populations, our study sought to assess the mediating role of choice and trait impulsivity in determining GD severity for these two age groups via path analyses. Our analyses point to a direct association between positive urgency (i.e. the tendency to lose control over behavior or act rashly when feeling exhilarated) and GD severity levels in patients under the age of the 30, though this association was not significant in patients over the age of 30. This finding suggests that the desire to prolong or intensify positive emotions may carry more weight in the impulsive choices of younger gamblers than in older gamblers. This observation dovetails with other research in young people that found that individuals who were unable to inhibit behavior in response to extremely positive moods showed higher enhancement and coping motives, which in turn were positively related to gambling problems (Canale et al., 2015a). Furthermore, higher levels of delay discounting directly correlated with positive and negative urgency in both age groups in our path analyses, suggesting that reported higher levels of temporal discounting in GD patients is linked to a tendency to act out during heightened emotional states as opposed to engaging in rash actions at other times. This finding underscores the importance of taking context into consideration when analyzing choice impulsivity and stresses the need to examine environment-based controlling variables instead of accepting overly simple explanations for differences in delay discounting levels (Andrade & Petry, 2014; Charlton et al., 2013; Dixon et al., 2006; Halfmann, Hedgcock, & Denburg, 2013; Kaplan, Reed, & Jarmolowicz, 2016; Rung & Young, 2015). Lastly, the present data uphold the position that lack of premeditation, understood as the tendency to act without thinking or as a failure to plan ahead, is associated with impaired decision making in young gamblers, a feature reported in many, but not necessarily all, GD patients (Del Prete et al., 2017; Zermatten, Van der Linden, d'Acremont, Jermann, & Bechara, 2005). Younger gamblers might be more likely than older gamblers to choose smaller-immediate rewards over larger-delayed rewards, partly due to the fact that they act without proper forethought. It may be conceivable to personalize adolescent gambling treatment according to personal impulsivity-related traits.

4.1. LIMITATIONS

The present study is not without its limitations. First, the cross-sectional nature of this study prohibits arriving to conclusions regarding causality and the direction of the effects examined. Longitudinal studies are needed to provide important insights on the interplay between impulsive choice, gambling problems, and impulsive traits. Other research, for example, has suggested that delay discounting, financial mismanagement, and addictive behaviors can contribute to one another (Grant & Chamberlain,

2014). Second, delay discounting and impulsivity were assessed using self-report measures that are, in all likelihood, unable to fully capture the spontaneous, non-rational decision-making processes of GD patients (Dixon et al., 2006; Slovic & Peters, 2006). Recent studies have found that applying episodic future thinking or altering the predictability of immediate reward can change delay discounting behavior, indicating that impulsive choice should be considered as reference-dependent (Kaplan et al., 2016b; Lempert, Glimcher, & Phelps, 2015). Third, it would have been of interest to take pharmacotherapy into account, being that GD patients frequently show comorbidities with other disorders (e.g. attention deficit hyperactivity disorder) and that the use of medications could potentially have influenced impulsivity levels (Gray & Climie, 2016). Lastly, our sample was largely made up of male GD patients and the generalizability of our results to other populations should be avoided.

5. CONCLUSIONS

This study provides greater understanding of the multidimensional construct of impulsivity. Our findings suggest that choice impulsivity is associated with impulsive personality traits in younger-aged patients. These results point to the possible existence of differing impulsivity mechanisms in younger and older gamblers, and highlight the weight of positive and negative urgency on influencing impulsive choices in younger gamblers. Ultimately, detailed information on how the three factor model of impulsivity (Mackillop et al., 2016) acts in behavioral addictions will allow for improving prevention and integrated treatment efforts.

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CONTRIBUTORS

SJM, JMM, TS, GMB, RG and FFA designed the study and were involved in developing the research aims. SJM, TS, GMB, JCP, CSM, JFN, FFA and RG aided in the literature search and the framing of the Introduction and Discussion section. RG, TS and VMR conducted the statistical analysis and interpretation of the results. SJM,MB,GMB, and RG contributed to the data collection. TS,GMB, FFA, JCP, JFN, CSM, JAFF, RG and SJM were involved in writing, proofreading and approving the final manuscript. All authors aided in preparing the revised manuscript. All authors have read and approved the final manuscript.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

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Table S1 (supplementary)

Test for group invariance of parameters (group variable: group of age)

		χ^2 (*df*=1)	*p*
Positive UR	Age (years-old)	3.866	**.049**
	Delay discounting: k-overall	1.538	.215
Negative UR	Age (years-old)	0.052	.820
	Delay discounting: k-overall	8.654	**.003**
DSM-5 criteria	Positive-UR	0.852	.356
	Negative-UR	0.112	.738
	Age (years-old)	7.296	**.007**
	Delay discounting: k-overall	0.181	.671

Note. df: degrees of freedom. Bold: significant parameter (.05 level).

Table S2 (supplementary)

Structural equation model; grouping variable: age group

			Coeff.	SE	z	*p*	95%CI coeff.	
Positive_UR	Age (years-old)	18-30 yrs-old	-	0.1122	-1.96	**0.050**	-	-
		31-70 yrs-old	0.2071	0.0612	0.98	0.328	0.4269 - 0.0599	0.0028 0.1799
	Discounting: k-overall	18-30 yrs-old	0.2666	0.1097	2.43	0.015	0.0601 0.0515	0.4816
		31-70 yrs-old	0.1187	0.0607	1.96	**0.050**	0.0003	0.2378
Negative_UR	Age(years-old)	18-30 yrs-old	-	0.1090	-0.40	0.688	-	0.1698
		31-70 yrs-old	0.0438 - 0.0450	0.0613	-0.73	0.463	0.2574 - 0.1651	0.0751
	Discounting: k-overall	18-30 yrs-old	0.4550	0.0921	4.94	**<0.001**	0.2744	0.6355
		31-70 yrs-old	0.1244	0.0607	2.05	**0.040**	0.0056	0.2433
DSM_5criteria	Positive_UR	18-30 yrs-old	0.2533	0.1489	1.990	**0.049**	0.0385	0.5450
		31-70 yrs-old	0.1081	0.0783	1.38	0.167	-	0.2615
	Negative_UR	18-30 yrs-old	0.1942	0.1587	1.22	0.221	0.0453 -	0.5053
		31-70 yrs-old	0.2516	0.0778	3.23	**0.001**	0.1169 0.0991	0.4042
	Age (years-old)	18-30 yrs-old	0.2070	0.1111	1.98	**0.049**	0.0108	0.4248
		31-70 yrs-old	-	0.0533	-4.93	**<0.001**	-	-
	Discounting: k-overall	18-30 yrs-old	0.2626 - 0.0338	0.1253	-0.27	0.787	0.3671 - 0.2795	0.1582 0.2118
		31-70 yrs-old	0.0279	0.0559	0.50	0.618	-	0.1375
Cov	e.Pos_UR,e.Neg-UR	18-30 yrs-old	0.6306	0.0736	8.57	**<0.001**	0.0818 0.4864	0.7748
		31-70 yrs-old	0.6996	0.0316	22.14	**<0.001**	0.6376	0.7615

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

Table S3 (supplementary)

Direct, indirect and total effects for variables into mediating paths; grouping variable: group of age

		Coeff.	SE	z	p	Standard.Coeff.
Direct effect						
Age (years-old)	18-30 yrs-old	0.0979	0.0541	1.81	0.070	0.2070
	31-70 yrs-old	-0.0511	0.0109	-4.69	**<0.001**	-0.2626
k-overall	18-30 yrs-old	-0.0476	0.1766	-0.27	0.787	-0.0338
	31-70 yrs-old	0.0324	0.0650	0.5	0.618	0.0279
Indirect effect						
Age (years-old)	18-30 yrs-old	-0.0288	0.0252	-1.14	0.254	-0.0609
	31-70 yrs-old	-0.0009	0.0043	-0.22	0.826	-0.0048
k-overall	18-30 yrs-old	0.2195	0.1028	2.14	**0.033**	0.1559
	31-70 yrs-old	0.0513	0.0255	2.01	**0.044**	0.0441
Total effect						
Age (years-old)	18-30 yrs-old	0.0691	0.0568	1.22	0.224	0.1461
	31-70 yrs-old	-0.0520	0.0115	-4.52	**<0.001**	-0.2675
k-overall	18-30 yrs-old	0.1719	0.1706	1.01	0.314	0.1220
	31-70 yrs-old	0.0837	0.0688	1.22	0.224	0.0720

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

STUDY 3

DIMENSIONS OF IMPULSIVITY IN GAMBLING DISORDER

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DIMENSIONS OF IMPULSIVITY IN GAMBLING DISORDER

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ABSTRACT

Background and aims: Impulsivity is a multidimensional construct. Although gambling disorder (GD) has been associated with elevated impulsivity, impulsivity across multiple domains has not been deeply investigated. We first aimed to examine whether associations between three facets of impulsivity (response impulsivity, choice impulsivity and impulsive tendency) varied between GD patients and healthy controls (HC). We next aimed to evaluate relationships between these three types of impulsivity, as proposed by theoretical models of impulsivity, and their associations with GD severity. **Methods:** The sample included 97 treatment-seeking adult men with GD, diagnosed according to DSM-5 criteria, and 32 male HC recruited from the general population. **Results:** Greater impulsivity in all three domains was found in men with GD as compared to men without GD. Associations between impulsivity facets were found in both groups, with response impulsivity being the only domain not associated with GD severity. **Discussion and conclusions:** Our findings confirm that multiple domains of impulsivity are relevant in GD. Future studies should examine the extent to which treatments aimed at targeting specific aspects of impulsivity improved outcomes.

Keywords
Gambling disorder; response impulsivity; choice impulsivity; impulsive tendency; delay discounting.

HIGHLIGHTS

- Multiple domains of impulsivity were elevated in gambling disorder patients.

- Positive correlations were observed between impulsive response, choice and tendency.

- Response impulsivity was not associated with gambling-disorder severity.

1.INTRODUCTION

Although impulsivity has been proposed as a multifactorial construct (Mitchell & Potenza, 2014), there is still a lack of consensus regarding its definition and the independence of impulsivity domains (Hodgins & Holub, 2015). Impulsivity has been defined as a tendency to respond with little forethought, often with disregard to the negative consequences to the impulsive individual or others (Moeller, Barratt, Dougherty, Schmitz, & Swann, 2001). Impulsivity has been found to factor into multiple forms, including response and choice forms, that can be measured across species (Fineberg et al., 2010, 2014; Hamilton, Littlefield, et al., 2015; Hamilton, Mitchell, et al., 2015). Response impulsivity, also termed impulsive action or motor impulsivity, involves impairments in delaying, withholding or interrupting inappropriate responses (Chowdhury, Livesey, Blaszczynski, & Harris, 2017; Hamilton, Littlefield, et al., 2015). High levels of this type of impulsivity have been associated with gambling disorder (GD), with GD participants demonstrating differences in response impulsivity in comparison with healthy control (HC) participants (Kertzman et al., 2008), including within treatment-seeking samples (Grant, Chamberlain, Odlaug, Potenza, & Kim, 2010). However, the existence of an association between GD severity and response impulsivity has not been examined in depth (Chowdhury et al., 2017), although some findings suggest a relationship (Brevers et al., 2012; Odlaug, Chamberlain, Kim, Schreiber, & Grant, 2011).

Delay discounting relates to impulsive choice and the extent to which an individual prefers a smaller-sooner over a larger-later reward (Hamilton, Mitchell, et al., 2015; Madden, Francisco, Brewer, & Stein, 2011). In the case of GD, cognitive disturbances related to risk-reward decision making have been reported (Potenza, 2014; Yau & Potenza, 2015), and individuals with GD tend to discount rewards more steeply (Grecucci et al., 2014; Ochoa et al., 2013; Petry, 2001). However, some research on GD severity and choice impulsivity has been inconsistent. Some studies suggest that GD severity and age may be the best statistical predictors of individual differences in delay-discounting rates (Alessi & Petry, 2003; Stea, Hodgins, & Lambert, 2011; Steward et al., 2017). However, some others have found that choice impulsivity cannot discriminate between individuals with problematic gambling and those with GD (Brevers et al., 2012; MacKillop, Anderson, Castelda, Mattson, & Donovick, 2006). Further, some theoretically related constructs (e.g., learning to make advantageous choices during a risk/reward decision-making task) have found GD to associate with disadvantageous decision making whereas others have not (Balodis et al., 2018).

A third form of impulsivity, henceforth termed "impulsive tendency" (also known as impulsivity trait), has been proposed. For example, the Barratt Impulsiveness Scale (BIS-11) has been found to factor into several domains including those relating to motor, non-planning and inattention (Patton, Stanford, & Barratt, 1995; Yip et al., 2018). While the BIS-11 has been studied across diagnostic groups (including in studies linking the measure to biological measures like brain structure in GD, drug addiction and non-addicted states), concerns have been raised regarding inconsistencies in factor structure across studies (Reise, Moore, Sabb, Brown, & London, 2013), including within

GD samples (Reid, Cyders, Moghaddam, & Fong, 2014). On the other hand, the UPPS-P model, derived from the extant literature and updated over time, proposes five factors of impulsivity: (lack of) perseverance, (lack of) premeditation, positive and negative urgency, and sensation seeking (Berg, Latzman, Bliwise, & Lilienfeld, 2015; Whiteside, Lynam, Miller, & Reynolds, 2001). Empirical studies have repeatedly reported an association between GD and impulsive tendencies (Aragay et al., 2018; Canale, Vieno, Bowden-Jones, & Billieux, 2017; Mestre-Bach et al., 2018; Savvidou et al., 2017). In particular, higher lack of perseverance, and positive and negative urgency levels have been found to be the features that best distinguish between patients with GD and HC (Billieux et al., 2012; Michalczuk, Bowden-Jones, Verdejo-Garcia, & Clark, 2011). Similarly, lack of premeditation is positively associated, in most cases, with poor decision making, a relevant feature in patients with GD (Navas, Verdejo-García, López-Gómez, Maldonado, & Perales, 2016). Other studies highlight that urgency levels, characterized by the tendency to act rashly when experiencing extreme moods, are linked with GD severity (Grall-Bronnec et al., 2012; Mestre-Bach et al., 2018).

The existing body of research on impulsivity and GD suggests an interaction between impulsive response, choice and tendency. Some studies uphold that sensation seeking, lack of premeditation and urgency could be linked with choice impulsivity and response impulsivity (Hodgins & Holub, 2015). Similarly, a correlation between impulsive tendencies and choice impulsivity has been described in GD, suggesting that individuals with GD who perceive themselves as being more prone to behaving impulsively may also make impulsive choices (Alessi & Petry, 2003). This correlation was also found in another study, but only in young patients with GD (Steward et al., 2017). Relatedly, Kräplin et al., (2014) found that urgency and premeditation were specifically associated with disadvantageous decision making. Finally, another study found GD to be associated with response impulsivity and choice impulsivity, although only the latter was linked with GD severity (Brevers et al., 2012).

At present, questions remain regarding relationships between response impulsivity, choice impulsivity and impulsive tendency. Empirical studies are needed to examine the multidimensional nature of these impulsive phenotypes in greater depth (MacKillop et al., 2016). As such, the aim of this study was two-fold. Our first aim was to examine whether the associations between three facets of impulsivity (response impulsivity, choice impulsivity and impulsive tendency) varied between GD patients and HC. Our second aim was to evaluate the intercorrelatedness of these three types of impulsivity in GD, as proposed by theoretical models of impulsivity (MacKillop et al., 2016), and their association with GD severity. We hypothesized that GD, as compared to HC participants, would exhibit greater impulsivity in all three domains, and that response impulsivity, choice impulsivity, and impulsive tendency would correlate with one another to varying degrees in the GD group, and GD severity would relate to impulsivity in the GD group.

2.METHODS

2.1.PARTICIPANTS AND PROCEDURE

An initial sample of 193 patients diagnosed with GD from the Department of Psychiatry at our University Hospital, consecutively recruited between September 2017 and April 2018, was included in the study. Only patients who sought treatment for GD as a primary mental health concern and who met DSM-5 GD criteria (APA, 2013) were included. Patients were voluntarily referred to our GD Unit through general practitioners or via other healthcare professionals.

Regarding sociodemographic features, data suggest a negative correlation between impulsivity and chronological age (Galvan, Hare, Voss, Glover, & Casey, 2007; Steinberg et al., 2008), and higher impulsivity levels in males (Cyders, 2013). For this reason, in the present study, male participants aged between 18 and 50 years were included. From this sample, 96 cases were excluded because they did not meet the inclusion criteria for this study: they were over 50 (n=42), suffered from a comorbid mental disorder (i.e. schizophrenia or other psychotic disorders) (n=17), did not meet DSM-5 criteria for GD (n=5), were female (n=22), or could not participate for practical reasons (n=10). The final sample was made up of 97 treatment-seeking adult men.

Experienced psychologists and psychiatrists conducted face-to-face clinical interviews to assess clinical and demographic variables, such as education level, origin or civil status. Patients were diagnosed with GD according to DSM-5 criteria (APA, 2013).

Participants, before initiating outpatient treatment, individually completed all the questionnaires utilized in this study. Neuropsychological measures were completed under the supervision of a staff psychologist.

Our study sample included 32 HC participants recruited using word of mouth. The exclusion criteria for the HC group included a lifetime history of GD, being female (to have a more homogeneous sample) or not being within the established age range (between 18 and 50 years, inclusive). The comparison group was recruited from the surrounding community.

2.2. MEASURES

2.2.1.GD SEVERITY

2.2.1.1.DSM-5 Criteria (APA, 2013)

Patients were diagnosed with gambling disorder if they met DSM-5 criteria (APA, 2013), which consist of nine different criteria and the presence of the disorder is set at a cut-off point of 4 or more.

2.2.1.2. South Oaks Gambling Screen (SOGS) (Lesieur & Blume, 1987)

This self-report 20-item screening questionnaire discriminates between probable pathological,

problem and non-problem gamblers. The Spanish validation used in this work showed excellent internal consistency (α = 0.94) and test–retest reliability (r = 0.98) (Echeburúa, Báez, Fernández, & Páez, 1994).

2.2.2.RESPONSE IMPULSIVITY

2.2.2.1. Conners' Continuous Performance Test, 2nd edition (CPT-II) (Conners, 2004)

The CPT-II is a computer-based task that involves participants pressing the space bar in response to visual stimuli (i.e., letters on a computer screen) that are presented over a span of 14 min. The CPT-II provides information about the participants' omission and commission error rates, reaction time, and response variability, which represent an assessment of sustained attention and inhibitory control. Higher scores on the CPT-II indicate worse performance.

2.2.3.CHOICE IMPULSIVITY

2.2.3.1. Delay discounting task (Kirby, Petry, & Bickel, 1999)

This 27-item self-administered tool was used to measure individual inter-temporal discount rates (k), providing a set of alternative choices between a smaller, immediate monetary reward and a larger, delayed monetary reward. Each question was designed to correspond to a different k value, which constitutes the measure of discounting rate and represents the amount of discounting of the later reward that renders it equal to the smaller reward. Respondents' answers are placed on reference discounting curves, where placement amid steeper curves indicates higher levels of choice impulsivity. Single k parameter-estimates can be obtained not only for an overall rate of discounting, but also for items with small, medium and large monetary rewards (Kirby et al., 1999). K values can range from 0 (selection of the delayed reward option for all items, or no discounting) to 0.25 (selection of the immediate reward option for all items, or always discounting). According to many studies using the delay discounting task (also termed the Monetary Choice Questionnaire) (Steward, Mestre-Bach, Fernández-Aranda, et al., 2017; Steward, Mestre-Bach, Vintró-Alcaraz, et al., 2017), the distributions of k values were normalized using square root transformation.

2.2.4.IMPULSIVE TENDENCIES

2.2.4.1. Impulsive Behavior Scale (UPPS-P) (Whiteside, Lynam, Miller, & Reynolds, 2001)

The UPPS-P measures five facets of impulsive behavior through self-report on 59 items: negative urgency; positive urgency; lack of premeditation; lack of perseverance; and sensation-seeking. Participants were instructed to consider their behavior during the past 6 months when completing the questionnaire. The Spanish-language adaptation of the UPPS-P showed good reliability (Cronbach's

α between 0.79 and 0.93) and external validity (Verdejo-García, Lozano, Moya, Alcázar, & Pérez-García, 2010).

2.3. STATISTICAL ANALYSIS

Statistical analyses were conducted with Stata15 for Windows. The comparison between the impulsivity measures between the groups (HC versus GD) was based on analysis of variance (ANOVA) adjusted for the participants' ages and education levels. Associations between variables (impulsivity measures and GD severity measures) were estimated through partial correlation coefficients, adjusted for age and education level.

In this study, effect sizes for mean comparisons were obtained through Cohen's d coefficient, considering 0.5>|d|>0.20 to be a small effect, 0.8>|d|>0.5 to be a moderate effect and |d|>0.8 to be a large effect (Kelley & Preacher, 2012). In addition, and due to the strong association between the sample size and significance tests for correlation estimates, 0.24>|r|>0.10 was considered to be small, 0.37>|r|>0.24 to be medium and |r|>0.37 to be large (these thresholds corresponds to Cohen's d values of 0.20, 0.50 and 0.80 respectively (Rosnow & Rosenthal, 1996).

Finally, increases in the type-I error due to multiple comparisons was controlled using the Finner method, a procedure included in family-wise-error-rate stepwise systems, which has been reported to be more appropriate than Bonferroni correction (Finner, 1993).

2.4.ETHICS

The present study was carried out in accordance with the latest version of the Declaration of Helsinki. The University Hospital Clinical Research Ethics Committee approved the study, and signed informed consent was obtained from all participants.

3.RESULTS

3.1. SAMPLE DESCRIPTION

The mean age for the HC group was 31.3 years old (SD=6.6). Most participants had completed secondary school (53.1%), 37.5% had a university education and 9.4% a primary school level of education. Most were born in Spain (87.5%) and were employed (71.9%).

The mean age for the GD group was 35.0 years (SD=8.8). Most had a primary school level of education (55.7% versus 40.2% secondary school and 4.1% university). Most were born in Spain (87.6%) and were employed (72.2%).

Significant differences were found between groups in terms of education level (c2=34.2, df=2, p<.001) and age (T=2.2, df=128, p<.030). Thus, we controlled for these factors in subsequent between-group analyses.

3.2. COMPARISONS BETWEEN THE GROUPS: ANOVA

ANOVAs confirmed that the GD group demonstrated greater GD severity than the HC group (Table 1). The GD group also demonstrated more commission errors on the CPT, demonstrated steeper discounting rates, and scored higher on all UPPS-P subscales (Table 1).

Table 1. Comparison between the groups: ANOVA

		Control *n=32*		Gambling Disorder *n=97*					
	α	Mean	SD	Mean	SD	*F*	*df*	*p*	|*d*|
Gambling severity									
DSM-5 total criteria	.934	0.06	0.25	7.86	5.33	68.09	1/127	**<.001***	**2.07†**
SOGS total score	.822	2.22	0.42	11.44	2.85	490.21	1/127	**<.001***	**5.51†**
[1]Response impulsivity, CPT									
Commissions		12.78	7.29	21.78	16.78	6.43	1/125	**.012***	**0.70†**
Hit Reaction Time		388.72	38.71	392.59	331.46	0.01	1/125	.955	0.02
Perseveration		-0.03	0.74	1.18	4.07	2.06	1/125	.154	0.41
[1]Delay discounting									
K, overall square root		0.1360	0.0782	0.1997	0.1553	3.91	1/125	**.047***	**0.52†**
[1]Impulsivity tendency, UPPS-P									
Lack of premeditation	.872	20.33	4.80	24.69	6.59	8.64	1/125	**.004***	**0.76†**
Lack of perseverance	.783	17.68	4.37	22.69	4.99	18.55	1/125	**<.001***	**1.07†**
Sensation-seeking	.864	25.39	8.20	30.04	8.47	5.56	1/125	**.043***	**0.56†**
Positive urgency	.942	20.06	5.92	32.24	10.47	28.10	1/125	**<.001***	**1.43†**
Negative urgency	.909	20.77	5.72	32.89	7.76	47.75	1/125	**<.001***	**1.78†**

Note. SQRT: Square root. SD: standard deviation. α: Cronbach's alpha in the sample.

[1]Results adjusted for age and education levels.

*Bold: significant comparison (.05 level). †Bold: effect size in the moderate (|*d*|>0.50) to high range (|*d*|>0.80).

p-values include Finner's correction for multiple comparisons.

3.3. ASSOCIATIONS BETWEEN IMPULSIVITY MEASURES

Table 2 contains the correlation matrix (partial correlations adjusted for age and education level) measuring associations between the impulsivity measures in the GD group. Positive coefficients in the moderate to high range were obtained between choice impulsivity and CPT-related perseveration and the UPPS-P positive urgency and negative urgency measures. Positive associations were also

obtained between most UPPS-P subscales.

Table 2. Associations between impulsivity measures: partial correlations adjusted for age and education level in the GD group

	1	2	3	4	5	6	7	8	9
1 CPT commissions	---	-.07	.03	.01	.04	.04	.01	.09	.02
2 CPT hit reaction time		---	-.02	.14	.07	.06	-.09	-.03	-.03
3 CPT perseveration			---	**.24†**	-.05	.01	.02	.11	.06
4 k-Overall square root				---	.20	.13	.08	**.37†**	**.27†**
5 UPPS-P Premeditation					---	**.47†**	-.08	.20	**.24†**
6 UPPS-P Perseverance						---	-.19	.15	**.25†**
7 UPPS-P Sensation							---	**.36†**	**.32†**
8 UPPS-P Positive Urge								---	**.76†**
9 UPPS-P Negative Urge									---

Note.†Bold: effect size in the moderate (|*r*|>0.24) to high range (|*r*|>0.37).
GD group (*n*=97).

Table 3 contains the correlation matrix for the HC group. In this subsample, choice impulsivity positively correlated with the CPT hit-reaction-time, and with the UPPS-P premeditation, positive urgency and negative urgency measures. Other correlations emerged: a) CPT commissions positively correlated with UPPS-P perseverance; b) CPT hit-reaction time negatively correlated with UPPS-P perseverance and negative urgency measures; c) CPT perseverance positively correlated with UPPS-P positive urgency; and, d) CPT measures correlated with one another (except for perseveration and hit-reaction-time), as well as several UPPS-P measures (Table 3). Choice impulsivitymeasures correlated with UPPS-P measures of premeditation and positive and negative urgency. Positive associations were also obtained between many UPPS-P subscales.

Table 3. Associations between impulsivity measures: partial correlations adjusted for age and studies level in the HC group

	1	2	3	4	5	6	7	8	9
1 Commissions	---								
2 Hit Reaction Time	**-.61†**	---							
3 Perseveration	**.45†**	-.11	---						
4 k-Overall square root	-.15	**.27†**	-.07	---					
5 UPPS-P Premeditation	.09	-.06	.17	**.33†**	---				
6 UPPS-P Perseverance	**.30†**	**-.40†**	.18	.04	**.45†**	---			
7 UPPS-P Sensation	-.03	.15	.08	.09	.20	-.11	---		
8 UPPS-P Positive	.23	-.13	**.40**	**.43†**	**.35†**	.17	.06	---	
9 UPPS-P Negative	.09	**-.34†**	.03	**.26†**	**.37†**	**.24†**	-.08	**.64†**	---

Note. SQRT: Square root. †Bold: effect size into the moderate (|*r*|>0.24) to high range (|*r*|>0.37).
HC group (*n*=32).

3.4. ASSOCIATIONS BETWEEN IMPULSIVITY AND GD SEVERITY

Table 4 contains the partial correlations (adjusted for age and education levels) between impulsivity measures and GD severity, stratified by group. In the HC group, DSM-5 total GD criteria positively correlated with CPT commissions and with the UPPS-P lack of perseverance; in this group, the SOGS total score positively correlated with measures of delay discounting and UPSS-P positive urgency. In the GD group, the DSM-5 total criteria for GD positively correlated with UPPS-P lack of premeditation and lack of perseverance, while the SOGS total score was positively associated with delay discounting and UPSS-P lack of perseverance. Figure 1 contains the scatterplot between overall delay discounting scores (k) and SOGS scores.

Table 4. Associations between impulsivity and GD severity: partial correlations adjusted for age and educational level

	Control (*n*=32)		Gambling Disorder (*n*=97)	
	DSM-5 total	SOGS total	DSM-5 total	SOGS total
Response impulsivity, CPT				
Commissions	**.40†**	.18	.04	.10
Hit Reaction Time	**-.35†**	-.09	.01	-.05
Perseveration	-.12	-.21	-.04	.07
Choice impulsivity, DELAY				
SQRT_K-Overall	-.05	**.44†**	-.07	**.34†**
Impulsivity tendency, UPPS-P				
Lack of premeditation	-.06	-.02	**.37†**	.20
Lack of perseverance	**.34†**	.04	**.34†**	**.34†**
Sensation seeking	-.20	.01	-.17	.15
Positive urgency	.05	**.24†**	-.09	.21
Negative urgency	.15	.16	-.16	.04

Note. SQRT: Square root. †Bold: effect size in the moderate (|*r*|>0.24) to high range (|*r*|>0.37).

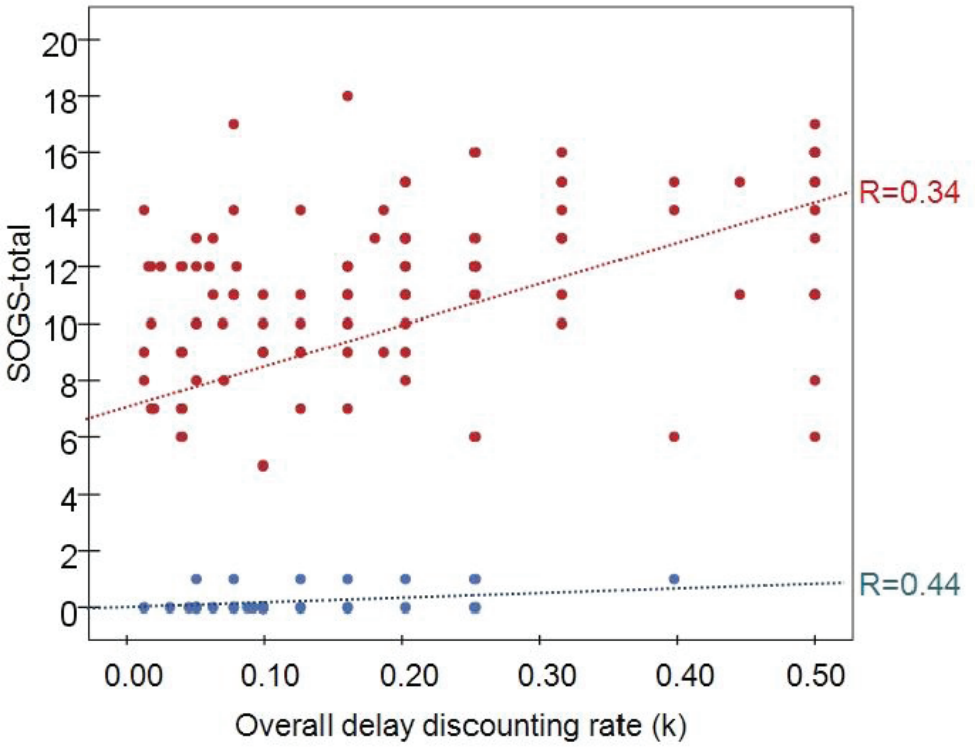

Figure 1. Scatter-plot showing relationship between delay discounting and GD severity

4.DISCUSSION

The present study analyzed whether associations between response impulsivity, choice impulsivity and impulsive tendency varied between GD patients and HC. Moreover, the interrelationship among these three types of impulsivity, and their associations with GD severity in GD, were examined. Our hypotheses were largely supported, and the implications of the findings are discussed below.

Regarding response impulsivity, patients with GD reported greater commission errors, defined as incorrect responses towards non-target stimulus, in comparison with HC participants. This result dovetails with previous studies finding that patients with GD are more prone to commit execution errors when facing no-go stimuli (Chowdhury et al., 2017). This leads us to postulate that response impulsivity is linked to a deficit in inhibitory control, which could partially explain difficulties in reducing or eliminating gambling behavior.

The findings of this study also showed that, in terms of choice impulsivity, patients with GD presented greater delay discounting than did HC participants. This finding is consistent with other studies

highlighting than patients with GD differ from HC when making monetary decisions, showing a biased tendency to discount rewards more rapidly and to select smaller, sooner amounts of money (Petry, 2001). These results may partly relate to why patients with GD may choose bets for more immediate gains, despite the negative consequences that such gambling may entail (Grecucci et al., 2014).

Furthermore, higher levels of all assessed dimensions of impulsive tendencies were observed in the GD relative to the HC group. This result is partially in line with previous studies that found higher impulsive tendencies, although results have varied between groups in sensation-seeking tendencies (Michalczuk, Bowden-Jones, Verdejo-Garcia, & Clark, 2011) and lack of perseverance (Billieux et al., 2012). These differences between groups could be explained due, to some extent, to the strong associations between these impulsive dimensions and essential GD clinical features, such as cognitive distortions (Del Prete et al., 2017; Michalczuk et al., 2011), gambling choices (Lutri et al., 2018; Moragas et al., 2015), emotion-regulation impairment (Navas et al., 2017), or GD-related illegal acts (Mestre-Bach et al., 2018).

Another finding to emerge from the present study is the interaction between the three impulsivity domains. Considering the clinical group, our results identified an association between choice impulsivity and impulsivity tendencies, with urgency being the dimension which had the greatest association with delay discounting. This finding is consistent with earlier studies highlighting a significant correlation between these two impulsivity facets (Michalczuk et al., 2011; Steward et al., 2017). Our results also indicate a positive correlation only between the response impulsivity domain or perseveration and choice impulsivity. This finding seems to be partially consistent with other research which found weak or no relationships between most facets of response and choice impulsivity (MacKillop et al., 2016; Stahl et al., 2014). The finding that there are several domains of response and choice impulsivity is consistent with the multifactorial frameworks of impulsivity.
Finally, a significant association was found between GD severity and two of the impulsivity facets, impulsive tendencies and choice impulsivity, which is consistent other findings (Mestre-Bach et al., 2018; Stea et al., 2011). Few data indicate a relationship between GD severity and response impulsivity (Chowdhury et al., 2017), and our study also failed to identify a significant association between response inhibition and GD severity among GD patients. This finding suggests that choice impulsivity, impulsive tendencies and response impulsivity could be considered as three separable entities, although the former two in particular seem to be partly inter-related. However, an impaired ability to inhibit motor responses does seem to be associated with greater disorder symptomatology in GD.

From a clinical perspective, it could be postulated that specific adjuvant interventions to address the facets of impulsivity associated with GD severity could potentially improve treatment outcomes. In this sense, technologically based interventions represent a new frontier for treatment, from the computerized adaptation of neurocognitive tasks to evaluate these processes, such as cognitive and

attentional bias (Boffo et al., 2017), to the use of mobile applications to condition the selection of healthy foods obesity (Kakoschke et al., 2018), or serious games for the treatment of impulsivity in eating disorders (Fernández-Aranda et al., 2012; Fagundo et al., 2013; Giner -Bartolomé et al., 2015) and in gambling disorder (Jiménez-Murcia et al., 2015).

4.1. LIMITATIONS AND FUTURE RESEARCH

The results of this study should be considered in light of its limitations. First, the sample was entirely male. Some studies carried out in healthy participants have found gender-related differences in impulsive tendencies (Caravaggio et al., 2017), choice impulsivity (Kirby & Maraković, 1996) and response impulsivity (Lage, Albuquerque, Fuentes, Corrêa, & Malloy-Diniz, 2013). Future studies would benefit from including women and comparing both groups from a three-factor impulsivity perspective (MacKillop et al., 2016). Second, the number of patients with GD in the present study was higher than the number of HC participants and there was a lack of group matching on the demographic measures. Future studies should include larger and more balanced HC samples. Third, both delay discounting and impulsive tendencies were evaluated through self-report assessments, and self-report and behavioral measures of impulsivity (even within the same domain) may weakly correlate or be uncorrelated (Krishnan-Sarin et al., 2007). Further, the extent to which these self-report measures may relate to decision-making processes that may be sensitive to contextual factors and may involve irrational and spontaneous aspects requires additional investigation. Fourth, the results should be interpreted cautiously given that separate instruments (some self-report and some behavioral) were used to evaluate each type of impulsivity, and poor concordance between self-report and behavioral measures of impulsivity has been reported (Ellingson, Potenza, & Pearlson, 2018). Fifth, previous research has suggested that, in the case of choice impulsivity, delay discounting levels in people with GD vary according to whether they are in a gambling context or not (Dixon, Jacobs, & Sanders, 2006). Relatedly, some individuals with GD may have a contextual control over discounting, choosing delayed rewards in order to avoid spending money immediately through gambling behavior (Dixon, Marley, & Jacobs, 2003). Future research should examine facets of impulsivity in different contexts and in relation to individual differences in gambling-related cognitions (Del Prete et al., 2017), in order to obtain a more precise evaluation of how different aspects of impulsivity relate to gambling behaviors. Moreover, validated instruments were not used to screen psychiatric morbidities in the HC group. Finally, longitudinal research is needed to understand changes in impulsivity over the course of addiction, particularly as changes in impulsivity may relate importantly to treatment outcomes (Blanco et al., 2009; Grant et al., 2010).

5.CONCLUSIONS

Taken together, one of the more significant findings to emerge from this study is the confirmation that impulsivity is not a singular construct in the case of GD. We identified three separable dimensions, although choice impulsivity and impulsive tendencies in particular appear interrelated. The current data

also highlight the interrelationship between these impulsivity facets and GD severity, suggesting that motor response impulsivity is not associated with GD severity. These results may be used to develop new interventions for patients with GD that target the dimensions most related with gambling behavior and GD severity.

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CONFLICT OF INTEREST

None of the authors have any conflicts of interest. Marc Potenza has consulted for Shire, INSYS, Rivermend Health, Opiant/Lakelight Therapeutics, and Jazz Pharmaceuticals; has received research support (to Yale) from Mohegan Sun Casino and the National Center for Responsible Gaming; has participated in surveys, mailings or telephone consultations related to drug addiction, impulse-control disorders or other health topics; has consulted for and/or advised gambling and legal entities on issues related to impulse-control/addictive disorders; has provided clinical care in a problem gambling services program; has performed grant reviews for research-funding agencies; has edited journals and journal sections; has given academic lectures in grand rounds, CME events and other clinical or scientific venues; and has generated books or book chapters for publishers of mental health texts.

AUTHOR'S CONTRIBUTION

GMB, TS, MNP, FFA, JMM and SJM contributed to the development of the study concept and design. RG performed the statistical analysis. GMB, TS, TMM, CVA, MLM, MNP, FFA and SJM aided with our interpretation of data. MNP, FFA, JMM and SJM supervised the study.

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STUDY 4

GAMBLING AND IMPULSIVITY TRAITS: A RECIPE FOR CRIMINAL BEHAVIOR?

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FRONTIERS IN PSYCHIATRY

GAMBLING AND IMPULSIVITY TRAITS: A RECIPE FOR CRIMINAL BEHAVIOR?

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ABSTRACT

Gambling disorder (GD) is a psychiatric condition that was recently recategorized as a non-substance-related addiction in the Diagnostic and Statistical Manual of Mental Health Disorders. Criminal activity is commonly associated with gambling; however, few empirical studies to date have examined sociodemographic and psychological variables in this population. In this study, we explored criminal behavior history in a sample of consecutively recruited treatment-seeking gamblers (n = 382) and compared subjects with a history of illegal acts (n = 103, 26.9%) to those with no criminal record (n = 279, 73.1%). Impulsivity and personality traits were specifically explored, along with other gambling-related severity factors. We found that gamblers who engaged in illegal activity were more likely to endorse high levels of urgency (i.e., the tendency to act out when experiencing heightened emotional states) and increased lack of premeditation. Gamblers with a history of criminal behavior also had greater GD severity levels and gambling-related debts. Additionally, these gamblers reported lower levels of self-directedness, which is characterized by difficulty in establishing and redirecting behavior toward one's goals. Likewise, gamblers who had conducted criminal acts showed a tendency to engage in greater risk-taking behavior. These results shed new light on this understudied population and provide insights for developing targeted harm-prevention interventions and treatment protocols.

Keywords
Gambling disorder, impulsivity, criminal behavior, psychopathology, risk factors.

INTRODUCTION

GAMBLING DISORDER (GD) CONCEPTUALIZATION

Gambling disorder is characterized by a maladaptive pattern of gambling behavior that persists despite negative consequences in major areas of life functioning. It was recently recategorized as a non-substance-related addiction in the Diagnostic and Statistical Manual of Mental Health Disorders (DSM-5) (1). This disorder more frequently occurs in men (2) and is often characterized by specific personality traits, high impulsivity levels, and cognitive distortions, such as illusion of control (3–5).

One of the DSM-IV-TR diagnostic criteria for pathological gambling (6) included carrying out criminal acts in order to support gambling behavior. However, after much debate, the scientific community considered that this criterion provided little accuracy, leading to the removal of the "illegal acts" criterion from DSM-5 (1). Many researchers in the field of criminology believe that committing criminal offenses in order to finance gambling behavior should be considered as an indicator of disorder severity, instead of as an independent diagnostic criterion (7, 8). Moreover, it has been argued that GD-related criminal acts seldom occur in the absence of other GD criteria (9). However, the clinical and societal importance of this criterion has been subject to considerable discussion (10). After a classification and regression tree analysis, Themcheff et al. (11) highlighted that the "illegal acts" criterion showed high discriminative capacity between social and problem gamblers, and suggested that policy makers take this information into account. Nonetheless, this framework requires additional empirical support before informed decisions can be made.

CRIMINAL BEHAVIOR RELATED TO GD

The self-reported prevalence of criminal behaviors in individuals diagnosed with GD ranges from 14 to 30% (8, 12). This relatively high mismatch between results could be explained bearing in mind that crime and GD are related in a complex and multi-factorial way, including high comorbidity with other disorders, the presence of associated risk behaviors, sociodemographic factors, and gambling-related circumstances (e.g., financial debts) (12–14). In an attempt to coalesce a functional theoretical framework, most of the existing body of research on this topic has focused on two main associations between these factors (15). On one hand, gambling behaviors could be part of a criminal lifestyle, related to antisocial personality disorder (16); on the other, criminal activity could be precipitated by GD, especially when money becomes scarce (13). Data suggest that the latter is more habitual, since individuals with GD usually do not have a criminal record or a history of norms transgression prior to developing gambling problems (17).

When considered within the framework of the general strain theory, gamblers who face negative events or emotions, such as extreme financial difficulties, might be more prone to turn to illegal activity to support their habit (18, 19). Likewise, these difficulties could also subsequently increase

the probability of carrying out illegal acts in order to try to relieve financial hardships (20). GD-related crimes are frequently reported as being committed in desperation in order to amend financial predicaments brought about by gambling-related losses, or, in some cases, to fund additional gambling episodes (21).

Nevertheless, not all individuals with GD and financial bur-dens engage in criminal behavior. Several attempts have been made to explain the risk factors associated with GD-related crime in greater depth. For example, substance abuse has been found to be prevalent in patients with GD (14, 22). This frequent comorbidity adds another complex factor as to why gamblers may commit crimes, although no longitudinal studies to date have established a causal relationship between substance abuse and gambling-related criminal acts. Results from another study suggested that stimulant substance abuse may potentially facilitate gambling-related illegal acts due to their disinhibitory effects (12). Similarly, GD severity positively correlates, in most cases, with the occurrence of criminal behaviors (23). Therefore, engagement in criminal acts to support one's gambling behavior is, in all likelihood reflective of GD severity reaching its nadir (8, 12, 21, 24, 25). During early stages of the disorder, crime is commonly reported to be carried out with remorse, and gamblers often claim that they have the intention of returning fraudulently obtained goods when their debts, derived from gambling behavior, have been settled. This logic for justifying criminal behavior greatly differs from others who commit crimes such as petty theft or fraud (26). However, when GD is consolidated and debts are increased, an individual with GD has more difficulties regulating their behavior according to their basic moral principles and signs of repentance are blurred (21, 27).

In addition to GD comorbidity and other clinical factors, sociodemographic and personality features are also associated with crime (12). One study identified different subtypes of GD patients who committed crimes, taking sociodemographic variables, personality traits and clinical information related to GD into account (28). Psychopathology levels and poor impulse control were some of the main characteristics that best distinguished GD groups with a criminal record. Although some findings in the criminology literature have suggested that GD patients present different typologies of criminal behavior, obtaining money to finance gambling behavior is usually the primary motive for these crimes (29). Specifically, the most common criminal offenses in this population are petty theft, theft, fraud and forgery (30). GD patients do not usually show a propensity for violent behavior; however, financially motivated violent crimes do occasionally occur in this population (31).

Assuming the "generality of deviance" perspective (32), which suggests that varied forms of risk-taking behaviors tend to cooccur among individuals, the spectrum of deviant and criminal behaviors appears to have a common denominator: the tendency to seek immediate reward or relief without concern for long-term negative consequences (33). Therefore, the authors suggest that self-control is a main factor in determining the likelihood of engaging in criminal acts (34). These behavioral patterns, such as personality traits associated with risk (sensation seeking, impulsivity and low self-control) and multiple domains of risky attitudes, are also common in patients with GD (35–37). The authors highlight the existence of a key wedge factor of common variance "the generality of

deviance" in gamblers, suggesting that shared personality traits, such as greater risk taking, may be a driver of deviant behavior (38). In this vein, Mishra et al. (39) suggested that GD was strongly associated with pro-gambling and risk-taking attitudes.

Impulsivity is increasingly understood to be an early risk factor for the development of both GD (40) and delinquency (41). Impulsivity is a multidimensional construct encompassing facets such as the dysregulation of outward behavior due to decreased inhibitory control or a prejudicial decision-making style (e.g., choosing immediate gratification over larger, delayed rewards) (35). In recent years, the UPPS-P framework of impulsivity has become one of the most utilized models of impulsivity in psychiatric research. This questionnaire divides impulsivity levels into five subscales: lack of premeditation, lack of perseverance, positive and negative urgency, and sensation seeking (42). Specifically, urgency, defined as emotionally charged impulsive behaviors in response to positive or negative moods, has been found to be crucial in distinguishing between clinically dysfunctional GD patients and recreational gamblers (43).

During adolescence (the age at which most individuals begin to gamble) (44), cognitive impulsivity has also been found to be associated with a more rapid acceleration into criminal behavior (41). Likewise, urgency and lack of premeditation are known to significantly correlate with each other in adolescents (45). Researchers have also observed that an impulsive decision-making style and high levels of urgency are associated with an increased acceptance of erroneous beliefs (e.g., believing that a series of losses must be followed by a win) during gambling behavior, thereby worsening economic consequences (46, 47). Given that gamblers encompass a very heterogeneous group of patients, one might postulate that gambling-related illegal acts could be more commonplace in younger, impulsive gamblers than in older gamblers whose gambling motivations might be driven by altered emotion regulation capacity (29, 35). To our knowledge, however, no studies to date have examined the role that impulsivity plays in criminal behavior within the context of gambling.

GD, CRIMINAL BEHAVIOR, AND THE SPANISH COURT SYSTEM

Within Spanish civil law/civil code, legal mechanisms exist which aim to limit the capacity of an individual with GD to inflict financial damage onto themselves or others. Namely, revoking legal guardianship or declaring civil incapacity allows for capital losses resulting from GD to be protected (48). Similarly, GD patients have the option to voluntarily bar themselves access to gambling establishments, either online or land-based, as part of a state-sponsored harm reduction program. Enrollment in the program can be indefinite; although participants may opt out of it at any time.

The Spanish Criminal Code does not specifically mention gambling as a mitigating or extenuating circumstance capable of reducing the gravity of an offense with regards to sentencing or moral opprobrium. However, in practice, the Spanish court system tends to apply discretion by imposing minimum penal-ties in cases characterized by reduced freewill that exhibit a clear causal relationship

between the committed crime and gambling addiction (17).

AIMS AND HYPOTHESIS

The primary aim of this study was to compare impulsivity traits in a sample of treatment-seeking GD patients who committed illegal acts to those who did not. Furthermore, we aimed to explore differences between these groups in terms of sociodemographic and psychological variables, and the type of illegal act committed in order to ascertain which variable(s) best predicted the presence of a history of criminal behavior.

As stated above, high levels of debt and significant financial problems because of gambling behavior is often indicated a primary motive for committing a crime (21); therefore, we hypothesized that the GD patients with a history of criminal behavior would present higher levels of debt than those without a criminal record. We also hypothesized that GD patients with a history of criminal behavior would be characterized by greater levels of GD severity, impulsivity, and overall psychopathology (8, 12). Likewise, we hypothesized that those gamblers with a history of committing multiple offenses would present increased psychopathology, GD severity and levels of accumulated debt (49).

MATERIALS AND METHODS

PARTICIPANTS AND PROCEDURE

The sample consisted of 382 patients with a diagnosis of GD who were being treated at the Gambling Disorder Unit within the Department of Psychiatry at Bellvitge University Hospital (Barcelona, Spain). This public hospital is certified as a tertiary care center for the treatment of addictive behaviors and oversees the treatment of very complex cases. Patients were derived to the Bellvitge University Hospital Gambling Disorder Unit through general practitioners or via another healthcare professional; some patients were derived from prison health services, though their treatment was not compulsory in the majority of cases. Nonetheless, in a few cases, a judge may have dictated the need for specific GD treatment at our unit. All treatment services for GD within the public Spanish healthcare system are provided free of charge.

Sociodemographic, clinical and criminal additional information was taken, and patients individually completed all the questionnaires required for this study (requiring approximately 2 h) before initiating outpatient treatment. Only patients who sought treatment for GD as their primary mental health concern and who met DSM-5 criteria for GD (1) were included in our sample. Exclusion criteria were: the presence of an organic mental disorder, intellectual disability, a neurodegenerative condition, such as Parkinson's disease, or an active psychotic disorder. Participants were classified in two groups according the presence (n = 279) or absence (n = 103) of criminal behaviors related to GD. Criminal behavior was assessed via a structured interview with a staff clinical psychologist.

The present study was carried out in accordance with the latest version of the Declaration of Helsinki. The University Hospital of Bellvitge Ethics Committee of Clinical Research approved the study, and written informed consent was obtained from all participants.

MEASURES

GD SEVERITY

DSM-5 CRITERIA (1)

Patients were diagnosed with pathological gambling if they met DSM-IV-TR criteria (6). It should be noted that with the release of the DSM-5 (1), the term pathological gambling was replaced with GD. All patient diagnoses were reassessed and recodified post hoc and only patients who met DSM-5 criteria for GD were included in our analysis.

SOUTH OAKS GAMBLING SCREEN (SOGS) (50)

This self-report 20-item screening questionnaire discriminates between probable pathological, problem and non-problem gamblers. The Spanish validation used in this work showed excellent internal consistency ($\alpha = 0.94$) and test–retest reliability ($r = 0.98$) (51).

IMPULSIVITY TRAITS

IMPULSIVE BEHAVIOR SCALE (UPPS-P) (52)

The UPPS-P measures five facets of impulsive behavior through self-report on 59 items: negative urgency; positive urgency; lack of premeditation; lack of perseverance; and sensation seeking. Individuals are asked to consider acts/incidents during the last 6 months when rating their behavior and attitudes. The Spanish- language adaptation shows good reliability (Cronbach's α between 0.79 and 0.93) and external validity (53).

PSYCHOPATHOLOGY

SYMPTOM CHECKLIST-REVISED (SCL-90-R) (54)

This is a 90-item questionnaire measuring psychological distress and psychopathology. The items assess nine symptom dimensions: somatization, obsessive-compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, and psychoticism. The global score [Global Severity Index (GSI)] is a widely used index of psychopathological distress and was the only variable from this questionnaire used in this study. The Spanish adapted version was used in this study

(55).

PERSONALITY

TEMPERAMENT AND CHARACTER INVENTORY-REVISED (TCI-R) (56)

The TCI-R is a reliable and valid 240-item questionnaire measured on a 5-point Likert-type scale to evaluate personality traits. It is structured using seven primary personality dimensions: four temperamental factors (novelty seeking, harm avoidance, reward dependence, and persistence) and three character dimensions (self-directedness, cooperativeness, and self-transcendence). The Spanish revised version used in this study (57) showed adequate internal consistency (Cronbach's alpha a mean value of 0.87).

ALCOHOL AND OTHER DRUGS USE-ABUSE

ALCOHOL USE DISORDERS IDENTIFICATION TEST (AUDIT) (58)

This test was developed as a simple screening method for excessive alcohol consumption. Internal consistency has been found to be high, and test–retest data have suggested a high reliability (0.86) and a sensitivity of around 0.90. Specificity in different set-tings and for different criteria averages 0.80 or more (59). In this work, cutoff points of 8 and 20 were used to identify individuals with alcohol abuse and alcohol dependence, respectively (60).

DRUG USE DISORDERS IDENTIFICATION TEST (DUDIT) (61)

The DUDIT is an 11-item screening instrument developed to identify non-alcohol drug use patterns and various drug-related problems in the general public, as well as in individuals in clinical settings who are likely to meet criteria for a substance dependence diagnosis (61). The first nine items are scored on a 5-point Likert scale ranging from 0 to 4, and the last two are scored on 3-point scales (values of 0, 2, 4). Total scores can range from 0 to 44, with higher scores being indicative of a more severe drug problem. The following risk levels have been suggested for DUDIT scores: no drug-related problems (total scores 0–5/1); possible drug-related problems, that is, risky or harmful drug habits that might be diagnosed as substance abuse/harmful use or dependence (6/2–24); likely heavily dependent on drugs (scores ≥ 25) (61).

OTHER SOCIODEMOGRAPHIC AND CLINICAL VARIABLES

Additional demographic, clinical, and social/family variables related to gambling were measured using a semi-structured face- to-face clinical interview described elsewhere (62). The gambling behavior variables covered included the age of onset of gambling behavior and of gambling-related problems, the average amount of money spent in a single gambling episode, the maximum amount

ever bet in a single episode, and the total amount of accumulated gambling debts. In addition, the interview explored lifetime criminal activity related to GD in order to supplement the information obtained through the eighth DSM-IV-TR criterion (6). Crime-centered typologies were used to group subjects into three categories: those who conducted petty theft (the most frequent criminal behavior in our clinical population); those who committed other offenses (including counterfeiting or crimes against the public, among others); and those with multiple types of offenses.

STATISTICAL ANALYSES

Statistical analyses were carried out with Stata 13.1. Comparison between groups was based on chi-square tests ($\chi 2$) for categorical variables, t-test procedures for two mean comparisons in independent groups, and analysis of variance for mean comparisons in three or more independent groups.

The predictive capacity of impulsivity (UPPS-P raw scores) for the presence of illegal acts was based on binary logistic regression (adjusted for the covariates age of onset, GD duration, cumulate debts from gambling and GD severity). Goodness of fit was assessed through Hosmer–Lemeshow test ($p > 0.05$ was considered adequate fitting), global predictive capacity through Nagelkerke's pseudo-R2 coefficient and global discriminative capacity through the area under the ROC curve.

Increases in Type-I error due to multiple statistical comparisons was controlled through Finner's correction, a procedure included in Familywise error rate stepwise procedures which offers more powerful results than Bonferroni correction (63). Effect size for comparisons between groups was estimated through Cohen's-d coefficient (moderate effect size was considered for $|d| > 0.50$ and good for $|d| > 0.80$), and through the 95% confidence interval (95% CI) for the logistic regression.

Since this study was planned posterior to the data recruitment, the calculation of the required sample was not possible. However, a power calculation for statistical analysis based on two independent mean comparisons was carried out with the following parameters: total sample size equal to $n = 382$, bilateral contrasts and expected mean values for the groups equal to 50 and 55 (these means were selected based on T-standardized scores commonly employed in clinical research, whose distributions include the parameters: mean $\mu = 50$ and SD $\sigma = 10$ in community samples). Estimated power resulted in 0.983 (risk $\beta = 0.017$, less than 2%).

For the chi-square test which compares two independent proportions (set at 60 and 75%), the power estimated resulted in 0.870 (risk $\beta = 0.130$).

RESULTS

SAMPLE DESCRIPTION

The first section of Table 1 includes the sociodemographic characteristics of the sample stratified by the presence/absence of a history of illegal behavior. Most participants were born in Spain (95.3%), had finished primary school (57.6%), were single or separated/divorced (59.2%), were employed (55.5%) and were in a middle-low to low socioeconomic status level (51.3%) (Hollingshead, Unpublished manuscript)1. No statistically significant differences in sociodemographic characteristics between patient groups were found.

The second section of Table 1 includes GD-related variables. No differences in chronological age, monthly income, and mean amount spent per gambling episode between groups were found. However, patients who reported engaging in illegal activities endorsed a younger age of gambling onset and longer duration of GD. Patients with a criminal record also had higher GD severity levels

TABLE 1 | Sample description.

	No illegal acts (n = 279)		Illegal acts (n =103)				
	n	%	*n*	%	χ^2	*df*	*p*
Nationality							
Spain	267	95.7	97	94.2	0.39	1	0.533
Other	12	4.3	6	5.8			
Education level							
Primary	163	58.4	57	55.3	1.97	2	0.373
Secondary	96	34.4	34	33.0			
University	20	7.2	12	11.7			
Civil status							
Single or divorced	168	60.2	58	56.3	0.48	1	0.491
With a partner (married)	111	39.8	45	43.7			
Employment							
Unemployed	119	42.7	51	49.5	1.43	1	0.231
Employed	160	57.3	52	50.5			
Socioeconomic status							
High	5	1.8	2	1.9	2.10	2	0.349
Mean	137	49.1	42	40.8			
Low	137	49.1	59	57.3			

Numeric variables	No illegal acts (n = 279)					Illegal acts (n = 103)					$T_{(df = 380)}$	SE	*p*
	Min	Max	Median	Mean	SD	Min	Max	Median	Mean	SD			
Age (years old)	18	75	42	42.70	14.08	19	75	39	39.73	12.25	1.89	1.47	0.059
Age of GD onset (years old)	12	70	28	30.23	12.12	13	67	26	26.79	10.07	2.49	1.27	0.013[a]
GD duration (years)	1	27	3	5.86	6.38	1	25	6	8.27	7.42	3.03	0.85	0.003[a]
Monthly income (€)	0	30,000	1,200	1,409	2,270	0	21,000	1,100	1,296	2,170	0.42	265.46	0.677
Maximum spent in a episode (€)	20	60,000	400	1,197	4,287	10	60,000	750	2,659	7,945	2.30	635.56	0.022[a]
Average spent per episode (€)	10	5,000	25	155	512	3	5,000	30	171	516	0.27	59.12	0.787
Cumulate debts (€)	0	60,000	675	6,256	12,404	0	60,000	2,175	13,348	19,148	3.95	1794.46	<0.001[a]
DSM-5 total criteria (α = 0.834)	4	9	7	6.45	2.26	4	9	8	7.77	1.33	5.58	0.24	<0.001[a]
SOGS total score (α = 0.800)	2	17	10	10.17	3.02	4	19	13	12.57	2.76	7.01	0.34	<0.001[a]

[a]*Significant comparison (0.05 level).*

Min, minimum; Max, maximum; df, degrees of freedom; α, Cronbach's alpha in the sample.

COMPARISON BETWEEN PATIENTS WITH AND WITHOUT A HISTORY OF CRIMINAL BEHAVIOR

Table 2 includes a comparison of impulsivity/personality traits, psychopathology, and substance use behaviors in patients who reported a history of engaging in illegal activity. Patients with a criminal history reported higher levels in positive and negative urgency, lack of premeditation and lack of perseverance com-pared to GD patients with no criminal record. GD patients who reported having committed gambling-related crimes also had higher levels of psychopathology (according to the SCL-90-R). In terms of personality traits, GD patients with a criminal record presented higher levels of novelty seeking and lower levels of self-directedness and cooperativeness compared to GD patients without a criminal record. No differences between groups were found with regards to substance use/abuse.

TABLE 2 | Clinical comparison between patients with and without illegal acts.

	α	No illegal acts (n =279)		Illegal acts (n =103)		$T_{(df=380)}$	SE	p	$\|d\|$	Power
		Mean	SD	Mean	SD					
Impulsivity: UPPS-P subscales										
Lack of premeditation	0.852	23.07	6.39	25.77	6.54	3.64	0.742	<0.001[a]	0.42	0.953
Lack of perseverance	0.852	21.47	5.27	23.16	6.14	2.65	0.636	0.008[a]	0.29	0.753
Sensation seeking	0.778	27.29	8.59	28.56	8.91	1.28	1.000	0.203	0.15	0.753
Positive urgency	0.851	31.01	10.44	34.46	10.14	2.88	1.195	0.004[a]	0.33	0.820
Negative urgency	0.922	32.30	7.05	34.09	7.01	2.21	0.812	0.028[a]	0.25	0.795
Psychopathology: SCL-90R										
GSI score	0.860	0.92	0.63	1.28	0.76	4.73	0.077	<0.001[a]	0.52[b]	0.997
Personality traits: TCI-R scales										
Novelty seeking	0.705	108.05	12.97	114.29	11.36	3.92	1.594	<0.001[a]	0.51[b]	0.974
Harm avoidance	0.808	99.12	16.76	100.50	15.85	0.72	1.906	0.470	0.08	0.888
Reward dependence	0.788	98.90	14.83	98.25	15.27	0.37	1.726	0.710	0.04	0.934
Persistence	0.885	107.94	20.46	107.46	22.51	0.20	2.427	0.844	0.02	0.946
Self-directedness	0.862	133.86	20.34	120.05	21.24	5.81	2.376	<0.001[a]	0.66[b]	0.908
Cooperativeness	0.797	132.03	14.48	126.85	18.09	2.89	1.793	0.004[a]	0.32	0.821
Self-Transcendence	0.818	60.61	13.70	63.26	15.40	1.62	1.636	0.106	0.18	0.634
Substances: use-abuse		n	%	N	%	χ^2	df	p	$\|d\|$	Power
Tobacco use		159	57.0	59	57.3	0.00	1	0.959	0.01	0.053
Alcohol: AUDIT total		5.26	6.44	5.86	6.81	0.59	1	0.557	0.09	0.060
Other drugs: DUDIT total		3.31	7.15	3.64	6.74	0.296	1	0.768	0.05	0.060

p includes Bonferroni–Finner correction for multiple comparisons.

[a]Significant comparison.

[b]Effect size in the moderate (|d| > 0.50) to high (|d| > 0.80) range.

df, degrees of freedom; |d|, Cohens'-d measuring effect size; α, Cronbach's alpha in the sample.

PREDICTIVE CAPACITY OF IMPULSIVITY LEVELS ON CRIMINAL BEHAVIOR

The upper part of Table 3 includes the logistic regression measuring the predictive capacity of impulsivity levels (measured through the UPPS-P scales) on the presence of illegal acts in the entire sample. The model was carried out in two blocks/steps: the first block included and set the covariates age of onset and GD duration and second block added the five UPPS-P subscales. After adjusting for the covariates, the odds of having a history of criminal behavior was increased for patients with higher scores in the lack of premeditation and positive urgency impulsivity subscales. Goodness of fit

was obtained (Hosmer–Lemeshow: p = 0.167), and the model showed moderate predictive capacity (the increase/change in the R^2 coefficient comparing first and sec-ond block was $\Delta R^2 = 0.12$) and moderate discriminative capacity (AUC = 0.68). Table S1 in Supplementary Material contains a new predictive model including also two additional GD-related measures as covariates into the first block: cumulate debts and disorder severity (SOGS total score). In the resulting logistic predictive regression, UPPS-P positive urgency raw score remained a significant predictor.

TABLE 3 | Predictive capacity of impulsivity profile (UPPS-P scores) on the presence of illegal acts: logistic regression adjusted for age of gambling disorder onset and GD duration.

	B	SE	Wald	*p*	OR	95%CI (OR)	
Covariates							
Age of GD onset	−0.018	0.012	2.173	0.140	0.982	0.959	1.006
GD duration (years)	0.052	0.018	8.490	0.004[a]	1.053	1.017	1.090
UPPS-P							
Lack of premeditation	0.059	0.026	5.261	0.022[a]	1.061	1.009	1.116
Lack of perseverance	−0.018	0.029	0.375	0.540	0.982	0.928	1.040
Sensation seeking	0.003	0.016	0.036	0.850	1.003	0.973	1.034
Positive urgency	0.044	0.018	5.639	0.018[a]	1.045	1.008	1.083
Negative urgency	−0.017	0.028	0.363	0.547	0.983	0.931	1.039
Fitting indexes: H-L; ΔR^2; AUC	0.167	0.121	0.684				

[a]*Significant parameter. N = 382.*

H-L, Hosmer–Lemeshow test (p-value); ΔR^2, increase in the Nagelkerke's R^2 coefficient comparing blocks 1 and 2; AUC, area under the ROC curve.

COMPARISON BASED ON TYPE OF ILLEGAL ACT

Table 4 contains a comparison between the n = 103 GD patients who reported a history of illegal activity based on the type of crime(s) committed (theft, other, or multiple). A number of patients (n = 25) chose not to specify which type of gambling-related illegal act they committed and these patients were excluded from this analysis. Patients who reported committing multiple types of illegal acts obtained the highest means in cumulate debts due to gambling, and higher GD severity levels according to the SOGS.

TABLE 4 | Clinical comparison for patients based on type of illegal act committed.

	Petty Theft		Other		Multiple		Petty theft vs. Other		Petty theft vs. multiple		Other vs. multiple	
	n = 38		*n* = 29		*n* = 11							
	Mean	SD	Mean	SD	Mean	SD	*p*	|*d*|	*p*	|*d*|	*p*	|*d*|
Gambling: duration-severity												
Age (years-old)	38.53	15.90	40.45	8.57	38.45	6.12	0.536	0.15	0.987	0.01	0.655	0.27
GD onset (years-old)	26.86	12.82	26.05	7.14	24.22	8.38	0.760	0.08	0.502	0.24	0.650	0.23
GD duration (years)	7.92	7.61	8.25	6.95	11.00	9.15	0.862	0.05	0.277	0.37	0.346	0.34
Maximum spent/episode (€)	1,493	2,645	3,657	1,1055	1,503	2,911	0.220	0.27	0.997	0.00	0.393	0.27
Mean amount spent/episode (€)	110	183	326	921	79	113	0.134	0.33	0.877	0.20	0.233	0.38
Cumulate debts (€)	3,083	8,314	21,593	23,680	26,380	26,480	0.001[a]	1.04[b]	0.001[a]	1.19[b]	0.491	0.19
DSM-5 total criteria	7.68	1.36	7.55	1.48	7.36	1.36	0.703	0.09	0.507	0.24	0.706	0.13
SOGS total score	11.84	2.63	12.45	3.42	14.27	1.42	0.389	0.20	0.015[a]	1.15[b]	0.074	0.70[b]
Substances: use-abuse	*n*	%	*n*	%	*N*	%	*p*	|*d*|	*p*	|*d*|	*p*	|*d*|
Tobacco use	20	52.6%	16	55.2%	5	45.5%	0.836	0.05	0.675	0.14	0.583	0.20
Alcohol use-abuse	6	15.8%	5	17.2%	2	18.2%	0.874	0.04	0.850	0.06	0.944	0.02
Other drugs use-abuse	9	23.7%	5	17.2%	1	9.1%	0.520	0.16	0.290	0.40	0.519	0.24

|d|, Cohens'-d measuring effect size.

p includes Bonferroni–Finner correction for multiple comparisons.

[a]*Significant comparison.*

[b]*Effect size in the moderate (|d| > 0.50) to high (|d| > 0.80) range.*

DISCUSSION

This study analyzed differences in impulsivity and personality traits between treatment-seeking GD patients who committed illegal acts and those who did not. Moreover, we sought to examine the interplay between criminal typology, sociodemographic features, and psychological variables.

Regarding the multidimensional nature of risk factors for engaging in crime, as suggested by previous studies, sociodemographic (especially gender and age) (64), education (65), and economic factors (such as socioeconomic status) (12) were determinants of the incidence of crime. In Western populations, the association between age and crime mainly follows a bell-shaped pattern, known as the age-of-crime curve, showing a reduction in criminal activity as an individual progress into adulthood (66, 67). Surprisingly, no differences were found between GD patients who committed crimes and those who did not, even though we hypothesized that the GD patients with a criminal record would be younger. It is worth noting, however, that our sample was made up patients voluntarily seeking treatment for GD and that we did not explore at what age these patients began engaging in illegal activity to finance their gambling behavior.

On the other hand, earlier studies have shown that education may counteract the risk of committing crimes, being that those with a higher level of education have higher expectations regarding the amount of income they can derived from legal ventures (65). Moreover, the inverse relationship between social stratification and delinquency turns out to be one of the main points of interest in criminology (68). However, contrary to expectations, this study did not find significant differences between groups in years of schooling. These results may partly be explained by the fact that our sample consisted of gamblers who sought treatment of their own volition and therefore our results

are not necessarily representative of gamblers as a whole. Similar issues arise in the case of substance abuse as most individuals report first using drugs at a younger age and not seeking treatment until they are often much older (69). In this vein, an additional explanation could be that only crimes related to gambling behavior have been evaluated and those subjects whose main clinical problem was exclusively GD were included in the study.

Keeping with our hypothesis, patients who committed GD-related crimes reported greater GD severity, higher maximum bets and more cumulated debts in comparison with those who did not. This result dovetails with previous studies also reporting that GD patients with gambling-related crimes experienced more severe gambling symptoms than did other gamblers (15, 16, 21, 27). These findings suggest that greater gambling-related economic expenditures (more money spent during gambling episodes and more overall gambling-related debts) would increase an individual's likelihood of resorting to illegal behaviors in order to obtain money rapidly and, consequently, to be able to continue addictive-like gambling behavior.

Another finding to emerge from the present study is the difference in age of onset of GD between both groups, showing earlier onset in the illegal acts group. In our study, the measure to determine "onset" referred to the moment when the patients identified that gambling behavior had become harmful and uncontrollable. In this vein, previous studies showed that several factors are associated with early GD onset, including higher trait impulsivity and substance use disorders (70, 71).

Relatedly, our stepwise analyses identified both positive urgency and lack of premeditation to be predictors of the presence of illegal activity in GD patients. Both of these impulsivity traits have been found to commonly be higher in younger individuals and could potentially be seen as a risk factor, though longitudinal are needed to support this claim (35, 72). With regards to personality traits, GD patients with a history of criminal behaviors also reported lower levels of self-directedness. Self-directedness is characterized by possessing an external locus of control and, therefore, encountering more difficulties in planning, decision making and achieving goals (56). This finding is consistent with other studies highlighting low levels of self-directedness across psychiatric disorders (73–75). Contrary to our hypothesis, no differences were found in substance use/abuse prevalence between GD patients who did and did not report committing gambling- related crimes. This may be partly due to the fact that we only assessed current substance-use patterns in our sample and that all of our patients were voluntarily seeking treatment.

Although some demographic risk factors have been identified for criminal recidivism (in particular gender, age, and race), in recent years there has been much debate about whether sociodemographic factors in themselves can fully account for the complexity behind reoccurring criminal behaviors (76, 77). In our sample, GD patients who had committed multiple offenses endorsed greater GD severity levels and greater amounts of gambling-related debts. These results coincide with other studies supporting the existence of subgroups of gamblers that are distinguishable according to their gambling-related criminal behaviors (27).

ETHICAL ISSUES RAISED BY THE STUDY

Our analysis seems to prompt at least two important moral issues. The first pertains to autonomy. If GD patients with a history of criminal behavior tend to report lower levels of self-directedness, it can be argued that their capacity for autonomous action is, in some sense, diminished. This is important because autonomy is tied to responsibility. The less autonomous an individual is, the less responsible we hold them for their actions. If GD patients who engaged in illegal acts tend to display lower levels of autonomy, we should take this fact into account when making attributions of responsibility. This overlaps with our previous discussion of the Spanish court system and its de facto concern for gambling- related instances of reduced free will. The second issue arises once we realize that both positive urgency and lack of premeditation are predictors of the presence of illegal activity in GD patients. Given the serious risk of adding stigmatization to this population, we should set a high bar in terms of predictive value before using such variables as proxy for policy-making. And if this becomes unavoidable, then efforts should be made to minimize the risk of stigmatization as much as possible. However, given the self-acknowledged limitations of this analysis, this should be considered (i.e., whether such predictors are robust enough for determining future policies) an open question.

LIMITATIONS

Our results must be interpreted in light of their limitations. The main weakness of this study was that exploring criminal behaviors through self-report in a clinical interview and not administering a validated psychometric instrument may have generated false negatives and limited the thoroughness of the obtained information. Second, our sample was made up exclusively of male GD patients, and taking into account that male gender is one of the indicators most associated with gambling-related crimes (12), the generalizability of the results to other populations is discouraged (78). Finally, the present study was focused exclusively on criminal behaviors carried out with the aim of financing debts derived from gambling or ensuring the continuity of gambling behavior. Future studies should consider the full scope of illegal behaviors carried out by GD patients, even those not directly related to gambling.

CONCLUSION

This study provides greater empirical understanding of the associations between GD, impulsivity, and criminal behavior. Our findings suggest that high levels of trait impulsivity, especially lack of premeditation and positive urgency, are predictors of the occurrence of crime in those who gamble. Further research should be undertaken to examine the effectiveness of interventions targeting impulse traits and recidivism risk management in gambling populations. Such detailed information would be useful in improving GD treatment and harm reduction interventions.

AUTHOR CONTRIBUTIONS

GM-B, TS, FF-A, RG, JM, and SJ-M designed the experiment based on previous results and the clinical experience of M-TN, AC, MB, LM, AP-G, NA, MG-P, CV-A, and NM-B. RG, GM-B, TS, FF-A, and SJ-M conducted the experiment, analyzed the data, and wrote a first draft of the manuscript. SJ-M, TS, GM-B, RG, PM, and FF-A further modified the manuscript.

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. Table S1. Predictive capacity of impulsivity profile (UPPS-P scores) on the presence of illegal acts: logistic regression adjusted for the age of GD onset, cumulate debts, GD severity and GD duration.

Covariates:	Age of GD onset	-0.020	0.015	1.970	.160	0.980	0.952	1.008
	GD duration (years)	0.048	0.021	5.557	.018	1.050	1.008	1.093
	Cumulate debts (€)	0.000	0.000	7.737	**.005**	1.000	1.000	1.000
		0.236	0.054	18.78	**<.001**	1.266	1.138	1.408
	GD severity: SOGS-total			8	*			
UPPS-P:	Lack of premeditation	0.043	0.029	2.218	.136	1.044	0.987	1.104
	Lack of perseverance	-0.006	0.033	0.031	.860	0.994	0.933	1.060
	Sensation seeking	0.006	0.018	0.105	.745	1.006	0.972	1.041
	Positive urgency	0.044	0.021	4.532	**.033***	1.046	1.004	1.089
	Negative urgency	-0.009	0.032	0.087	.768	0.991	0.930	1.055
Fitting indexes:	*H-L; ΔR^2; AUC*	*.265*	*.050*	*.777*				

Note. H-L: Hosmer-Lemeshow test (*p-value)*. ΔR^2: increase in the Nagelkerke's R^2 coefficient comparing blocks 1 and 2. AUC: area under the ROC curve.

*Bold: significant parameter. *N=382*.

STUDY 5

THE PREDICTIVE CAPACITY OF DSM-5 SYMPTOM SEVERITY AND IMPULSIVITY ON RESPONSE TO COGNITIVE-BEHAVIORAL THERAPY FOR GAMBLING DISORDER: A 2-YEAR LONGITUDINAL STUDY

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ABSTRACT

Background: DSM-5 proposed a new operational system by using the number of fulfilled criteria as an indicator of gambling disorder severity. This method has proven to be controversial among researchers and clinicians alike, due to the lack of studies indicating whether severity, as measured by these criteria, is clinically relevant in terms of treatment outcome. Additionally, numerous studies have highlighted the associations between gambling disorder and impulsivity, though few have examined the impact of impulsivity on long-term treatment outcomes. **Methods:** In this study, we aimed to assess the predictive value of DSM-5 severity levels on response to cognitive-behavioral therapy (CBT) in a sample of male adults seeking treatment for gambling disorder (n = 398). Furthermore, we explored longitudinal predictors of CBT treatment response at a follow-up, considering UPPS-P impulsivity traits. **Results:** Our study failed to identify differences in treatment outcomes between patients categorized by DSM-5 severity levels. Higher baseline scores in negative urgency predicted relapse during CBT treatment, and higher levels of sensation seeking were predictive of drop-out from short-term treatment, as well as of drop-out at 24-months. **Conclusions:** These noteworthy findings raise questions regarding the clinical utility of DSM-5 severity categories and lend support to the implementation of dimensional approaches for gambling disorder.

Keywords
Gambling disorder, cognitive-behavioral therapy, impulsivity, dsm-5, dropout, relapse.

1. INTRODUCTION

Gambling disorder (GD) constitutes a psychiatric condition categorized in the latest version of the Diagnostic and Statistical Manual of Mental Health Disorders (DSM-5) [1] as a non-substance-related addiction. This disorder is characterized by a recurrent and persistent pattern of gambling behavior that leads to clinically significant distress. Patients with GD often suffer from cognitive distortions, such as illusions of control [2,3], high psychopathology levels [4–6], and dysfunctional personality traits (such as high novelty seeking) [7–9].

In addition to this clinical symptomatology, numerous studies have highlighted the associations between GD and impulsivity [10–13]. Specifically, there is evidence to support that trait impulsivity affects both the aetiology and maintenance of this behavioral addiction [14,15]. The most used framework in recent years for the study of GD has been the UPPS-P [16,17]. It categorizes impulsivity into five independent dimensions: sensation seeking, which refers to one's disposition to seek exciting experiences; (lack of) perseverance, that reflects the tendency to not persist in an activity that can be arduous; (lack of) premeditation shows the tendency to act without considering the consequences of the behavior; and positive and negative urgency, understood as emotionally charged impulsive behaviors in response to positive or negative moods [18,19].

In the case of GD, the scales that best distinguish treatment- seeking patients from healthy controls are lack of perseverance and positive and negative urgency, with GD patients endorsing greater levels in all three measures [15,20]. It is common for patients with GD to report using gambling behavior to mitigate states of anxiety or depression, possibly due to impaired emotion regulation mechanisms [20–22]. The role of sensation seeking, as assessed by the UPPS-P, is not clear in the case of GD and some studies do not support higher levels of this trait in comparison with healthy controls [20,23,24]. Finally, lack of premeditation has been shown to be associated with poor decision-making abilities, which is a common feature in patients with GD [16,17,25].

According to the DSM-5, the greater presence of GD symptomatology increases the severity of the disorder [1]. In this vein, existing research recognizes the bond between impulsivity and GD severity [26–28]. In view of this association and in order to carry out classification from a dimensional point of view, the DSM-5 proposed a new operationalization of clinical severity by numbering criteria. This system is used as an indicator of GD severity and is divided into three levels: mild (four to five criteria), moderate (six to seven), and severe (eight or nine) [1,29]. However, this new classification has proven to be controversial among researchers and clinicians alike, highlighting the need to assess whether severity, as measured by these criteria, is clinically relevant [29–31].

A wide range of treatment options are available for GD, including various psychological approaches (e.g. self-help groups and peer-support interventions) and pharmacological treatment [32]. However, not all patients with GD obtain long-term benefits from psychological interventions, with success

rates at a 6-month 1-year follow-up ranging anywhere from 30% and to 71% [33–36]. A recent systematic review of evidence relating to pre-treatment predictors of gambling outcomes following psychological treatment identified older age, lower gambling symptom severity, lower levels of gambling behaviors and alcohol use, and higher treatment session attendance as likely predictors of successful treatment outcome [37]. Additionally, higher levels of sensation seeking (though not as measured by the UPPS-P) were associated with negative treatment outcomes at post-treatment or medium-term follow-up [37]. Findings such as these are practical for clinicians in choosing treatment strategies by allowing them to take into account the characteristics of the individual seeking treatment. Nonetheless, evidence regarding the clinical utility of current working definition of GD symptom severity boundaries is scare [29,31] and recent calls have been made to incorporate broader outcome domains that extend beyond disorder-specific symptoms in order to develop a single comprehensive to measure all aspects of gambling recovery [38].

Therefore, taking into account the findings described above, the aims of this study were threefold: a) to explore the association between gambling-related variables and impulsivity traits in a sample of adult men who met criteria for GD; b) to estimate the predictive capacity of the impulsivity measures on GD treatment outcome (after 4 months of CBT treatment and at a two-year follow-up), namely considering relapse and dropout as outcome measures; and c) to examine the associations between DSM-5 severity categories on treatment outcome.

2. MATERIAL AND METHODS

2.1. PARTICIPANTS AND PROCEDURE

An initial sample of 519 patients diagnosed with GD from the Department of Psychiatry at a University Hospital, recruited between March 2013 and July 2017, was considered. They were voluntarily derived to the Gambling Disorder Unit through general practitioners or via other healthcare professionals. From this sample, 112 cases were excluded due to the fact that they decided not to enter treatment. Moreover, female patients (n = 8) and one case an incomplete evaluation were excluded. A total of 398 male patients were included in the final sample. Exclusion criteria for the study were the presence of a mental disorder (i.e. schizophrenia or other psychotic disorders) or intellectual disability. Patients were screened via a structured interview by experienced clinical psychologists and psychiatrists before being included in the study sample. These same therapists carried out the CBT therapy intervention.

The present study was carried out in accordance with the latest version of the Declaration of Helsinki. The University Hospital Clinical Research Ethics Committee approved the study, and written informed consent was obtained from all participants.

2.2. TREATMENT

The cognitive-behavioral therapy (CBT) group treatment program used in this study consisted of 16 weekly outpatient sessions at a University Hospital, lasting 90 min each. The follow-up period of visits included evaluations at 1, 3, 6, 12 and 24 months. CBT groups were led by an experienced clinical psychologist as well as a licensed co-therapist. To ensure treatment fidelity, treatment providers were trained on how to adhere closely to the treatment manual [39]. The goal of this treatment plan was to educate patients on how to implement CBT strategies in order to minimize all types of gambling behavior in order to eventually obtain full abstinence. The topics addressed in the treatment plan included: psychoeducation regarding the disorder (its course, vulnerability factors, diagnostic criteria, etc.), stimulus control (money management, avoidance of potential triggers, self-exclusion programs, etc.), response prevention (alternative and compensatory behaviors), cognitive restructuring focused on illusions of control over gambling and magical thinking, emotion-regulation skills training, and other relapse prevention techniques. This treatment program has already been described elsewhere [39] and its short and medium-term effectiveness has been reported in other studies [36,40,41]. Throughout treatment, attendance to treatment sessions, control of spending and the occurrence of relapses were recorded weekly on an observation sheet. A relapse was defined as the occurrence of a gambling episode once treatment had begun. This is common for many studies carried out with patients who meet criteria for GD [41–43]. Failure to attend three consecutive CBT sessions was considered a criterion for dropout.

2.3. INSTRUMENTS

2.3.1. DSM-5 CRITERIA [1]

Patients were diagnosed with pathological gambling if they met DSM-IV-TR criteria for this disorder [44]. It should be noted that with the release of the DSM-5 [1], the term pathological gambling was replaced with GD. All patient diagnoses were reassessed and recodified post hoc and only patients who met DSM-5 criteria for GD were included in our analysis.

2.3.2. SOUTH OAKS GAMBLING SCREEN (SOGS) [45]

This 20-item screening questionnaire discriminates between probable pathological, problem and non-problem gamblers based on the frequency and nature of gambling behaviors. The Spanish validation used in this work showed excellent internal consistency ($\alpha = 0.94$) and test-retest reliability ($r = 0.98$) [46].

2.3.3. IMPULSIVE BEHAVIOR SCALE (UPPS-P) [47]

The UPPS-P measures five facets of impulsivity through self-report on 59 items: negative urgency; positive urgency; lack of premeditation; lack of perseverance; and sensation seeking. Individuals are asked to consider acts/incidents during the last 6 months when rating their behaviors and attitudes.

The Spanish Language adaptation showed good reliability (Cronbach's α between 0.79 and 0.93) and external validity [19]. Consistency in the study sample was between good (α = 0.75 for lack of perseverance scale) to excellent (α = 0.92 for positive urgency).

2.3.4. OTHER SOCIODEMOGRAPHIC AND CLINICAL VARIABLES

Additional sociodemographic and variables related to gambling were measured using a semi-structured, face-to-face clinical interview described elsewhere [39].

2.4. STATISTICS

Statistical analyses were carried out with Stata15 for Windows. Firstly, the predictive capacity of GD severity (according to DSM-5 criteria) and UPPS-P impulsivity levels on relapse during CBT treatment, dropout during CBT and dropout in completing patients at the 24-month follow-up was assessed with binary logistic regression adjusted for the patients' age. These models were adjusted into two blocks: a) first block entered and fixed the covariate age; b) second block added the predictive independent variables through the ENTER method. The Hosmer-Lemeshow test assessed goodness-of-fit ($p > .05$ was considered adequate fit), global predictive capacity for the predictive variables entered into the second block was assessed through the changes in Nagelkerke's pseudo-R2 coefficient (DR2), and the global discriminative capacity of the final model was estimated via the area under the ROC curve (AUC).

Comparison between UPPS-P scores at baseline between the categorical GD severity groups (using DSM-5 criteria) was based on analysis of variance (ANOVA), adjusted for the participants' age, including pairwise comparisons to assess differences between the groups.

Finally, survival analyses measured the time to dropout and the first relapse during the CBT intervention, as well as the comparison of the GD severity groups at baseline. This study obtained the Kaplan-Meier (product-limit) estimator and used the Cox's regression adjusted for the participants' age to compare the survival cumulate curves between the three GD severity groups (i.e. mild, moderate, and severe). The survival function is a method used to measure the probability of patients "living" (surviving without the presence of the outcome, in this study without dropout and without the presence of gambling relapses) for a certain amount of time after the intervention. One of the most relevant advantages of this procedure is that it allows for the modeling of censored data, which occurs if patients withdraws from the study [48,49].

3. RESULTS

3.1. DESCRIPTION OF THE SAMPLE

The mean age of the study sample was 41.5 years (SD = 13.1), the mean age of GD onset was 28.5 years (SD = 10.8), with a mean duration of 6.5 years (SD = 6.4). Table 1 includes a complete sociodemographic and clinical description of study sample.

3.2. PREDICTIVE CAPACITY OF GD SEVERITY AND IMPULSIVITY LEVELS TREATMENT OUTCOME

The number of participants who dropout during the CBT program was n = 182 (risk of dropout equal to 45.7%; 95% confidence interval, 95%CI: 40.8% to 50.6%) and the participants who reported gambling episodes during the course of the treatment was n = 119 (risk of relapses: 29.9%; 95% CI: 25.4% to 34.4%). The attrition from treatment completion to the 24-month follow-up was high (risk of dropout during the 2 years follow-up equal to 89.8%: 95%CI: 85.8% to 93.8%). Table 2 includes the binary logistic regression models assessing the predictive capacity of baseline GD severity (the number of DSM-5 criteria) and UPPS-P impulsivity levels on treatment outcome (all the models are adjusted for the covariate age). All models in this table obtained good fitting indexes ($p > .05$ in the H-L test).

The risk of drop out during the CBT program (the first model in Table 1) was higher for participants who reported higher lack of perseverance and sensation seeking scores. The risk of having a gambling episode (relapsing) during CBT treatment was higher for participants with higher negative urgency levels (the second model in Table 2). Finally, the risk of drop out during the two-year follow-up after the CBT program (the third model in Table 2, obtained for the subsample of patients who finished CBT treatment therapy without dropout) was increased for patients who reported higher scores in sensation seeking.

Table 1
Sample description (n = 398).

Sociodemographic variables	*n*	%	Clinical variables	*α*	Mean	SD
Origin*Spain*	375	94.2%	Age (years-old)		41.52	13.12
Other country	23	5.8%	Gambling disorder onset (years)		28.48	10.76
Civil status*Single*	196	49.2%	Duration of gambling (years)		6.53	6.44
Married-partner	156	39.2%	Mean bets per episode (euros)		149.9	491.2
Separated-divorced	46	11.6%	Largest bet in an episode (euros)		1607.1	5301.8
Education level*Primary*	227	57.0%	Cumulate debts, at present (euros)		22,048.8	164228.9
Secondary	142	35.7%	DSM-5 total criteria	.744	7.27	1.52
University	29	7.3%	SOGS total criteria	.740	11.26	2.74
Employment*Unemployed*	173	43.5%	UPPS-P Lack of premeditation	.846	24.40	6.57
Employed	225	56.5%	UPPS-P Lack of perseverance	.778	22.13	5.64
			UPPS-P Sensation seeking	.860	27.63	8.89
			UPPS-P Positive urgency	.918	32.18	10.55
			UPPS-P Negative urgency	.806	33.14	7.10

Note. SD: standard deviation. Cronbach's alpha in the sample. SOGS: South Oaks Gambling Screen.

Table 2
Predictive capacity of DSM-5 GD severity and the UPPS-P scores on treatment outcome (second block of the regressions adjusted for age).

	B	*SE*	*Wald*	*p*	*OR*	*95%CI(OR)*		ΔR^2	H-L	AUC
Drop out during CBT										
Age (years-old)	*−0.017*	*0.009*	*3.728*	*.054*	*0.98*	*0.97*	*1.00*	.047	.083	.658
Severity of GD (DSM-5 total)	−0.062	0.079	0.606	.436	0.94	0.81	1.10			
UPPS-P Lack of premeditation	−0.001	0.021	0.003	.956	1.00	0.96	1.04			
UPPS-P Lack of perseverance	0.051	0.024	4.745	**.029***	1.05	1.01	1.10			
UPPS-P Sensation seeking	0.049	0.013	13.517	**<.001***	1.05	1.02	1.08			
UPPS-P Positive urgency	−0.002	0.015	0.012	.914	1.00	0.97	1.03			
UPPS-P Negative urgency	0.002	0.022	0.007	.936	1.00	0.96	1.05			
Relapses during CBT										
Age (years-old)	*−0.008*	*0.009*	*0.815*	*.367*	*0.99*	*0.97*	*1.01*	.026	.516	.602
Severity of GD (DSM-5 total)	−0.025	0.085	0.083	.773	0.98	0.83	1.15			
UPPS-P Lack of premeditation	−0.012	0.021	0.319	.572	0.99	0.95	1.03			
UPPS-P Lack of perseverance	0.036	0.025	2.097	.148	1.04	0.99	1.09			
UPPS-P Sensation seeking	0.014	0.014	0.983	.322	1.01	0.99	1.04			
UPPS-P Positive urgency	−0.012	0.015	0.569	.451	0.99	0.96	1.02			
UPPS-P Negative urgency	0.052	0.024	4.825	**.028***	1.05	1.01	1.10			
[1]Drop-out at 24-month follow-up										
Age (years-old)	*−0.026*	*0.019*	*1.856*	*.173*	*0.965*	*0.940*	*1.011*	.062	.331	.682
Severity of GD (DSM-5 total)	*−0.040*	*0.184*	*0.047*	*.828*	*0.961*	*0.671*	*1.377*			
UPPS-P Lack of premeditation	−0.058	0.051	1.305	.253	0.944	0.854	1.042			
UPPS-P Lack of perseverance	0.081	0.055	2.183	.140	1.085	0.974	1.208			
UPPS-P Sensation seeking	0.070	0.035	3.938	**.047***	1.072	1.001	1.149			
UPPS-P Positive urgency	−0.014	0.033	0.182	.670	0.986	0.924	1.052			
UPPS-P Negative urgency	−0.048	0.053	0.827	.363	0.953	0.859	1.057			

Note. [1]Model for patients who finished CBT treatment ($n = 216$).
ΔR^2: increase in the Nagelkerke's pseudo R^2 comparing blocks 1 and 2. H-L: Hosmer and Lemeshow test (*p-value*). AUC: area under the ROC.
* Bold: significant parameter (.05 level). Italics: coefficients for the covariate age. (Sample size: $n = 398$).

3.3. COMPARISON OF UPPS-P IMPULSIVITY LEVELS BETWEEN DSM-5 GD SEVERITY GROUPS

Table 3 includes the ANOVA comparison, adjusted for age, comparing baseline UPPS-P impulsivity levels between the three GD severity groups (mild, moderate, and severe) (Table S1, Supplementary material, includes comparisons for additional clinical measures of these groups). As a whole, mean positive and negative urgency levels increased with GD severity.

Table 3
Comparison of UPPS-P scores based on DSM-5 GD severity categories: ANOVA adjusted for patients' age.

GD severity →	Mild (4-5 criteria) ($n = 65$)		Moderate (6-7 criteria) ($n = 133$)		Severe (8-9 criteria) ($n = 200$)		Pairwise comparisons: Mild vs moderate		Mild vs severe		Moderate vs severe	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*p*	*|d|*	*p*	*|d|*	*p*	*|d|*
Lack of premeditation	22.60	6.81	23.76	6.45	25.42	6.34	.228	0.18	**.002***	0.43	**.023***	0.26
Lack of perseverance	20.86	6.24	21.59	5.70	22.91	5.30	.389	0.12	**.012***	0.35	**.038***	0.24
Sensation seeking	26.26	9.00	26.44	8.37	28.87	8.89	.886	0.02	**.032***	0.29	**.011***	0.28
Positive urgency	25.19	8.68	30.17	10.19	35.78	9.99	**.001***	**0.53†**	**<.001***	**1.13†**	**<.001***	**0.56†**
Negative urgency	27.70	6.81	31.86	6.29	35.76	6.51	**<.001***	**0.63†**	**<.001***	**1.21†**	**<.001***	**0.61†**

Note. SD: standard deviation. *Bold: significant comparison (.05 level).
† Bold: effect size into the moderate ($|d|>0.50$) to high range ($|d|>0.80$).

3.4. SURVIVAL ANALYSIS COMPARING DSM-5 GD SEVERITY GROUPS

Fig. 1 contains the survival function estimated with the Kaplan- Meier method for the rate of dropout and relapses during the CBT program, stratified by DSM-5 gambling severity group (mild, moderate and severe). No statistical differences for these outcomes were found comparing the three groups:

Cox's regression adjusted for the participants' age obtained χ2-wald = 0.02, df = 1, p = .892 for dropout and χ2-wald = 0.02, df = 1, p = .892 for relapses.

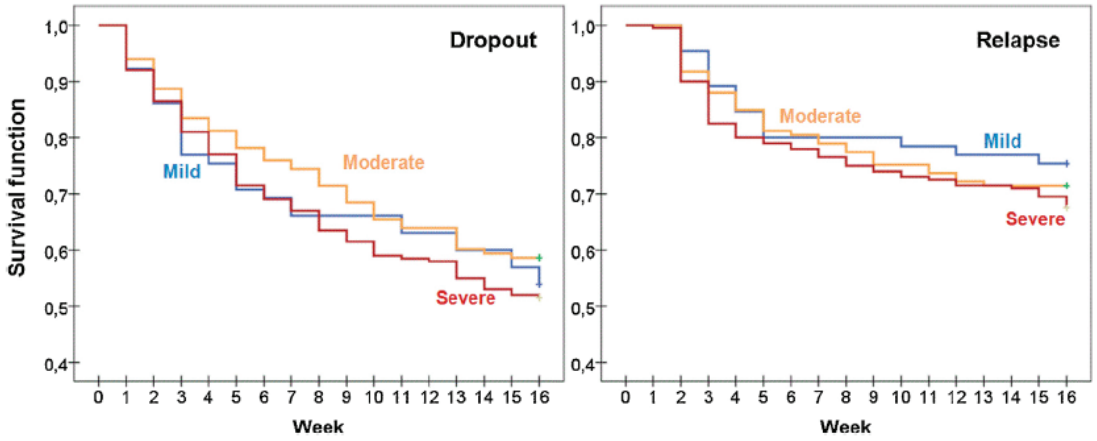

Fig. 1. Cumulative survival functions for dropout and relapse during the 16-week CBT program.

4. DISCUSSION

The present study estimated, in a sample of male patients seeking treatment for GD, the predictive capacity of impulsivity traits and gambling severity on treatment outcome, namely considering relapse and dropout. We also sought to examine the associations between impulsivity, GD severity and treatment response.

Regarding the predictive model, sensation seeking was a predictor of dropout, both during treatment and in follow-up stages. To date, there is a paucity of scientific literature analyzing the association of this construct with GD treatment outcome. However, previous studies in the field suggest that patients with high levels of sensation present a clinical phenotype that could interfere with adherence to treatment guidelines [37,50,51]. These patients may be especially motivated at the start of treatment to become involved in a treatment program with the expectation of receiving the benefits of abstinence, but this interest in the novelty of treatment often quickly fades due to their personality profile [52]. Relatedly, lack of perseverance was another predictor of dropout during treatment and in the follow-up period. Other addiction studies have provided similar evidence, finding that treatment completers had significantly higher persistence levels than those who abandon therapy [53].

Finally, negative urgency was identified as a predictor of relapse during treatment in the present study. This finding broadly supports the results of other studies in addictions linking high levels of impulsivity with short-term and mid-term relapses [54]. More specifically, negative urgency has been associated with poorer therapy outcomes [55] and greater relapse risk. This leads us to postulate that

patients with GD are more vulnerable to making rash decisions when experiencing negative mood states, such as frustration or anxiety, leading to more frequent relapses. Gambling behavior, in these cases, is therefore likely used as a means of negative reinforcement in order to regulate affective states. Moreover, it is known that in GD, as the disorder progresses, behavior is increasingly maintained by a pattern of negative reinforcement than positive reinforcement [56]. Therefore, impulsiveness could arise from seeking out relief from negative emotional states rather than from a need to obtain immediate reward [57]. From a phenomenological perspective, it is feasible that disinhibition plays a mediating role between these two dimensions [58,59], with numerous studies suggesting that inhibition is impaired in some patients with GD and that disinhibition, in turn, can be a risk factor for relapse [60,61].

Another finding to emerge from the present study is the difference in urgency levels bearing in mind DSM-5 severity categories (mild, moderate and severe). Specifically, the present data uphold the position that in those cases in which the severity of GD is greater, levels of urgency are also higher. This observation dovetails with other research that found that impulsivity was a predictor of GD severity and poor prognosis [62,63].

Although other studies have associated greater GD severity with poorer response to treatment [37], our study failed to identify differences in treatment response using DSM-5 GD severity categorizations. The DSM-5 provides nine diagnostic criteria for GD and it is pre-assumed that all criteria have an equal diagnostic impact [31]. One of the drawbacks of this dichotomous approach is that factors, such as the frequency and the level of distress brought about by gambling behaviors [29,59]. Our findings raise further questions regarding the clinical validity of merely summing the number of criteria endorsed by an individual and whether DSM-5 GD severity categories accurately reflect actual GD symptom severity, if each is weighted equally. In the line of the study by Bottesi et al. [58], future studies should consider contrasting dimensional measures with DSM-5 categories in order to determine which best serves as a predictor of treatment response. Doing so could aid clinicians in shifting away from categorical definitions of gambling and allow for more tailored treatment programs that bear in mind the patients' individual features that place them at greatest risk.

4.1. LIMITATIONS

The present study is not without its limitations. First, all data were collected from men who sought treatment and future studies would benefit from including women with GD. Second, impulsivity traits were assessed using self-report measures that are, in all likelihood, unable to fully capture the multi-factorial nature of impulsivity in GD patients. Third, our study only examined the effectiveness of one type of intervention and it would be useful to know if similar results are present using a multiple-arm study design [64]. Finally, it would have been of interest to take pharmacotherapy into account, being that GD patients frequently show comorbidities with other disorders (e.g. depression, attention deficit hyperactivity disorder) and that the use of medications could potentially have

influenced impulsivity levels.

5. CONCLUSIONS

This study aimed to identify short- and long-term predictors of response to treatment in sample of treatment-seeking patients with GD. In concordance with other studies, our findings indicate that increased sensation-seeking levels were a predictor of abandoning treatment, along with greater lack of perseverance scores. Furthermore, we found that greater negative urgency scores increased the risk of relapsing during the 16-week CBT treatment program. However, contrary to our initial hypothesis, increased severity, as categorized by the DSM-5, was not indicative of poorer response to treatment. These results raise doubts with respect to the clinical utility of such severity categories and support the use of dimensional approaches in future studies.

DECLARATIONS OF INTEREST
None.

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Table S1. Comparison of age, onset and duration of the GD between the GD severity groups at baseline

GD severity →	Mild (4-5 criteria) (*n*=65)		Moderate (6-7 criteria) (*n*=133)		Severe (8-9 criteria) (*n*=200)		Pairwise comparisons Mild vs moderate		Mild vs severe		Moderate vs severe	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*p*	|*d*|	*p*	|*d*|	*p*	|*d*|
Age (years)	44.78	12.82	43.70	14.25	39.00	10.14	.578	0.08	**.002***	**0.50†**	**.001***	0.38
Onset GD (years)	30.36	10.76	30.36	11.57	26.62	9.90	.999	0.00	**.014***	0.36	**.002***	0.35
GD Duration (years)	7.46	7.27	5.75	6.22	6.74	6.27	.080	0.25	.434	0.11	.169	0.16
Spending/episode (€)	138.0	501.0	117.6	448.8	175.1	515.5	.784	0.04	.598	0.07	.297	0.12
Spending/episode (€, max)	752.7	1165.3	1828.1	6923.0	1737.8	4854.0	.181	0.22	.194	0.28	.879	0.02
Cumulate debts (€)	7425	20762	33314	261923	19310	89441	.299	0.14	.613	0.18	.447	0.07
DSM-5 total criteria	4.66	0.48	6.63	0.48	8.55	0.50	**<.001***	**4.10†**	**<.001***	**7.97†**	**<.001***	**3.90†**
SOGS total score	8.94	2.03	10.43	2.49	12.58	2.36	**<.001***	**0.66†**	**<.001***	**1.65†**	**<.001***	**0.89†**

Note. SD: standard deviation. *Bold: significant comparison (.05 level).

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

STUDY 6

GAMBLING DISORDER: THE ROLE OF IMPULSIVITY AND COMPULSIVITY

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GAMBLING DISORDER: THE ROLE OF IMPULSIVITY AND COMPULSIVITY

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ABSTRACT

Introduction: Associations between gambling disorder (GD) and impulsivity have been identified. However, less is known regarding compulsivity in GD and how compulsivity associates with different impulsivity domains. **Methods:** In this study, we examined associations between self-reported and behavioral measures of impulsivity (assessed through the Barratt Impulsiveness Scale (BIS-11) and the Experiential Discounting Task (EDT), respectively) and compulsivity (measured using the Padua Inventory and the Wisconsin Card Sorting Test (WCST), respectively) in an adult sample with GD (n=132). Structural Equation Modelling (SEM) was used to explore associations between impulsivity and compulsivity measures, age and GD severity. **Results:** BIS-11 non-planning and BIS-11 total scores positively correlated with GD severity. The standardized coefficients for the SEM showed a direct positive contribution of BIS-11 non-planning, Padua total scores and EDT scores to GD severity. Participants' age only significantly contributed to WCST perseverative errors, and no direct or indirect effects were found with respect to GD severity. **Discussion and conclusions:** The findings suggest that specific aspects of impulsivity and compulsivity may contribute to GD severity. Interventions specifically targeting domains that are most relevant to GD severity may improve treatment outcomes.

Keywords
gambling disorder, impulsivity, compulsivity, severity, spectrum.

INTRODUCTION

When viewed from a transdiagnostic framework, impulsivity and compulsivity contribute to the development, maintenance and severity of mental disorders including gambling disorder (GD) (Fauth-Bühler, Mann, & Potenza, 2017; Fineberg et al., 2010). Even though impulsivity and compulsivity are distinct constructs, both may involve impaired abilities to inhibit or delay behaviors and be present concurrently or at different times in the same disorder (Hollander & Rosen, 2000). While impulsivity and compulsivity had been hypothesized to lie at different ends of a continuous spectrum (Hollander & Wong, 1995), data suggest that the constructs may be more orthogonal, with elevated levels of each in disorders like GD (Potenza, 2007a).

Impulsivity has been defined as a "predisposition toward rapid, unplanned reactions to internal or external stimuli with diminished regard to the negative consequences of these reactions to the impulsive individual or to others" (Brewer & Potenza, 2008; Moeller, Barratt, Dougherty, Schmitz, & Swann, 2001). As suggested by this definition, impulsivity is a multifaceted construct and may include components related to pre-potent motor disinhibition (impulsive action (Hamilton, Littlefield, et al., 2015)) and difficulties in delaying gratification (impulsive choice (Hamilton, Mitchell, et al., 2015)), and each may relate to specific neurocognitive mechanisms (Fineberg et al., 2010, 2014; Kozak et al., 2018). Impulsivity has been implicated in multiple psychiatric disorders, such as attention-deficit/hyperactivity disorder (Geurten, Catale, Gay, Deplus, & Billieux, 2018; Hinshaw, 2018), eating disorders (Claes et al., 2015; Fagundo et al., 2013; Kessler, Hutson, Herman, & Potenza, 2016; Steward, Mestre-Bach, Vintró-Alcaraz, et al., 2017), and substance use disorders and behavioral addictions (Bőthe et al., 2018; Leeman & Potenza, 2012; Steward, Mestre-Bach, Fernández-Aranda, et al., 2017). In GD, high levels of both, impulsive action (Chowdhury, Livesey, Blaszczynski, & Harris, 2017) and impulsive choice (Fortgang, Hoff, & Potenza, 2018; Steward, Mestre-Bach, Fernández-Aranda, et al., 2017) have been observed, although there is a lack of consistency in explaining their association with GD severity (Brevers et al., 2012; Chowdhury et al., 2017; MacKillop, Anderson, Castelda, Mattson, & Donovick, 2006). Some research considered age and GD severity as the best predictors of individual differences in choice impulsivity (Alessi & Petry, 2003; Stea, Hodgins, & Lambert, 2011; Steward et al., 2017).

Compulsivity has been defined as involving, "the performance of repetitive and functionally impairing overt or covert behavior without adaptive function, performed in a habitual or stereotyped fashion, either according to rigid rules or as a means of avoiding perceived negative consequences" (Fineberg et al., 2014). In GD, compulsive features have been found (Scherrer, Xian, Slutske, Eisen, & Potenza, 2015), such as impairments in cognitive flexibility that may involve difficulty in learning from mistakes and implementing alternative problem-solving methods (Álvarez-Moya et al., 2009; Forbush et al., 2008; Marazziti et al., 2008). During performance of attentional set-shifting tasks like the Wisconsin card sorting test (WCST; Lezak, Howieson, Bigler, & Tranel, 2012), worse performance (less flexibility or more compulsivity) has been observed in individuals with GD versus

those without, with findings indicating more perseverative errors (van Timmeren, Daams, van Holst, & Goudriaan, 2018). Moreover, self-reported compulsivity has been positively associated with GD severity and may reflect poor control over gambling-related thoughts and behaviors (Blanco et al., 2009).

Changes in decision making processes and impulsivity dimensions are affected by neural development across the lifespan (Argyriou, Um, Carron, & Cyders, 2018; Kalapatapu, Lewis, Vinogradov, Batki, & Winhusen, 2013; Steinberg et al., 2008). More specifically, it has been postulated that higher ages imply a greater maturation of the mesolimbic dopamine circuit and the cognitive control system, thereby reducing the degree to which delayed rewards are devalued (Argyriou et al., 2018). Regarding compulsivity, differences have been found between different age groups in features such as cognitive flexibility, task memory and planning, suggesting a progressive decline in these traits as individual develop (Grieve, Williams, Paul, Clark, & Gordon, 2007; Rodríguez Villegas & Salvador Cruz, 2015).

Therefore, although an association between impulsivity, compulsivity, age and GD severity has been described, at a clinical level it is difficult to identify and describe how this interaction occurs and which dimensions of impulsivity and compulsivity are most strongly associated with the clinical characteristics of this disorder. Moreover, in GD, the simultaneous examination of both impulsivity and compulsivity through self-reported and behavioral measures has been scarce. Elevated impulsivity and compulsivity have been observed in both self-report and behavioral measures of impulsivity and compulsivity and have been at times linked to treatment outcomes (Blanco et al., 2009; Bottesi, Ghisi, Ouimet, Tira, & Sanavio, 2015; J. Grant, Odlaug, Chamberlain, Potenza, & Kim, 2010; Tavares & Gentil, 2007). Although complex relationships between impulsivity and compulsivity have been proposed (Potenza, 2007b; Tavares & Gentil, 2007), few studies have concurrently investigated self-reported and behavioral measures of both impulsivity and compulsivity in conditions like GD. Finally, there is scarce research evaluating the meditational role of these two domains between age and GD severity.

Here we examined the interplay between self-reported and behavioral measures of impulsivity and compulsivity and GD severity in adults with GD. Furthermore, Structural Equation Modeling (SEM) was used to explore associations between age and these clinical factors. We hypothesized that GD severity levels would positively relate to both self-reported and behavioral measures of impulsivity and compulsivity. We also hypothesized that age would be associated with compulsivity, as suggested by previous studies (Grieve, Williams, Paul, Clark, & Gordon, 2007; Rodríguez Villegas & Salvador Cruz, 2015), and that impulsivity would show a direct association with GD severity, as observed previously (Mestre-Bach et al., 2019).

METHODS

PARTICIPANTS AND PROCEDURE

The sample was comprised of 132 participants who met criteria for GD. They were recruited at Yale University in the Problem Gambling Clinic through advertisements. Individuals 18 years or older with a diagnosis of DSM-IV pathological gambling as determined by structured interview were included (J. E. Grant, Steinberg, Kim, Rounsaville, & Potenza, 2004). The study was conducted in accordance with the latest version of the Declaration of Helsinki. The Yale Human Investigation Committee approved the study, and signed informed consent was obtained from all participants.

MEASURES

GD DIAGNOSTIC AND CLINICAL CHARACTERISTICS

South Oaks Gambling Screen (SOGS) (Lesieur & Blume, 1987)

This questionnaire includes 20 items assessing the frequency and severity of gambling-related activities (scores range from 0 to 20). This questionnaire discriminates between probable non-problem gambling (from 0 to 2), probable problem gambling (from 3 to 4), and probable pathological gambling (from 5 to 20), with higher scores being indicative of greater problem-gambling severity. The SOGS is a widely used instrument to screen for gambling problems in research and clinical settings, and has been used as a measure of GD severity (Potenza et al., 2003).

IMPULSIVITY

The Barratt Impulsiveness Scale (BIS-11) (Patton, Stanford, & Barratt, 1995)

The BIS-11 is a 30-item, self-report instrument that includes three subscales: (1) attentional, (2) motor, and (3) non-planning. Item responses range from 1 to 4 (Rarely/Never, Occasionally, Often, Almost Always/Always). It has demonstrated adequate test-retest reliability (Spearman's rho ρ.83) and acceptable internal consistency (α.83), with a score of 72 or higher representing high impulsivity (Patton et al., 1995).

Experiential discounting task (EDT)

The EDT is a computerized task in which subjects experience chose smaller, sooner and certain rewards versus larger, later and probabilistic rewards in real time (Reynolds & Schiffbauer, 2004). Subjects completed four session blocks associated with different time delays, three of which involved choices between an adjusting and certain amount (initially, $0.15) that was delivered immediately or

a standard amount ($0.30) that was delayed and probabilistic (35%). For the other session, there was no delay (0 s), and the reward ($0.30; probability, 35%) was delivered immediately. Choice options were indicated by the "illumination" of light bulbs on the screen. The immediate amount (right side of screen) was adjusted in value in that the amount increased by a set percentage following a delayed standard choice but decreased following an immediate choice. The delayed standard amount (left side of screen) was not adjustable. The standard option choice resulted in a wait of a specified delay (0, 7, 14, and 28 s). If the money was delivered, it could be transferred to the "bank" by clicking on the "illuminated" bank building image, which resulted in coin delivery from a coin dispenser. For each choice block, subjects made choices until an indifference point was reached, defined as choosing each option (i.e., immediate and delayed) three times within six consecutive choice trials—thus keeping the adjusting amount constant over those six choices. After an indifference point was established or the delayed option was chosen 15 times (reflecting minimal discounting), the session ended. The remaining sessions (i.e., 7, 14, and 28 s) were completed in ascending order.

The plot of the indifference curves (normalized indifference point plotted for each delay interval) for each individual were fit with either an exponential (VS=VAe –kd) or a hyperbolic (VS=VA/ 1+Kd) function where the subjective value (VS) was a modification of the actual value (VA) by the delay (d) and a discount constant (k) (Mazur 1987). The k value represents the steepness of the delay-discounting curve and was used as a measure of choice impulsivity. A higher k represents higher choice impulsivity. Curve-fitting was conducted using Prism 5 (GraphPad software). We assessed the proportion of choices for each delay interval (delayed choice ratio=delayed choice/total choice) and compared impulsive and non-impulsive subjects (dichotomized by median k).

COMPULSIVITY

The Padua Inventory (Sanavio, 1988; Sternberger & Burns, 1990)

The Padua Inventory is a 60-question self-report instrument that assesses obsessive and compulsive tendencies. The inventory contains four factors: impaired control over mental activities, which assesses ruminations and exaggerated doubts; fear of contamination; checking; and, impaired control over motor activities which measures urges and worries related to motor behavior, such as violent impulses. The Padua Inventory has shown high test-retest reliability, high internal consistency, and good convergence validity with other obsessionality-compulsivity instruments (Sanavio, 1988; Sternberger & Burns, 1990).

The Wisconsin Card Sorting Test (WCST) (Lezak et al., 2012)

The Wisconsin Card Sorting Test (Lezak et al., 2012) is a set-shifting task designed to assess cognitive flexibility. It assesses tendencies to shift cognitive strategies in response to altering conditions, and in so doing assesses strategic planning, organized searching and the use of environmental feedback

to modify cognitive approaches. The test consists of 128 cards that vary according to three attributes: the number, color, and shape of their elements. Participants are instructed to sort the cards in piles beneath four reference cards that vary in these same dimensions. The only feedback given to the participant is the word "right" or "wrong" after each sorting. Initially, color is the correct sorting category, and positive feedback is given only if the card is placed in the pile with the same color. After ten sequential correct answers the categorization criteria changes. Thus, only classifications that match the new category will result in positive feedback. Participants must learn to change the sorting categories according to the feedback they receive. The test ends after all cards are sorted, or after six full categories are completed. The number of complete categories, the percentage of perseverative errors (i.e., failures to change sorting strategy after negative feedback) and the percentage of non-perseverative errors are recorded.

STATISTICAL ANALYSIS

Statistical analysis was conducted with Stata15 for Windows. First, associations between impulsivity and compulsivity measures with GD severity (SOGS-total score) were estimated through partial correlation coefficients (r) adjusted for the participants' gender and age. Due to strong associations between r-coefficients and sample size in determining statistical significance, $|r|>0.10$ but less than 0.24 was considered a low/poor effect size, $|r|>0.24$ but less than 0.37 was considered a moderate effect size and $|r|>0.37$ was considered a large effect size (Rosnow & Rosenthal, 1996).

Second, the underlying mechanism between impulsivity-compulsivity measures with GD severity was evaluated through path analysis implemented via structural equation modeling (SEM), a statistical procedure that allows for estimation of mediational relationships including direct and indirect dependencies among a set of variables (Kline, 2005). The maximum-likelihood estimation (MLE) method of parameter estimation was used and goodness-of-fit was evaluated using standard statistical measures including the root mean square error of approximation (RMSEA), Bentler's Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI), and the standardized root mean square residual (SRMR) (Barrett, 2007). Adequate model fit was considered non-significant by chi-square (χ^2) tests and if the following criteria were met (Barrett, 2007): RMSEA<.08, TLI>.9, CFI>.9 and SRMR<.1. The global predictive capacity of the model was measured by the coefficient of determination (CD). The study model included impulsivity-compulsivity measures and age as endogenous variables, and SOGS total score as the exogenous variable. The participant's gender was included as a group variable with the aim to assess the invariance of the SEM structural coefficients by gender.

RESULTS

SAMPLE DESCRIPTION

The frequency distribution of the sociodemographic and clinical variables of the study are included in Table 1. Most participants were male (71.2%), white (60.6%) and single (58.3%). The mean age was 42.8 years (SD = 12.3) and the mean score on the SOGS scale was 12.1 (SD = 4.0).

Table 1 Sample description (n=132)

Sociodemographic variables		*n*	*Percentage*
Gender	*Female*	38	28.8%
	Male	94	71.2%
Race	*White*	80	60.6%
	Black	48	36.4%
	Other	4	3.0%
Marital status	*Single*	77	58.3%
	Married	22	16.7%
	Separated-divorced	33	25.0%
Education level	*Postgraduate*	6	4.5%
	College graduate	25	18.9%
	Some college without diploma	52	39.4%
	High school diploma/GED	45	34.1%
	Less than high School.	4	3.0%
Clinical measures		*Mean*	*SD*
Age (years-old)		42.77	12.25
GD: SOGS total score		12.10	4.03
WCST Trials		102.06	22.04
WCST Perseverative responses		14.36	10.12
WCST Perseverative errors		12.91	8.19
WCST Non-perseverative errors		14.54	8.85
Padua Impaired-Control		8.62	10.52
Padua Contamination		9.07	8.94
Padua Checking		5.15	6.25
Padua Motor		1.60	3.29
Padua Total		24.44	24.37
BIS-11 Attentional		15.53	4.08
BIS-11 Motor		24.46	5.19
BIS-11 Non-planning		26.21	5.08
BIS-11 Total		66.20	11.91
EDT-k-delay-measure		0.084	0.276

Note. SD: standard deviation. GD: gambling disorder. SOGS: South Oaks Gambling Screen; WCST: Wisconsin Card Sorting Test; BIS-11: Barratt Impulsiveness Scale; EDT: Experiential discounting task.

CORRELATIONS BETWEEN VARIABLES

Table 2 contains the correlation matrix with the partial correlation coefficients (adjusted for gender and age) between the study variables. Associations with effect size in the moderate to high range are marked in bold. GD severity positively correlated with BIS-11 non-planning and BIS-11 total scores. The EDT-k level was also positively correlated with BIS-11 scores, except for the non-planning scale. All remaining significant associations were between subscales of the same questionnaire.

Table 2 Correlation between the impulsivity and compulsivity measures with the SOGS-total score: Partial correlation adjusted by sex and age

		2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	SOGS total score	.03	-.07	-.06	.00	-.01	-.02	-.06	.00	-.03	.15	.23	**.25†**	**.26†**	.08
2	WCST Trials	---	**.67†**	**.68†**	**.75†**	.13	.05	.13	.03	.11	.05	-.11	.02	-.02	.07
3	WCST Persever.responses		---	**.99†**	**.60†**	.18	.12	.17	.06	.17	-.01	-.15	-.05	-.09	.06
4	WCST Persever.errors			---	**.63†**	.18	.13	.17	.08	.18	-.03	-.15	-.04	-.09	.05
5	WCST Non-persever.errors				---	.20	.04	.20	.10	.17	.03	-.08	.02	-.02	.12
6	Padua Impaired-Control					---	**.55†**	**.80†**	**.66†**	**.92†**	.21	.01	.01	.08	-.02
7	Padua Contamination						---	**.58†**	**.31†**	**.79†**	.04	-.11	-.20	-.12	.00
8	Padua Checking							---	**.46†**	**.87†**	.08	.04	-.13	-.01	.04
9	Padua Motor								---	**.65†**	.18	.02	-.02	.07	.01
10	Padua Total									---	.15	-.02	-.10	.00	.01
11	BIS Attentional										---	**.55†**	**.48†**	**.79†**	**.24†**
12	BIS Motor											---	**.55†**	**.86†**	**.27†**
13	BIS Non-planning												---	**.83†**	.16
14	BIS Total													---	**.27†**
15	EDT-k														---

Note. †Bold: effect size into the moderate (|*R*|>0.24) to high range (|*R*|>0.37). Sample size: *n*=132.

PATH ANALYSIS

The standardized coefficients for the SEM are included in the diagram in Figure 1 and the complete results of the model testing direct, indirect and total effects are included in Table 3. The joint test measuring the invariance of the structural parameters by participants' gender obtained non-significant results (χ^2=13.02, p=.162), indicating that the path analysis did not significantly differ between men and women. Adequate fitting was obtained for the SEM: x2=7.06 (p=.530), RMSEA=0.002, CFI=0.998, TLI=0.999 and SRMR=0.053. Global predictive capacity for the model was around 18%. The path diagram indicated a direct positive contribution of BIS-11 non-planning, Padua Inventory total and EDT-k on GD severity. Participants' ages only significantly contributed to WCST perseverative errors, and no direct or indirect effects were found with respect to GD severity.

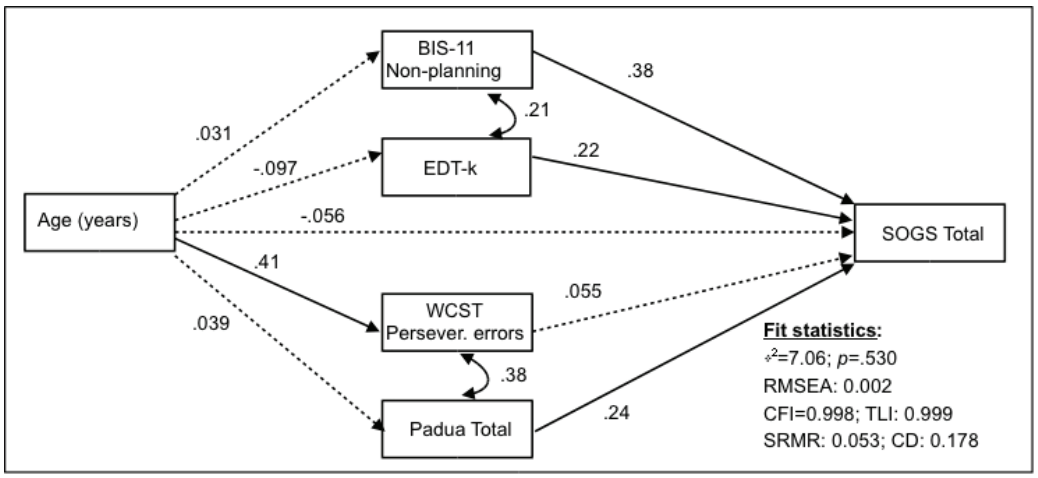

Figure 1 Path diagram with structural equation modeling showing standardized coefficients (n=132)

Note. Continuous parameter: significant parameter. Dash line: non-significant parameter. BIS-11: Barratt Impulsiveness Scale; EDT: Experiential discounting task; WCST: Wisconsin Card Sorting Test; SOGS: South Oaks Gambling Screen.

Table 3 SEM: direct, indirect and total effects

		Direct effects					Indirect effects					Total effects				
		B	SE (B)	z	p	St(B)	B	SE (B)	z	p	St(B)	B	SE (B)	z	p	St(B)
PADUA-total																
Age	Women	0.075	0.322	0.23	0.816	0.039	0	---			0	0.075	0.322	0.23	0.816	0.039
	Men	-0.160	0.218	-0.74	0.462	-0.079						-0.160	0.218	-0.74	0.462	-0.079
SOGS-total																
PADUA-total	Women	0.051	0.034	1.51	0.048	0.240	0	---			0	0.051	0.034	1.51	0.048	0.240
	Men	0.060	0.016	-0.62	0.047	0.234						0.060	0.016	-0.62	0.047	0.234
BIS-non plan.	Women	0.305	0.123	2.47	0.014	0.376	0	---			0	0.305	0.123	2.47	0.014	0.376
	Men	0.112	0.086	1.3	0.045	0.134						0.112	0.086	1.3	0.045	0.134
EDT-k	Women	3.890	2.502	1.55	0.040	0.223	0	---			0	3.890	2.502	1.55	0.040	0.223
	Men	2.139	2.188	-0.98	0.038	0.101						2.139	2.188	-0.98	0.038	0.101
WCST-persev.	Women	0.031	0.098	0.32	0.750	0.055	0	---			0	0.031	0.098	0.32	0.750	0.055
	Men	-0.069	0.051	-1.37	0.172	-0.150						-0.069	0.051	-1.37	0.172	-0.150
Age	Women	-0.023	0.064	-0.36	0.721	-0.056	0.009	0.047	0.19	0.848	0.022	-0.014	0.068	-0.2	0.839	-0.034
	Men	0.070	0.034	2.07	0.039	0.227	-0.012	0.014	-0.87	0.386	-0.040	0.057	0.032	1.77	0.077	0.186
BIS-non plan.																
Age	Women	0.016	0.084	0.19	0.853	0.031	0	---			0	0.016	0.084	0.19	0.853	0.031
	Men	-0.024	0.039	-0.61	0.539	-0.066						-0.024	0.039	-0.61	0.539	-0.066
EDT-k																
Age	Women	-0.002	0.004	-0.59	0.558	-0.097	0	---			0	-0.002	0.004	-0.59	0.558	-0.097
	Men	-0.002	0.002	-1.05	0.293	-0.112						-0.002	0.002	-1.05	0.293	-0.112
WCST-persev.																
Age	Women	0.298	0.110	2.7	0.007	0.410	0	---			0	0.298	0.110	2.7	0.007	0.410
	Men	0.211	0.067	3.13	0.002	0.318						0.211	0.067	3.13	0.002	0.318

Note. B: coefficient. SE: standard error. St(B): standardized coefficient. Sample size: *n*=132.

DISCUSSION

The first aim of the present study was to examine associations between impulsivity, compulsivity, and GD severity in adults with GD. The second goal was to explore the mediating role of impulsivity and compulsivity levels between age and GD severity by means of a path analysis. GD severity was positively correlated with self-reported impulsivity (BIS-11 non-planning and BIS-11 total scores). The standardized coefficients for the SEM showed a direct positive contribution of self-reported impulsivity (BIS-11 non-planning), behavioral impulsivity (EDT scores) and self-report compulsivity (Padua total scores) to GD severity. Participants' age only significantly contributed to behavioral compulsivity (WCST perseverative errors), and no effects were found with respect to GD severity.

Regarding impulsivity, behavioral choice impulsivity (assessed using EDT-k) correlated with self-reported impulsivity (assessed using the BIS-11 and correlating with measures of attentional, motor and total forms of impulsivity). Previous studies found weak or no relationships between most facets of motor and choice impulsivity (MacKillop et al., 2016; Stahl et al., 2014). This may partly be explained by the discrepancies between behavioral and self-report measures of impulsivity-related assessments (Ellingson, Potenza, & Pearlson, 2018), questioning whether these different tools assess the facets of impulsivity they are intended to measure (Cyders & Coskunpinar, 2012; Duckworth & Kern, 2011). Alternatively, as prior studies have not examined groups with GD, it is possible that these forms of impulsivity are more closely related in GD than in the general population.

The present findings suggest that self-reported and behavioral measures of compulsivity are not highly correlated. Many instruments assessing compulsivity are based on obsessive-compulsive disorder (OCD) conceptualizations and may not be ideal for considering compulsivity as a transdiagnostic construct (Robbins, Gillan, Smith, de Wit, & Ersche, 2012; Yücel & Fontenelle, 2012), due to, among other things, the clinical and neurobiological differences between GD and OCD (El-Guebaly, Mudry, Zohar, Tavares, & Potenza, 2012). However, like impulsivity, compulsivity may be a multifaceted construct that includes several conceptually and empirically separable features, such as attentional bias/disengagement or failures in contingency-related cognitive flexibility during habit learning (Fineberg et al., 2010, 2014). As such, each assessment could be assessing different features that may link to clinical characteristics in unique fashions. None of the impulsivity dimensions were associated with compulsivity measures in the present study. This finding supports the notion that both are separate constructs, as suggested by previous data (Hodgins & Holub, 2015).

Another finding to emerge from the pathway of the present study is the association between impulsivity, compulsivity and GD severity. The SEM showed a direct positive contribution of impulsivity (BIS non-planning and EDT-k) on GD severity. While some prior studies have found no correlation between specific dimensions of impulsivity (assessed with the BIS-11) and GD severity (Lutri et al., 2018), others have found that only high attentional and motor impulsivity BIS-11 scores had significant associations with GD severity (Leppink, Redden, & Grant, 2016), and others have found, as in the present study, an association between choice impulsivity and GD severity (Mestre-Bach et al., 2018). The reasons for the seemingly discrepant results may result from differing characteristics of the samples being studied (e.g., sociodemographic or clinical characteristics, cultural contexts) or other factors, and more research is warranted to examine these possibilities.

The SEM also showed a direct positive contribution of compulsivity on GD severity, although only the total score on the Padua Inventory had a significant association with GD severity. Previous studies suggest that performance differences linked to compulsivity may be associated with the development and the maintenance of GD symptomatology. The cognitive inflexibility or the tendency to perseverate on a behavior could, for example, increase the risk for developing GD behavior; alternatively, compulsivity could be a consequence of GD (van Timmeren et al., 2018). Longitudinal studies are warranted to investigate these possibilities further.

The finding that not all measures of compulsivity showed an association with GD severity coincides with previous studies, which did not found an association between the WCST performance and GD severity (Hodgins & Holub, 2015). These results suggest that impulsivity may contribute more strongly to the acquisition and development of GD than compulsivity, as found in other behavioral addictions (Bőthe et al., 2018), although more studies are needed to examine these relationships.

Finally, gender and age are two sociodemographic factors that should be considered, in relationships between impulsivity, compulsivity and GD severity (Cyders, 2013; Galvan, Hare, Voss, Glover, &

Casey, 2007; Granero et al., 2009; Steinberg et al., 2008; Steward, Mestre-Bach, Fernández-Aranda, et al., 2017). The present study did not observe differences between men and women in the SEM, although higher impulsivity levels were observed, as were anticipated (Fattore & Melis, 2016). Age significantly contributed to WCST perseverative errors, coinciding with previous studies by identifying a reduction in cognitive flexibility at older ages (Grieve et al., 2007; Rodríguez Villegas & Salvador Cruz, 2015). However, age wasn't directly associated with any of the impulsivity measures, as found in previous studies, reaffirming that impulsivity is a complex construct and that more studies focused on its cognitive domains are needed (Steinberg et al., 2008).

CLINICAL IMPLICATIONS

The findings have multiple clinical implications. The utility of categorical classifications has been questioned (Insel et al., 2010), and transdiagnostic features may link more closely to biological constructs (Hernández-Guzmán, Del Palacio, Freyre & Alcácar-Olán, 2011). For example, impulsivity has been found to link to insular, amygdalar and hippocampal structures across individuals with GD, cocaine-use disorder and neither disorder (Yip et al., 2018). As suggested (Moeller et al., 2001), clinical data focusing on impulsivity and compulsivity may be used to shift towards a more dimensional framework of psychiatric diagnosis and treatment. This approach may lead to improvements in treatment, especially as changes in both impulsivity and compulsivity have been linked to treatment outcomes in GD (Berlin et al., 2013; Blanco et al., 2009; J. Grant et al., 2010). A dimensional perspective also addresses the critical heterogeneity in the neurobiology of addiction and it may help to identify biomarkers suitable for assessment (Kwako, Bickel, & Goldman, 2018).

LIMITATIONS AND FUTURE RESEARCH

The present study has limitations. First, our sample included participants with GD who were not seeking treatment, and this may limit the generalizability of the results to different clinical populations. Future research should include a treatment-seeking sample, as well as a healthy control group, to assess possible differences between groups in these constructs. In this sense, examining the validity of these results to other addictions would be another essential scientific contribution, as suggested previously (Potenza, 2007c). Second, the cross-sectional design of this work does not a llow for inferences to be made regarding causality or changes in impulsivity and compulsivity over the course of GD. Longitudinal studies are needed to examine these relationships. Future studies focused on impulsivity, compulsivity and age of onset of GD would be helpful in order to examine whether a switch from impulsivity (in early stages of the addiction course) to compulsivity exist (van Timmeren et al., 2018). Finally, the Padua Inventory originally was designed for clinical populations with OCD. However, it has been linked to clinically relevant aspects of GD in independent samples (Blanco et al., 2009) Nonetheless, a greater focus on new instruments considering compulsivity within a transdiagnostic framework (Guo et al., 2017) and that are not specifically focused on OCD may produce findings that could help to clarify relationships with compulsivity in GD populations (Yücel & Fontenelle, 2012).

CONCLUSIONS

This study provides greater understanding of how impulsivity and compulsivity may relate to GD severity. Our findings suggest impulsivity and compulsivity are multifaceted and separable constructs and not all impulsivity and compulsivity domains contribute equally to GD severity. The findings suggest that these two multifactorial constructs deserve greater attention in both research and clinical settings. Interventions specifically targeting domains that are most relevant to the maintenance of GD may help improve treatment outcomes.

DECLARATIONS OF INTEREST

None of the authors have any conflicts of interest. Marc Potenza has consulted for Shire, INSYS, Rivermend Health, Opiant/Lakelight Therapeutics, and Jazz Pharmaceuticals; has received research support (to Yale) from Mohegan Sun Casino and the National Center for Responsible Gaming; has participated in surveys, mailings or telephone consultations related to drug addiction, impulse-control disorders or other health topics; has consulted for and/or advised gambling and legal entities on issues related to impulse-control/addictive disorders; has provided clinical care in a problem gambling services program; has performed grant reviews for research-funding agencies; has edited journals and journal sections; has given academic lectures in grand rounds, CME events and other clinical or scientific venues; and has generated books or book chapters for publishers of mental health texts.

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Table 17. Resume of the main results of the six studies

		STUDY 1	STUDY 2	STUDY 3	STUDY 4	STUDY 5	STUDY 6
AIM A	Choice Impulsivity	AN-R and HCs ↓ delay discounting levels in comparison of bulimic spectrum disorders	No differences in delay discounting levels between young and older patients with GD	+ delay discounting levels in patients with GD in comparison with HCs			
	Impulsive Tendencies	↑ urgency in bulimic spectrum disorders No differences in urgency between AN-R and HCs	Differences in all the subscales except urgency were found taking age into account	↑levels of all impulsive tendencies in patients with GD in comparison with HCs	Positive urgency and lack of premeditation: predictors of the presence of illegal activity	Lack of perseverance and sensation seeking: predictors of dropout during treatment and in follow-ups Negative urgency: predictor of relapse during treatment	
	Response Impulsivity			+ commission errors in GD patients in comparison with HCs			
	Interaction Impulsivity Dimensions		Correlation between choice and trait impulsivity (urgency and lack of premeditation) in young patients with GD ↑delay discounting correlates with urgency in both groups Lack of premeditation associated with impaired decision process in young patientswith GD	Association between choice and trait impulsivity, being urgency the strongest association			Choice impulsivity correlated with BIS-11 (attentional, motor and total)
AIM B	Severity of the Disorder / Illegal acts	AN-BP ↑ severity than AN-R	Similar GD severity in both groups Association between positive urgency and GD severity in young patients with GD	Association between GD severity and trait and choice impulsivity	↑ GD severity in patients with GD and a history of illegal acts Multiple offenses associated with ↑ GD severity	Association between GD severity and urgency No differences in treatment outcome regarding GD severity	Association between impulsivity, compulsivity and GD severity
AIM C	Compulsivity						Self-report and behavioral measures did not correlate No association between compulsivity and impulsivity

5. DISCUSSION

5.1. DISCUSSION OF THE MAIN FINDINGS

5.1.1.IMPULSIVITY DIMENSIONS

Historically, the most frequently cited risk factor for mental disorders, such as EDs or GD, has been impulsivity (428). However, broad definitions of this construct may ignore the possibility that particular dimensions of impulsivity are uniquely related to specific types of maladaptative behaviors, such as eating or gambling (428). Therefore, the overarching goal of this thesis (aim A) was to study different types of impulsivity in depth and their interaction in two of the disorders included on the impulsive-compulsive spectrum (GD and EDs).

5.1.1.1.CHOICE IMPULSIVITY

Multidisciplinary empirical evidence has emphasized the relevance of choice impulsivity, especially in clinical populations, among EDs (429,430), and substance (62,152) and behavioral (62,431) addictions are included.

In reference to EDs, **Study 1** revealed differences between bulimic-spectrum disorders (in that case, BED and AN-BP) and AN-R and HCs, the former showing the highest levels of choice impulsivity. These results were consistent with those of previous studies showing impulsivity levels to be higher in BED and BN compared to AN (432).

In the specific case of BED, higher choice impulsivity rates have been observed in people with obesity and without BED than in HCs, attending to different types of reward (monetary, food, sedentary activity, and massage time) (170). Therefore, a lack of conscious decision making and a tendency to loss of inhibitory control processes have been observed in this population, which may explain the presence of binge eating and/or purging symptomatology (429,432–434).

With respect to AN, similar to **Study 1**, other research has also failed to detect differences in choice impulsivity between this ED and HC groups (435). In this line, some authors suggested that reduced levels of choice impulsivity and marked self-controlled symptomatology in AN could be considered as an undernutrition marker and be associated with habits (such as dietary restriction and cognitive concerns about weight and shape) whose objective is reducing negative emotional states (429,430). When evaluating differences in choice impulsivity according to AN subtype, other investigations also reported higher levels of impulsive symptomatology, such as binge eating behaviors, as well as greater preference for rewards in AN-BP (172,436). These findings, in reference to differences in choice impulsivity, would support a spectrum model, evidencing self-regulation difficulties in EDs, in which bulimic-spectrum disorders (BED, BN and AN-BP) would present higher reward-related impulsivity levels, while AN-R would be characterized by an exaggerated tendency to delay gratification (429,432). Therefore, choice impulsivity could be considered an effective marker to

distinguish between different EDs (432).

Considering GD, as portrayed by **Study 3**, this clinical population seems to present higher levels of choice impulsivity compared to the general population. Other studies have found similar results in this sense, stressing that people with GD tend to delay rewards more steeply than do non-gamblers, evidencing a different reward magnitude perception between both populations (282,294,437). These results would partially explain why individuals with a diagnosis of GD may choose bets offering more immediate gains, even when knowing the possible negative consequences associated with these gambling behaviors.

In the same way, as mentioned by Rachlin and colleagues (438), assuming that a player lost nine times in a row, the only option for the string to be positive is to increase the payoff on the tenth bet. In the context of repeated gambling behaviors, individual losses are considered less valuable than individual gains (438,439). Likewise, if the player focuses on the string rather than the individual bet, he tends to increase the risk in the gambling behaviors after experiencing losses (438). Therefore, in the context of delay discounting, the longer one has waited for a reward, the bigger that reward has to be to justify the wait (438).

Focusing on the decision-making process in GD, we intended to study possible age differences according to choice impulsivity (**Study 2**). Behavioral experiments have proven that, as the biological age increases, the individual becomes more capable of delaying gratification longer (440). For example, while a four-year-old child tends to immediately eat the cookie, a six-year-old child could organize his behavior during a ten-minute waiting period, rejecting the minor immediate reinforcement and consequently receiving two cookies in return (438,440). Adults would have the ability to organize their behavior over a large time span, contemplating the losses and benefits of their acts, and exhibiting, therefore, greater levels of self-control (438,440).

Based on these models, higher choice impulsivity levels were hypothesized in patients with GD with younger ages (between 18 and 30 years) compared to those with older ages (between 31 and 70 years). However, no differences in this impulsivity dimension were found when comparing the two age groups. This may be due to two key aspects: the selection of age ranges and GD severity. The lack of observable differences could be due to the fact that all subjects included in the study were adults, and perhaps the differences in this impulsivity dimension are most evident between differentiated developmental stages (that is, between childhood and adolescence and between adolescence and adulthood). Another possible explanation would be that, based on the clinical characteristics of GD, both groups presented similar GD severity levels, suggesting that this association scales to GD severity levels (287,315,323,441,442).

5.1.1.2.RESPONSE IMPULSIVITY

Response impulsivity is considered another essential dimension of impulsivity, and its presence has been highlighted in disorders such as SUDs (443) and behavioral addictions (81).

Study 3, through the use of a Go/No-go task, showed a higher number of commission errors in patients with GD compared to the HC group. Similar studies suggest that individuals with GD, compared to HCs, are more likely to fail to withhold a response to a no-go stimulus (323,441,442). In addition to commission errors, other studies have also found patients with GD to have a higher probability to fail to execute a response to a go stimulus, which would suggest certain deficits in sustained attention (297,444). These findings would partially explain the failed attempts to control and stop maladaptive gambling behavior, evidencing a general deficit in inhibitory control (81). Those gamblers with higher levels of response impulsivity, therefore, would present a higher risk of developing a GD because, among other aspects, they would present a lower probability of interrupting gambling behavior, even when receiving external signals to cease gambling (81).

5.1.1.3.IMPULSIVE TENDENCIES/TRAITS

Impulsive tendencies/traits have been evaluated via the UPPS-P, one of the tools with greater empirical support in the impulsivity field (110). Based on this theoretical model, in the present thesis, higher levels of impulsive tendencies/traits have been observed in clinical samples when compared with the general population (**Studies 1 and 3**).

Regarding EDs, **Study 1** reported higher urgency levels in bulimic-spectrum disorders compared to the AN-R and HC groups. These results highlight the role of emotion in the impulsive behaviors that are characteristic of EDs. They coincide with previous studies finding that urgency levels in both BN and AN-BP patients are related to AN-R, enhancing maladaptive behaviors associated with bulimic symptoms, as well as subjective loss of control of food intake (185,428,445,446). In light of these findings, bingeing behaviors could be negatively reinforcing (447), bearing in mind that, among other aspects, emotional dysregulation has been associated with excess weight (448) and neuroimaging studies suggest that emotions, especially negative affect, increase the rewarding value of food (449).

Likewise, considering the case of behavioral addictions, higher levels in all facets of the UPPS-P model were observed in patients with a GD diagnosis, in comparison with HCs (**Study 3**). In this line, however, not all facets have the same weight in this disorder, with lack of perseverance not having a direct association with GD because it implies attentional processes that are not necessarily altered in GD (300). Similarly, the most clinically relevant impulsive tendencies/traits in the case of GD are urgency and lack of premeditation, and these have been associated with specific cognitive

mechanisms (450). It is not surprising, therefore, that previous studies found that individuals with GD, compared to HCs, exhibited higher levels in both impulsive traits (311). Thus, it has been suggested that lack of premeditation is associated with poor decision-making abilities, which is an established hallmark of GD (107,451). In the specific case of negative urgency, those individuals with higher levels in this facet are more likely to use gambling behavior as a strategy to try to regulate negative affective states (such as boredom or dysphoria) in the short term, despite the fact that this entails negative consequences (such as conflicts or financial difficulties) (311,452). Individuals with GD would therefore have greater difficulties in freeing themselves from negative emotional states, needing to use more cognitive resources with the aim of regulating these emotions or to employ different regulatory strategies, such as suppression, which could consume more cognitive resources (359,453). Finally, although the association between sensation seeking and GD remains inconsistent, it has been suggested that this facet is related to gambling preferences, such as gambling typology (strategic versus non-strategic) or frequency of gambling behavior (103,454).

In studying the predictive role of these facets in GD, we observed that positive urgency and lack of premeditation could be considered predictors of the presence of illegal gambling-related acts (**Study 4**). It should be borne in mind that emotional processing facilitates action (455). This interrelationship between emotion and action would, in most cases, be an adaptive process aimed at seeking opportunities or avoiding immediate threats (104). However, the intense experience of emotions, together with the loss of cognitive resources and the interference with the rational decision-making process, increases the probability of carrying out imprudent or risky behaviors, such as alcohol consumption, illicit drug use, or unsafe sexual practices (104,456,457). The commission of criminal behaviors related to gambling could be considered as a risky behavior, although there is a paucity of studies analyzing its relationship with affective state. On the other hand, it is not surprising that an association has been found between lack of premeditation and the commission of gambling-related illegal acts, since this impulsivity trait is related to the effectiveness of the decision-making processes (450). Therefore, criminal behaviors would be carried out without sufficient prior reflection on the consequences of this choice (110,458).

Sensation seeking could be a predictor of dropout, both during GD treatment and in the follow-up stage (**Study 5**). Sensation seeking is associated with motivational factors and with greater neurobiological response to novel stimuli (459). Patients showing high levels of sensation seeking may reveal high motivation to initiate a treatment that would make them experience the benefits of abstinence, although these novelty effects may quickly fade due to their personality profile (460). In turn, lack of perseverance was also a predictor of dropout at both temporal moments of the intervention. Studies in the field of addictions have reported similar results, with those individuals who complete therapeutic intervention presenting higher levels of persistence than those who abandon it (461).

Finally, negative urgency could be considered a relapse predictor factor during treatment (**Study 5**). This result coincides with previous evidence in the field of addictions linking negative urgency with

poorer therapy outcomes and greater relapse risk (462). These findings may suggest that patients with GD are more vulnerable to making rash decisions when experiencing negative mood states, such as frustration or anxiety, leading to more frequent relapses. In these cases, gambling behavior may be used as a form of negative reinforcement, regulating affective states, especially in advanced stages of the disorder (319).

5.1.1.4.INTERACTION BETWEEN IMPULSIVITY DIMENSIONS

When evaluating the interaction between the different dimensions of impulsivity, it was observed that the most potent interrelation in samples with a GD diagnosis was between choice impulsivity and impulsive tendencies/traits, especially urgency (**Studies 2 and 3**). This seems to confirm, at least partially, that urgency is associated with poor prepotent response inhibition, such as difficulties in interrupting a previously automated motor response (463,464). These difficulties may be related to GD (323,465,466), as they are, among other aspects, a relapse predictor factor (311,467).

In younger populations with GD, an interrelationship between lack of premeditation and choice impulsivity was also detected (**Study 2**). Lack of premeditation is associated with difficulties in balancing immediate benefits against future ones, implying, therefore, less beneficial decisions in delay discounting procedures (102).

Both facets, lack of premeditation and urgency, correlated with each other (**Study 3**), suggesting that they are not completely independent and, although each of them is based on separate cognitive processes, that it is possible that they share some psychological mechanisms (96,468).

In addition, choice impulsivity also correlated mainly with the attentional and motor dimensions of the BIS-11 (**Study 6**), another of the most widely used self-reporting tools in the field of impulsivity. While the attentional dimension assesses the ability to remain focused on daily activities, the motor dimension focuses on the tendency to respond without prior reflection on the consequences of actions. Therefore, it is not surprising that there was a correlation between choice impulsivity and the BIS-11 subscales, reflecting difficulties in inhibitory control (81,88,89,310).

Although these results make it possible to deepen the association between choice impulsivity and mental disorders such as EDs or GD, it remains unclear whether greater choice impulsivity levels lead to these disorders or raise delay discounting (81).

5.1.2. IMPULSIVITY AND CONTROVERSIAL GD DSM-5 CRITERIA

The second main aim of this thesis (aim B) was to assess the association between impulsivity and GD DSM-5 criteria, specifically the illegal acts criterion and the inclusion of three severity levels.

5.1.2.1.ILLEGAL ACTS

The central objective of **Study 4** was to delve more deeply into the role that gambling-related crimes have in GD, considering the controversy in the scientific field regarding this diagnostic criterion (246,247) and its association with impulsive tendencies/traits and with GD severity, another controversial diagnostic aspect (233,234).

We observed that the group that had committed illegal acts associated with gambling behavior presented higher levels of GD severity. In addition, multiple offenses were also associated with higher GD severity and with a higher number of debts, which would support the need to establish subtypes of gamblers according to the gambling-related crimes they have committed (238). These results lead us to believe that this is a particularly relevant clinical factor for this disorder and strongly associated with GD severity, the presence of which should be considered in both diagnostic and treatment evaluation phases.

5.1.2.2.GD SEVERITY

Since impulsivity has been identified as a predictor of GD severity (356,469,470), further empirical evidence was required to determine whether all dimensions of impulsivity are equally associated with the severity of this disorder.

An association between GD severity and impulsive tendencies/traits was observed (**Study 3**), in particular, between GD severity and urgency levels (**Studies 2 and 5**). These results coincide with previous studies, which highlight this facet as the clearest marker of severity (310,311) and as best able to differentiate between individuals with GD and HCs (300,312). Since urgency has been related to both affective and executive mechanisms, such as heightened emotional reactivity or prepotent response inhibition (300,313–315), it could be considered, therefore, that these are decisive in the case of GD. In this line, and contemplating age differences, in **Study 2** we observed a direct association between GD severity and positive urgency in younger individuals. Data on the younger population have also indicated that those individuals with greater difficulties inhibiting behaviors within the context of intense negative emotions were more likely to experience gambling problems (471). These results lead us to postulate, from a clinical context, that there is a greater association between positive urgency and GD in early stages of the disorder, because the disorder is still perceived as egosyntonic, and there is euphoria and excitement about the possibility of receiving immediate rewards. However, in more advanced phases of the disorder, with greater egodistonia, gambling behavior may be more associated with negative emotions (negative urgency).

Choice impulsivity levels were also associated with GD severity (**Study 3**). Previous results in this line have been inconsistent, as the effect size has been small and heterogeneous in the association

between both factors (278,315). The magnitude of this association would therefore vary depending on other clinical factors, such as whether or not to have the self-concept focused on financial success (472).

Response impulsivity was, however, the only impulsivity dimension not correlated with GD severity (**Study 3**). There is no empirical evidence identifying a significant association between these two factors in the context of GD (81), suggesting that the impaired ability to inhibit motor responses does not play an essential role in contemplating GD severity. Therefore, taking into account that not all impulsivity dimensions are associated in the same way with GD severity, it would be possible to consider them as three independent, though partially interrelated, entities.

At the longitudinal level, numerous factors have been considered crucial in adherence to treatment for GD, such as sociodemographic factors, indebtedness, the inclusion of concerned significant others, the presence of psychiatric comorbidities, and gambling patterns (367,395,473,474). Previous studies have also reported an association between GD severity and poorer treatment outcome (475). However, in the present thesis, no differences in response to treatment were found when the three levels of severity proposed by the DSM-5 for GD were taken into account (**Study 5**). These results would justify the lack of consensus about the validity of the new severity categorization proposed by the DSM-5. As other authors have suggested (270), new research should consider determining the best predictor of treatment response by evaluating dimensional and categorical measures.

5.1.3.COMPULSIVITY AND ITS INTERACTION WITH IMPULSIVITY DOMAINS

The last main aim (aim C) was to examine compulsivity levels and the interaction between impulsivity and compulsivity levels in individuals with GD.

As in previous studies (270,273), different facets of compulsivity in GD were evaluated using the self-report PADUA and the WCST (task/ attentional set-shifting) without finding a correlation between the two (**Study 6**). This lack of association could be interpreted as meaning that these domains refer to completely separate components of compulsivity, probably related to independent neural circuits (92). This fact would reinforce the understanding of impulsivity and compulsivity as "umbrella" constructs.

Neither compulsivity measure was associated with impulsivity dimensions, although both constructs were associated with GD in the present thesis (**Study 6**), as previous studies reported (118,119). This result supports the notion suggested by previous data, emphasizing the independence of both constructs (476). However, although they are not interrelated constructs, it is observed that both have an essential role in GD, being associated with the severity of the disorder (**Study 6**), as indicated in previous studies (270,477). Taking the impulsivity-compulsivity shift into account, both clinical

features could occur at different moments of the disorder (270).

5.2.CLINICAL IMPLICATIONS

These findings have a number of practical implications. Starting from the original debate about the latent structure of mental disorders (478), both categorical and dimensional perspectives have been studied. The categorical diagnostic framework shows serious limitations in classification, the search for a clear etiology, the definition of a course, and the prescription of a treatment for each mental disorder (4,479). Nevertheless, as suggested by previous studies (51), clinical data concerning impulsivity and compulsivity constructs can be used to shift towards a more dimensional mental health framework. This could lead to improvements at diagnostic and therapeutic levels, guaranteeing more accurate diagnoses, a reduction of the comorbidity rates, and greater flexibility when considering inter-individual differences. However, since the dimensional approach is relatively recent and the empirical evidence is limited, there are many doubts about its viability (479).

Likewise, a greater knowledge of the etiology of both mental disorders allows for the delineation of different clinical profiles, taking impulsivity and compulsivity into account. Those individuals who present a greater presence of these risk factors would benefit, therefore, from the development of therapeutic interventions focused on the alteration of decision making, the tendency to present impulsive behaviors before the experimentation of emotional states of high intensity, or failures in task/attentional set-shifting, among other essential aspects. In this sense, new adjuvant tools could be effective for addressing these aspects that are part, both directly and indirectly, of the symptomatology of these disorders, such as serious games (480-482).

Moreover, considering the importance of multidisciplinarity in the study of mental disorders, broadening the range of knowledge, at the psychological level, about how the dimensions of impulsivity and compulsivity interact would allow us to provide new evidence in other fields (such as neuroscience) to study impulsivity and compulsivity from other perspectives (for example, by making use of biomarkers).

5.3.STRENGTHS OF THE STUDY

METHODS

Sample

The strongest point of this thesis has been the inclusion of two theoretically suggested mental disorders that form part of the impulsive-compulsive spectrum, ED and GD, as well as the inclusion of HC groups, in order to establish comparisons between populations. Although these are two disorders that, at first glance, seem disparate if sociodemographic factors such as sex and age are taken into account, both appear to have common transdiagnostic factors, such as impulsivity and compulsivity.

In addition, since this is a clinical population, there may be relevant clinical differences between those who seek treatment and those who do not, so both types of sample were included to ensure the generalization of the results.

Assessment

The main strength in relation to the evaluation has been the use of both self-report and behavioral measures, which have been validated and widely used in this field of study. In addition, the multifactorial nature of impulsivity and compulsivity has been contemplated through the combined use of different tools for each construct.

Procedure

Since this is a compilation of studies with different samples, an attempt has been made to control possible factors that could interfere with the analysis and interpretation of the results through the use of a standardized evaluation and treatment protocol (416).

5.4. LIMITATIONS AND FUTURE RESEARCH

DESIGN

The cross-sectional nature of most of the compiled studies does not allow for the assessment of causality or directionality of the studied effects. Therefore, more longitudinal studies are required in order to detect and understand possible oscillations in impulsivity and compulsivity levels associated with the course of these mental disorders.

In reference to the included longitudinal study, it examined the effectiveness of CBT. Future research could use a multiple-arm study design to test the efficacy of other types of interventions. Likewise, a post evaluation of impulsivity and compulsivity levels would make it possible to detect whether these therapeutic approaches have a direct or indirect impact on the reduction of the negative consequences of both domains. Future studies could evaluate other clinical factors that may be related to dropout and relapse. These could be indicative of the level of recovery of patients, such as total access to money or, on the contrary, the presence of external control.

BACKGROUND

One of the current central limitations in the field of impulsivity and compulsivity is the existence of multiple conceptualizations and theoretical models, which greatly hinders the comparability of results. This thesis has been focused on the study of the impulsive-compulsive spectrum, but it must be remembered that additional psychological and neurobiological components are part of impulsivity

and compulsivity, which have even come to be seen as "umbrella" terms. More empirical studies are, therefore, needed in order to outline which specific dimensions can be included under the label of impulsivity and compulsivity.

METHODS

Sample

The majority of studies in GD have been focused exclusively on samples made up of men and, in the case of EDs, of women, limiting the generalization of the results to clinical populations of the opposite sex. Although the predominance of the male sex in GD and the predominance of the female sex in EDs evidence the clinical reality, future studies would benefit from including the opposite sex with the same disorder. This would allow a comparison based on sex from a dimensional perspective.

The present thesis has included a sample with a diagnosis of AN and BED. Future studies could also include patients with BN or OSFED in order to evaluate impulsivity and compulsivity in the whole range of EDs. As for GD, new lines of research could evaluate, besides the clinical variables contemplated in the present thesis, the influence of both dimensions of the spectrum in different subtypes of gamblers, attending mainly to gambling preferences.

Assessment

Impulsivity

In reference to choice impulsivity, it was evaluated by monetary reward tasks in all the studies. In future research, it would be interesting to assess other types of reward in addition, especially food in the case of EDs. It is also well known that both emotional state and context influence the decision-making process (483,484), showing that this type of impulsivity should be considered as reference-dependent (485). In the specific case of GD, the levels of delay discounting change depending on whether or not they are evaluated in the context of gambling (486). Relatedly, some individuals with GD may evidence contextual control over discounting, selecting delayed rewards in order to avoid spending money immediately through gambling behavior (437). Future studies could examine the choice impulsivity levels in different contexts and in relation to individual differences in gambling-related cognitions (487). They could also take into account the present mood and financial situation of the individuals while they complete the study measures, in order to obtain a more exhaustive and detailed evaluation of how different aspects of impulsivity are associated with gambling behaviors.

It should be noted that some of the studies in this thesis have included exclusively self-report measures, while others have mixed self-report with behavioral measures. When using self-report measures, it is important to remember that they are unable to fully capture the multi-factorial nature of impulsivity. The results obtained from the combination of both types of evaluation measures

should be interpreted cautiously given that even within the same domain, they may weakly correlate or be uncorrelated (83,488).

Compulsivity

The present thesis has mostly studied task/attentional set-shifting levels. Future studies could evaluate, from a dimensional perspective, the presence of more than one domain at a time, such as contingency-related cognitive flexibility or attentional bias/disengagement.

Future research could also study the shift from impulsivity to compulsivity using clinical samples, as well as exploring the role of compulsivity in response to treatment.

Psychopathology and personality

No instruments validated to screen psychiatric morbidities, other than ED or GD, were used in the HC groups. Future studies should assess this aspect in depth. It would also be interesting to evaluate the presence of personality disorders that may interfere with the results, especially to evaluate antisocial personality disorder by studying the relationship between impulsivity and illegal acts.

Pharmacology

The assessment of pharmacotherapy due to comorbidity with other disorders is common, such as attention deficit hyperactivity disorder or depression (489), and its influence on impulsivity and compulsivity could be another focus of future research.

Criminal behaviors

Exploring criminal behaviors through self-report in a clinical interview and not administering a validated psychometric instrument may have generated false negatives and limited the thoroughness of the obtained information.

Moreover, the present study was focused exclusively on criminal behaviors carried out with the aim of financing debts derived from gambling or ensuring the continuity of gambling behavior. Future studies should consider the full scope of illegal behaviors carried out by GD patients, even those not directly related to the gambling behavior.

In addition to these general limitations, specific limitations have been included in each study included in this thesis.

6. CONCLUSIONS

From a nosological point of view, this thesis has been framed in a dimensional classification of mental illnesses, deepening in the analysis of clinical correlates associated with two of the disorders most related to impulsivity and compulsivity: EDs and GD.

The following conclusions may be excerpts from the studies that make up this thesis:

Eating disorders:

1) Clinical heterogeneity has been confirmed, especially taking into account the impulsivity levels among patients with AN-R and AN-BP. While the first ones showed an inadequate self-control, the binge eating behaviors carried by individuals with AN-BP seem to be driven by emotional states and impulsivity traits. Therefore, the importance of separating the two subtypes of AN is confirmed.

Gambling disorder:

2) Impulsivity and compulsivity may be considered two independent domains in GD, supporting the perspective of the dimensional impulsive-compulsive spectrum.

3) Both domains should not be considered as singular constructions, since their multifactorial nature has been proven.

4) Impulsivity and compulsivity do not contribute to GD in an equitable way, with impulsivity being more strongly associated with severity.

5) In the specific case of impulsivity, all the dimensions assessed (choice, response and tendencies/traits) seem to be interrelated.

6) In this line, and taking into account concretely choice impulsivity and impulsive tendencies/traits, an association has been observed between these two dimensions in young patients, corroborating that age is a key factor in both, GD and impulsivity.

7) Not all the dimensions of impulsivity contribute in the same way to GD, and response impulsivity was not significantly associated with the GD severity.

8) An association between impulsivity, GD and the commission of criminal acts related to the gambling behavior has been proven. More concretely, it has been observed that high levels of impulsivity (especially positive urgency and lack of premeditation) could be considered as predictors of the occurrence of crime in populations with GD.

9) Impulsive tendencies/traits may be related to treatment outcome in GD. Specifically, the facets of

sensation seeking and lack of perseverance have been identified as dropout predictors, while negative urgency could be considered a relapse predictor.

10) With reference to GD severity, it was not possible to demonstrate that greater severity was indicative of a better response to the disorder treatment, which would question the clinical applicability of the proposed severity criteria in the DSM-5.

7. SUMMARY IN SPANISH / RESUMEN

INTRODUCCIÓN

En el campo de la psiquiatría existe un creciente interés por abordar los trastornos mentales desde una perspectiva dimensional, con el objetivo de resolver las principales limitaciones de los enfoques categóricos. Desde esta perspectiva dimensional y, específicamente, considerando el espectro impulsivo-compulsivo, se ha sugerido que tanto la impulsividad como la compulsividad tienen un papel esencial en enfermedades mentales como el trastorno de juego o los trastornos de la conducta alimentaria.

La impulsividad se ha asociado con los trastornos de la conducta alimentaria, especialmente con los de tipo bulímico, y con el trastorno de juego. Sin embargo, aunque parece existir un consenso sobre su naturaleza multifactorial, la mayoría de los estudios empíricos rara vez han evaluado a la vez sus diferentes dimensiones en las distintas poblaciones clínicas. Esto conlleva una inadecuada caracterización de uno de los factores de riesgo esenciales a nivel transdiagnóstico.

En referencia a la compulsividad, aunque el interés por este constructo ha aumentado y se ha sugerido que podría tener un efecto directo sobre diferentes trastornos mentales, pocas investigaciones la han estudiado conjuntamente con la impulsividad ni han utilizando diferentes herramientas de evaluación, a fin de explorar sus dominios de manera independiente.

Por lo tanto, resulta esencial descifrar cómo se asocian ambos constructos entre sí, así como averiguar cómo se correlacionan con distintos trastornos mentales.

OBJETIVOS

Los modelos teóricos dimensionales sugieren que el trastorno de juego y los trastornos de la conducta alimentaria presentan dos factores de riesgo compartidos esenciales: la impulsividad y la compulsividad.

A fin de ahondar en la asociación existente entre estos factores, los principales objetivos de la presente tesis fueron tres:

En primer lugar, estudiar la interacción entre los diferentes tipos de impulsividad en trastornos incluidos en el espectro impulsivo-compulsivo (en concreto, trastorno de juego y trastornos de la conducta alimentaria).

En segundo lugar, evaluar la asociación entre la impulsividad y los criterios del Manual Diagnóstico DSM-5 más polémicos utilizados para el diagnóstico de trastorno de juego, específicamente el criterio de actos ilegales y la inclusión de tres niveles de gravedad del trastorno.

Por último, examinar las dimensiones de compulsividad y la interacción entre ellas y los niveles de

impulsividad en el caso específico del trastorno de juego.

METODOLOGÍA

Las diferentes muestras estudiadas en esta tesis incluyen pacientes con diagnóstico de trastorno de juego o trastornos de la conducta alimentaria según criterios del Manual Diagnóstico DSM-5. Los participantes se obtuvieron del Departamento de Psiquiatría del Hospital Universitario de Bellvitge, así como de la Clínica de Problemas de Juego de la Universidad de Yale.

RESULTADOS

Estudio 1. Impulsividad de elección e impulsividad rasgo en trastornos de la conducta alimentaria

El estudio 1 investigó la impulsividad de elección (delay discounting) y la impulsividad rasgo en 80 controles sanas y en 80 mujeres adultas con un diagnóstico de trastorno de la conducta alimentaria (56 mujeres con anorexia nerviosa y 24 con trastorno por atracón).

Las pacientes con anorexia nerviosa del subtipo restrictivo mostraron tasas de delay discounting menos pronunciadas que las pacientes de los subtipos trastorno por atracón y anorexia nerviosa del tipo por atracón/purgas. En comparación con las controles sanas y las pacientes con anorexia nerviosa del subtipo restrictivo, las pacientes con anorexia nerviosa del subtipo por atracón/purgas presentaron mayores niveles de delay discounting y urgencia, tanto positivas como negativa.

Nuestros hallazgos sugieren que la restricción presentada por pacientes con anorexia nerviosa del subtipo restrictivo estaría asociada con un autocontrol desproporcionado, mientras que las conductas de atracón podrían estar originadas, en mayor medida, por estados emocionales de elevada intensidad, así como por rasgos de impulsividad.

Estudio 2. Impulsividad de elección e impulsividad rasgo en el trastorno de juego

En el estudio 2 se examinó si la asociación entre la impulsividad de elección (delay discounting) y la impulsividad rasgo difería entre pacientes con trastorno de juego más jóvenes (18-30 años) y aquellos de mayor edad (31-70). En segundo lugar, se trató de desenmarañar el papel mediador de la impulsividad en la conducta de juego en ambos grupos de edad.

No se encontraron diferencias en los niveles de delay discounting entre los pacientes más jóvenes y aquellos de mayor edad. Sin embargo, se identificaron correlaciones significativas entre el delay discounting y los niveles de urgencia (la tendencia a actuar precipitadamente bajo estados emocionales de elevada intensidad) exclusivamente en el grupo más joven. Los pathanalyses también

identificaron la urgencia positiva y negativa como factores mediadores de los niveles de gravedad del trastorno de juego en pacientes jóvenes.

Estos resultados sugerirían que la urgencia influye, en mayor medida, en la toma de decisiones en edades más tempranas.

Estudio 3. Dimensiones de impulsividad en el trastorno de juego

En el estudio 3 se examinó si las asociaciones entre tres de las facetas de la impulsividad más descritas y aceptadas a nivel teórico (impulsividad de respuesta, impulsividad de elección e impulsividad rasgo) variaban al comparar pacientes con trastorno de juego y controles sanos. Asimismo, se evaluó la asociación entre estas tres dimensiones de impulsividad y la gravedad del trastorno de juego.

En el estudio se observaron mayores niveles de impulsividad (en los tres dominios) en los pacientes con trastorno de juego, en comparación con los controles sanos. Por otro lado, en ambos grupos se encontraron asociaciones entre las dimensiones de impulsividad, siendo la impulsividad de respuesta el único dominio que no estuvo asociado a la gravedad del trastorno de juego.

El estudio confirmaría, por tanto, que la impulsividad no es un constructo unidimensional en el caso del trastorno de juego.

Estudio 4. Trastorno de juego, impulsividad rasgo y conducta criminal

En este estudio se exploró el historial de conducta criminal en una muestra de pacientes con trastorno de juego (n = 382) comparando sujetos con un historial de actos ilegales relacionados con la conducta de juego con aquellos sin antecedentes penales. Además, se exploraron rasgos de impulsividad y personalidad, junto con otros factores de gravedad relacionados con el trastorno de juego.

Encontramos que los pacientes con trastorno de juego que habían llevado a cabo actos ilegales eran más propensos a presentar elevados niveles de urgencia (es decir, la tendencia a actuar de manera impulsiva al experimentar estados emocionales de elevada intensidad), así como una mayor falta de premeditación. Este grupo también presentó mayores niveles de gravedad del trastorno de juego, así como mayores deudas relacionadas con el juego. Además, los pacientes con historial delictivo reportaron niveles más bajos de autodeterminación, rasgo de personalidad caracterizado por la dificultad para establecer y redirigir el comportamiento hacia las propias metas.

Este estudio proporciona una mayor comprensión empírica de las asociaciones entre el trastorno de juego, la impulsividad y la conducta delictiva. Nuestros hallazgos sugieren que elevados niveles de impulsividad rasgo, especialmente la falta de premeditación y la urgencia positiva, son predictores de la ocurrencia del crimen en aquellos pacientes con trastorno de juego.

Estudio 5. Impulsividad, gravedad y respuesta al tratamiento en trastorno de juego

En este estudio se evaluó el valor predictivo de los niveles de gravedad del Manual Diagnóstico DSM-5 sobre la respuesta al tratamiento cognitivo-conductual en una muestra de adultos varones con un diagnóstico de trastorno del juego (n = 398). Además, se exploraron los factores predictores de respuesta al tratamiento cognitivo-conductual en el período de seguimiento, considerando los rasgos de impulsividad propuestos por el modelo UPPS-P.

Nuestro estudio no logró identificar diferencias en respuesta al tratamiento entre los pacientes, categorizados según los niveles de gravedad propuestos por el Manual Diagnóstico DSM-5. Puntuaciones iniciales más elevadas en urgencia negativa predijeron un mayor riesgo de recaída durante el tratamiento cognitivo-conductual, y niveles más elevados de búsqueda de sensaciones predijeron un mayor riesgo de abandono del tratamiento, tanto a corto plazo como a los 24 meses. Estos hallazgos cuestionan la utilidad clínica de las categorías de gravedad del Manual Diagnóstico DSM-5 y brindan apoyo a la implementación de un enfoque dimensional que contemple el trastorno del juego.

Estudio 6. Impulsividad y compulsividad en el trastorno de juego

En este estudio se exploraron las asociaciones entre impulsividad (evaluada a través de la Escala de Impulsividad de Barratt (BIS-11) y la Tarea de Descuento Experiencial (EDT)) y los niveles de compulsividad (medidos utilizando el Inventario de Padua y la Tarea de Clasificación de Tarjetas de Wisconsin (WCST)) en una muestra adulta con trastorno de juego (n=238). Se exploraron, además, las asociaciones entre las medidas de impulsividad y compulsividad, la gravedad del trastorno de juego y la edad.

La escala de no planificación del BIS-11, así como las puntuaciones totales del BIS-11 correlacionaron positivamente con la gravedad del trastorno de juego. El análisis SEM mostró una contribución positiva directa de la escala de no planificación del BIS-11, las puntuaciones totales del PADUA y las puntuaciones del EDT sobre la gravedad del trastorno de juego. La edad de los participantes sólo tuvo una contribución significativa en los errores perseverativos del WCST, aunque no se hallaron efectos directos o indirectos sobre la gravedad del trastorno de juego.

Nuestros hallazgos apoyan la noción de que no todos los dominios de impulsividad y compulsividad contribuyen por igual a la severidad del trastorno de juego.

DISCUSIÓN Y CONCLUSIONES

Las siguientes conclusiones pueden ser extraídas de los estudios que componen esta tesis:

Trastornos de la conducta alimentaria:

1) Se ha observado una heterogeneidad clínica, especialmente teniendo en cuenta los niveles de impulsividad, entre pacientes con anorexia nerviosa del subtipo restrictivo y anorexia nerviosa del subtipo por atracón/purgas. Mientras que los primeros mostraron un autocontrol desproporcionado, las conductas de atracones llevadas por individuos con anorexia nerviosa del subtipo por atracón/purgas parecen estar impulsadas por estados emocionales y rasgos de impulsividad. Por lo tanto, se confirma la importancia de separar los dos subtipos de anorexia nerviosa.

Trastorno de juego:

2) La impulsividad y la compulsividad pueden considerarse dos dominios independientes en el trastorno de juego, apoyando la perspectiva dimensional del espectro impulsivo-compulsivo.

3) Se ha probado la naturaleza multifactorial de ambos dominios.

4) La impulsividad y la compulsividad no contribuyen al trastorno de juego de forma equitativa, estando la impulsividad más fuertemente asociada a la gravedad del trastorno de juego.

5) En el caso específico de la impulsividad, todas las dimensiones evaluadas (impulsividad de elección, impulsividad de respuesta e impulsividad rasgo) parecen estar interrelacionadas.

6) En esta línea, y teniendo en cuenta concretamente la impulsividad de elección y la impulsividad rasgo, se ha observado una asociación entre estas dos dimensiones en pacientes jóvenes, corroborando que la edad es un factor clave tanto en el trastorno de juego como en la impulsividad.

7) No todas las dimensiones de impulsividad contribuyen de la misma manera al trastorno de juego, y la impulsividad de respuesta no se asocia significativamente con la gravedad del trastorno de juego.

8) Se ha comprobado una asociación entre la impulsividad, el trastorno de juego y la comisión de actos delictivos relacionados con la conducta de juego. Más concretamente, se ha observado que elevados niveles de impulsividad (especialmente urgencia positiva y falta de premeditación) podrían ser considerados como factores predictores de la ocurrencia de delitos en poblaciones con trastorno de juego.

9) Los rasgos impulsivos pueden estar relacionados con la respuesta al tratamiento para trastorno de

juego. Específicamente, las facetas de búsqueda de sensaciones y la falta de perseverancia han sido identificadas como predictores de abandono, mientras que la urgencia negativa podría considerarse un predictor de recaída.

10) Con referencia a la gravedad del trastorno de juego, no fue posible demostrar que una mayor gravedad se asociara a una mejor respuesta al tratamiento, lo que cuestionaría la aplicabilidad clínica de los criterios de gravedad propuestos en el Manual Diagnóstico DSM-5.

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pictures improve risky long-term health decisions. J Appl Behav Anal. 2016;49(1):148–69.
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9. ANNEX

CURRICULUM VITAE

Gemma Mestre-Bach
47889973-V

Education

B.A.	University of Barcelona (Psychology) 2012
M.S.c.	AEPCCC. European Foundation of Psychology (Master's in Clinical Psychology) 2013
M.S.c.	AEPCCC. European Foundation of Psychology (Master's in Sexual Medicine) 2014
M.S.c.	Valencian International University (Master's in Third Generation Therapies) 2015
M.S.c.	Miguel Hernández University (Master's in Criminology and Victimology) 2017
PhD	University of Barcelona (Medicine and Translational Research) 2019

Additional preparation

2016	Ilustre Colegio Oficial de Médicos de Madrid (Statistics and Clinical Epidemiology 3rd edition).
2018	Sociedad Española de Investigación sobre Perfiles Criminológicos (SEIPC). (Specialization in criminal pathology and forensics).

Career/Academic Appointments

2012-13	Psychologist, Dendros Psychology Centre, Barcelona, Spain
2012-13	Psychologist, Specialized Service in Eating Disorders (SETCA), Barcelona, Spain
2013-16	General Health Psychologist, Dexeus University Hospital, Barcelona, Spain
2015-19	PhD Researcher at Bellvitge University Hospital/Bellvitge Biomedical Research Institute (IDIBELL)
2018	Visiting Research Scientist in Yale University, School of Medicine, Department of Psychiatry CT, USA

Teaching experience

2015-16	Teaching Staff Collaborator, Autonomous University of Barcelona, Barcelona, Spain
2015	Teaching in "CBT treatment course for psychiatrists". Societat Catalana de

	Psiquiatria i Salut Mental, Barcelona, Spain
2017	Teaching in course "Evaluation of problematic screen use in adolescents and youth" (INT2017/0995), SPOTT Diputació de Barcelona, Barcelona, Spain

ADMINISTRATIVE POSITIONS

2015-present	Member, Centro de Investigación Biomédica en Red Obesity and Nutrition (CIBERobn), Spain
2014-present	Member, Spanish Association of Sexuality and Mental Health (AESEXSAME), Spain

PROFESSIONAL HONORS & RECOGNITION

2018: Miguel Hernández University, Master's Extraordinary Award
2017: AESEXAME, Spanish Junior Investigator Award
2016: Consorcio Sanitario de la Anoia, V Tomas de Flores Award for Research in Mental Health
2016: AESEXAME, Spanish Junior Investigator Award
2015: Neuroscience, Health Habits and Longevity Atlas Award
2015: AESEXAME, Spanish Junior Investigator Award

CURRENT PROJECTS

Agency: Spanish Health Ministry
I.D.# PI17/01167
Title: "Food Addition in Obesity and Related Food Disorders: Neurobiological and Clinical Substrates"
P.I.: Fernando Fernández Aranda, PhD
Role on Project: Co-investigatorProject period: 01/01/2018 – 12/31/2020

Agency: Ministerio de Sanidad, Servicios Sociales e Igualdad
I.D.# PR338/17-MSSSI (expedient: 2017I067)
Title: "Neurobiological and clinical substrates in gambling disorder"P.I.:Susana Jiménez-Murcia, PhD
Role on Project: Co-investigatorProject period: 2017-2019

CURRENT GRANTS

Agency: Agència de Gestió d'Ajuts Universitaris i de Recerca (AGAUR)
ID.# 2016FI_B 00568/ 2017FI_B1 00145 / 2018 FI_B2 00174
PhD Position Scholarship

PRESENTATIONS & SYMPOSIA

2018: 5th International Conference on Behavioral Addictions, Cologne, Germany, "Underlying mechanisms of the comorbid presence of compulsive buying with gambling disorder: a pathways analysis".

2018: I Simposio de Psicosomática y Psiquiatría, Barcelona, Spain, "Clinical, psychopathological and sexual evaluation in a patient with female genital mutilation after a clitoral reconstruction intervention. Case study".

2018: Behavioral Addiction Group Meeting, Yale University, New Haven, CT, United States, "Motor impulsivity, choice impulsivity and impulsivity traits in a sample of male patients with gambling disorder".

2018: Bellvitge University Hospital PhD Day, Barcelona, Spain, "Gambling and Impulsivity Traits: A Recipe for Criminal Behavior?".

2017: IX International Sexuality and Mental Health Course, Sexuality and Mental Health Spanish Association, Salamanca, Spain, "Psychopathology and Sexual Dissatisfaction Associated with Female Genital Mutilation".

2017: International Conference on Eating Disorders, Prague, Czech Republic, " Enduring Changes in Decision Making in Patients with Full Remission from Anorexia Nervosa".

2017: XXXII Conference on Behavior Therapy and Behavioral Medicine in Clinical Practice, Barcelona, Spain, "Reward and punishment sensitivity in women with gambling disorder or compulsive buying: Implications in treatment outcome".

2017: Bellvitge University Hospital PhD Day, Barcelona, Spain, "Reward and punishment sensitivity in women with gambling disorder or compulsive buying: Implications in treatment outcome".

2017: ECNP neuroscience to evidence based psychological treatments – The promise and the challenge, Nice, France "Enduring Changes in Decision Making in Patients with Full Remission from Anorexia Nervosa".

2017: 4th International Conference on Behavioral Addictions, Haifa, Israel, "Compulsive

Buying Behavior: Characteristics of Comorbidity with Gambling Disorder."

2017: 4th International Conference on Behavioral Addictions, Haifa, Israel, "Reward And Punishment Sensitivity In Women With Gambling Disorder And Compulsive Buying Behavior: Implications In Treatment Outcome".

2017: 47th Spanish Society of Psychosomatic Medicine Congress, Barcelona, Spain "Sex Addiction Phenotypes and Personality Disorders".

2016: 22nd Annual Eating Disorders Research Society, New York City, USA." Long-term changes in neuropsychological functioning in anorexia nervosa patients in full remission".

2016: 11th European Conference on Gambling Studies and Policy, Lisbon, Portugal, "Compulsive Buying Behavior: Characteristics of Comorbidity with Gambling Disorder".

2016: 11th European Conference on Gambling Studies and Policy, Lisbon, Portugal, "Food Addiction in Gambling Disorder: Frequency and Clinical Outcomes."

2016: 11th European Conference on Gambling Studies and Policy, Lisbon, Portugal, "The Involvement of a Concerned Significant Other in Gambling Disorder Treatment Outcome".

2016: International Conference on Eating Disorders, Academy of Eating Disorders, San Francisco, CA " Use of videogames as complementary therapeutic tool for CBT in bulimia nervosa patients".

2016: VIII International Meeting on Psychiatry, Sexuality and Humanism, Sexuality and Mental Health Spanish Association, Salamanca, Spain, "Personality traits in patients with psychogenic and mixed erectile dysfunction".

2016: 68th Meeting of the Catalan Neuropsychological Society, Barcelona, Spain, "Long-term changes in decision-making in patients with full-remission from anorexia nervosa".

2016: XXXII Conference on Behavior Therapy and Behavioral Medicine in Clinical Practice, Barcelona, Spain, "Decision making in obesity, gambling disorder and substance-use disorders".

2015: VIII International and XIII National Clinical Psychology Congress, Granada, Spain, "Survey on Hospital Care Services in Perinatal Mental Health in Catalonia and Balearic Islands: Pilot Study".

2015: Obesity and Nutrition in the 21st Century Symposium, CIBEROBN, Madrid, Spain, "Use of Videogames as Complementary Therapeutic Tool for Cognitive Behavioral Therapy in Bulimia Nervosa Patients".

2015: Iberian Meeting of Sexuality and Mental Health, Guimarães, Portugal, "Sexual Desire Disorders: from Inhibition to Addiction".

2015: 14th Meeting of the European Council on Eating Disorders, Heidelberg, Alemania, "Use of videogames as complementary therapeutic tool for cognitive behavioral therapy in bulimia nervosa patients".

2015: VIII International Sexuality and Mental Health Course, Sexuality and Mental Health Spanish Association, Salamanca, Spain, "Sexual desire and its problems in clinical practice".

2015: IV Perinatal Mental Health Conference, Marcé Spanish Society, Barcelona, Spain, "Current status of perinatal mental health services in Catalonia".

2015: 12 National SEEDO Congress: Obesity and Metabolic Complications, Malaga, Spain, " Use of videogames as complementary therapeutic tool for cognitive behavioral therapy in bulimia nervosa patients".

2014: VII International Meeting on Psychiatry, Sexuality and Neurosciences, Salamanca, Spain, "Inhibited Sexual Desire Assessment: EDSIF development and initial validation".

2013: III Workshop on Mental Health Research, Research Group in Mental Health and Women, Barcelona, Spain, "EDSIF Questionnaire for the evaluation of female sexual desire: development and initial validation".

2013: XVII National Psychiatry Congress, Sevilla, Spain, "Phenotypes in behavioral addictions: gambling disorder vs. sex addiction".

2013: VII International Course on Sexuality and Mental Health, Sexuality and Mental Health Spanish Association, Salamanca, Spain, "Phenotypes in behavioral addictions: gambling disorder vs. sex addiction".

JOURNAL SERVICE (PEER REVIEWER)

Reviewer for Plos One
Reviewer for Revista Argentina de Clínica Psicológica
Reviewer for Journal of Behavioral Addictions
Reviewer for Revista da Associação Médica Brasileira
Reviewer for Psychiatry Research

BIBLIOGRAPHY

Peer-Reviewed Publications

1. **Mestre-Bach, G.**, Steward, T., Granero, R., Fernández-Aranda, F., Talón-Navarro, M.T., Cuquerella, À., Baño, M., Moragas, L., del Pino-Gutiérrez, A., Aymamí, N., Gómez-Peña, M., Mallorquí-Bagué, N., Vintró-Alcaraz, C., Magaña, P., Menchón, J.M., Jiménez-Murcia, S., 2018. Gambling and Impulsivity Traits: A Recipe for Criminal Behavior? Front. Psychiatry 9, 6.

2. **Mestre-Bach, G.**, Steward, T., Granero, R., Fernández-Aranda, F., del Pino-Gutiérrez, A., Mallorquí-Bagué, N., Mena-Moreno, T., Vintró-Alcaraz, C., Moragas, L., Aymamí, N., Gómez-Peña, M., Sánchez-González, J., Agüera, Z., Lozano-Madrid, M., Menchón, J.M., Jiménez-Murcia, S., 2019. The predictive capacity of DSM-5 symptom severity and impulsivity on response to cognitive-behavioral therapy for gambling disorder: A 2-year longitudinal study. Eur. Psychiatry 55, 67–73.

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BRIEF REPORT

Delay Discounting of Reward and Impulsivity in Eating Disorders: From Anorexia Nervosa to Binge Eating Disorder

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Abstract

Evidence points to eating disorder patients displaying altered rates of delay discounting (one's degree of preference for immediate rewards over larger delayed rewards). Anorexia nervosa (AN) patients are believed to have an increased capacity to delay reward, which reflects their ability to override the drive to eat. Contrarily, binge eating disorder (BED) patients are associated with a reduced predisposition to delay gratification. Here, we investigated monetary delay discounting and impulsivity in 80 adult women with EDs (56 AN and 24 BED), diagnosed according to Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition criteria, and 80 healthy controls. AN-restrictive (AN-R) subtype patients showed less steep discounting rates than BED and AN-bingeing/purging subtype patients. Compared with healthy controls and AN-R patients, BED and AN-bingeing/purging patients presented higher delay discounting and positive and negative urgency levels. Our findings suggest that restriction in AN-R patients is associated with disproportionate self-control, whereas bingeing behaviours could be more driven by emotional states and impulsivity traits. Copyright © 2017 John Wiley & Sons, Ltd and Eating Disorders Association.

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Introduction

Certain personality characteristics, such as rigidity or perfectionism, are often related to anorexia nervosa-restricting subtype (AN-R; National Institute for Clinical Excellence, 2004), whereas other features, such as impulsivity and emotion dysregulation, are commonly associated to bulimic-spectrum disorders, encompassing AN-bingeing/purging subtype (AN-BP), bulimia nervosa (BN) and binge eating disorder (BED; Atiye, Miettunen, & Raevuori-Helkamaa, 2015; Claes, Vandereycken, & Vertommen, 2002; Lavender & Mitchell, 2015; Waxman, 2009). Likewise, the extent to which an individual chooses immediate gratification over larger, delayed rewards varies across psychiatric disorders (Amlung, Vedelago, Acker, Balodis, & MacKillop, 2017; Story, Moutoussis, & Dolan, 2015) and contexts (Kaplan, Reed, & Jarmolowicz, 2016; Lempert & Phelps, 2016). This tendency to disproportionately value immediate rewards during decision making is known as delay discounting or temporal discounting and is normally measured by having subjects choose between a smaller-immediate reward and a larger-delayed reward (e.g. 'Would you prefer € 45 now or € 88 in 7 days?'; Madden & Bickel, 2009). As opposed to delayed gratification, or deferred gratification, which is the ability to resist the temptation for an immediate reward and wait for a later reward, delay discounting is a sign of one's preference for smaller immediate rewards over larger but delayed rewards (Odum, 2011). Being more prone to choosing immediate rewards has been associated with clinical conditions, such as gambling disorder (Steward *et al.*, 2017), substance abuse (Grant & Chamberlain, 2014) and obesity (Caleza, Yañez-Vico, Mendoza, & Iglesias-Linares, 2016; Epstein, Salvy, Carr, Dearing, & Bickel, 2010).

In the case of EDs, evidence points to a phenotypic overlap across disorders with respect to delay discounting (Bartholdy *et al.*, 2017; Stojek & MacKillop, 2017). EDs characterized by higher levels of impulsivity, namely, BN and BED, are associated with a preference for immediate rewards, regardless of whether the reward is monetary (Davis, Patte, Curtis, & Reid, 2010; Kekic *et al.*, 2016) or a food reward (Manwaring, Green, Myerson, Strube, & Wilfley, 2011). On the other hand, being overly cautious and choosing

delayed rewards more than is expected has been linked to AN (Decker, Figner, & Steinglass, 2015; Steinglass *et al.*, 2012, 2017). This tendency is thought to reflect the unusually elevated level of self-control found in AN patients and possibly reflects a vulnerability marker for the disorder (Kanakam, Krug, Collier, & Treasure, 2017; Stojek & MacKillop, 2017). By regularly forgoing the immediate rewards provided by food in favour of the longer term goal of reducing body weight, the behavioural habit of not discounting rewards is increasingly understood to be a potential maintenance factor for AN (Walsh, 2013). Likewise, in the case of EDs associated with excess weight, the inability to resist the temptation of immediate rewards (i.e. unhealthy and palatable foods) is believed to be a detrimental influence on adherence to the dietary guidelines that commonly form part of BED treatment programs (Citrome, 2015).

Impulsivity factors, such as a lack of premeditation and acting out rashly in response to extreme moods, have also been linked to heightened delay discounting (Stojek, Fischer, Murphy, & MacKillop, 2014; VanderBroek-Stice, Stojek, Beach, vanDellen, & MacKillop, 2017). The UPPS-P model contemplates impulsivity as a multidimensional construct and utilizes five separate subscales to assess impulsive behaviour and traits. Positive urgency refers to the tendency to act impulsively when undergoing positive affect; negative urgency reflects the propensity to act impulsively when experiencing negative affect; lack of perseverance shows the tendency to not persist in an activity that can be arduous or boring; lack of premeditation refers to the tendency to act without considering the consequences of an action; and sensation seeking indicates one's disposition to seek exciting experiences (Verdejo-García, Lozano, Moya, Alcázar, & Pérez-García, 2010).

In the EDs, an interaction among lack of premeditation, negative urgency and bingeing and purging behaviours has been identified (Anestis, Smith, Fink, & Joiner, 2009; Bardone-Cone, Butler, Balk, & Koller, 2016), with these maladaptive behaviours often being carried out in negative mood states (Fischer, Smith, & Anderson, 2003). Contrarily, AN-R patients tend to present reduced levels of impulsivity-related traits on the UPPS-P (Claes, Vandereycken, & Vertommen, 2005). It must be highlighted, however, that there is a dearth of studies evaluating both trait and choice (i.e. delay discounting) impulsivity across EDs when taking AN subtypes into account.

Aims

As such, in this study, we sought to assess delayed discounting and impulsivity in extreme-eating/weight conditions, in comparison with healthy controls (HCs). Given the aforementioned differences in impulsivity features, we also sought to examine whether delay discounting tendencies differed between AN-BP and AN-R subtype patients. We hypothesized that increased delay discounting and impulsivity levels would be associated with bulimic-spectrum disorders (AN-BP and BED), whereas these tendencies would be reduced in AN-R patients.

Methods

Sample and procedure

Our sample was made up of 80 ED female patients (37 AN-R, 19 AN-BP and 24 BED patients), who were recruited as consecutive referrals to the ED Unit within the Department of Psychiatry at Bellvitge University Hospital (Spain). These patients were compared with 80 matched HC. Patients were originally diagnosed according to Diagnostic and Statistical Manual of Mental Disorders (DSM), Fourth Edition text revision (APA, 2000) criteria by means of the Structured Clinical Interview for DSM Disorders I (First, Gibbon, Spitzer, & Williams, 1996). However, DSM Fourth Edition text revision diagnoses were reanalysed post hoc by using DSM-5 criteria (APA, 2013). Study inclusion criteria were the following: being female and being over the age of 18. The study exclusion criteria were the following: the presence of an organic mental disorder and an intellectual disability and, in the case of HCs, a history of EDs or any other psychiatric condition. For this purpose, prior to assessment, the participants were asked about lifetime or current ED symptomatology and diagnosis, and they reported minimum and maximum BMI. HCs who had high levels of ED symptomatology and high scores of psychopathology were excluded from the sample.

Unit staff psychologists and psychiatrists carried out clinical evaluations during two structured face-to-face interviews. The first was conducted to provide information on current ED symptoms, antecedents and other psychopathological data of interest. The second interview consisted of a psychometrical assessment and eating behaviour monitoring through daily reports. HCs were provided with the study questionnaire following screening.

The present study was carried out in accordance with the latest version of the Declaration of Helsinki. The Bellvitge University Hospital Clinical Research Ethics Committee approved the study, and signed informed consent was obtained from all participants.

Measures

Eating disorder symptomatology was assessed via the validated Spanish version of the Eating Disorders Inventory 2 (Garner, 1998; internal consistency measured by Cronbach alpha for the total score in the study sample was excellent, $\alpha = .921$). The UPPS-P Impulsive Behaviour Scale-UPPS (Verdejo-García *et al.*, 2010) was used to measure impulsivity-related traits (internal consistency in the study sample was good, ranging from .789 in lack of perseverance to .923 in positive urgency). On the UPPS-P, individuals are asked to consider acts/incidents during the last 6 months when rating their behaviour and attitudes.

Delay discounting was assessed by using a validated paper-and-pencil monetary choice task (Kirby, Petry, & Bickel, 1999). This task elicits individual intertemporal discount rates (k) by providing a set of alternative choices between a smaller, immediate monetary reward and a larger, delayed monetary reward. Each of these questions was designed to correspond to a different k value, which represents the amount of discounting of the later reward that renders it equal to the smaller reward. The task is scored by calculating where the respondent's answers place him/her amid reference discounting curves, with placement on steeper curves indicating higher levels of choice impulsivity. Point single k parameter estimates can be obtained to represent not only the overall rate of discounting but also for items with small, medium and large monetary rewards (Kirby *et al.*, 1999). Overall k values can range from 0 (selection of the delayed reward option on all items or no discounting) to 0.25 (selection of the immediate reward option on all items). As previous studies have shown a

magnitude effect on discounting rates (*k*-values decrease as the amount of the rewards increase), *k* values were separately estimated by using three magnitude categories (Kirby & Petry, 2004): small (€25–35), medium (€50–60) and large (€75–85) delayed rewards. The distributions of *k* values were normalized by using square root transformation.

Statistical analyses

Analyses were conducted with STATA15 for Windows. Comparison of discounting rates (*k* index) and impulsivity levels (UPPS-P) between groups was carried out by using analysis of variance (ANOVA, including post hoc pairwise comparisons through Scheffé's procedure). The effect size for pairwise comparisons in the ANOVA analyses was estimated through the Cohen's *d* coefficient ($|d| > 0.50$ was considered moderate effect size, and $|d| > 0.80$ was considered large effect size). To avoid increases in type I error due to multiple comparisons, Finner's procedure was used (a method included in familywise error rate methods, which offers a more powerful test than Bonferroni correction).

Results

Sample characteristics

Table 1 includes a description of the sociodemographic and ED-related variables of the sample groups. Significant differences were found with respect to age, with AN-BP and BED patients being older than HCs and AN-R patients. For this reason, all pairwise comparisons controlled for this variable. As is to be expected, Eating Disorders Inventory 2 total scores were higher in the ED groups than in HCs.

Comparison of delay discounting and impulsivity levels between groups

Table 2 contains the results of the ANOVA comparing *k*-index values (for small, medium, large and overall rewards) between groups. Compared with the other ED groups, *k* values for patients with AN-R were significantly lower, indicating lower levels of delayed discounting. In comparison with HC and AN-R patients, both BED and AN-BP patients presented significantly higher levels of delay discounting. No significant differences were obtained between BED and AN-BP patients in terms of *k*-values.

The first panel of Figure 1 displays the group means of the *k* indexes measuring delay discounting for small, medium and large rewards. The second panel includes boxplots for overall *k* indexes separated by group.

In terms of UPPS-P, we found significant differences between groups in multiple dimensions. Compared with HCs, lack of premeditation scores were found to be higher in BED patients. Lack of perseverance scores were also higher in AN-BP and BED patients compared with HCs. The same pattern held true for both positive and negative urgency. Finally, all ED groups obtained lower scores on sensation seeking compared with HCs.

Discussion

In this study, we aimed to compare delay discounting and impulsivity in HCs and in patients in extreme-weight conditions, namely, AN and BED, emphasizing the differences between bulimic-spectrum disorders and AN-R.

Anorexia nervosa-bingeing/purging subtype patients reported greater ED severity in comparison with AN-R patients, as is consistent with other studies (DeJong *et al*., 2013; Edler, Haedt, & Keel, 2007; Lavender *et al*., 2017). Likewise, as is commonly observed in clinical populations, the mean age of patients with AN was lower than BED patients. For this reason, we chose to control for this variable when making group comparisons.

The findings of the present study dovetail with previous reports of altered monetary delay discounting in patients with EDs and uphold the utility of employing spectrum models to order to understand ED behaviour (Jiménez-Murcia *et al*., 2015; Wierenga *et al*., 2014). Similar to other research (Lavagnino, Arnone, Cao, Soares, & Selvaraj, 2016; Mole *et al*., 2015), we found that patients with BED discounted rewards more steeply than HCs. This tendency may reflect alterations in the neural subprocesses underpinning choice impulsivity such as enhanced salience of immediate reward and/or diminished prospection (Bari & Robbins, 2013). In addition, we found that patients with AN-BP subtype, though not AN-R subtype, had greater discounting than HCs. As such, increased rates of delay discounting may contribute to

Table 1 Sample description

		HC $n = 80$		AN-R $n = 37$		AN-BP $n = 19$		BED $n = 24$				
		Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*	*F*	*df*	*p*
Age (years old)		23.0	4.43	24.3	7.22	28.6	6.56	33.6	8.59	20.35	3/156	<.001
ED related measures		Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*	*F*	*df*	*p*
EDI-2: total score	α = .921	28.2	17.2	59.2	34.8	104.7	43.1	112.0	42.6	66.75	3/156	<.001
Onset of ED (years old)		—	—	18.35	6.07	18.21	4.58	20.27	8.21	0.73	3/77	.488
Duration of ED (years)		—	—	5.35	6.00	10.53	8.86	12.80	8.81	6.77	3/77	.002
Binges/weekly		—	—	—	—	1.79	3.22	5.08	5.46	5.40	1/41	.025
Purges/weekly		—	—	—	—	4.94	5.34	—	—	—	—	—
BMI present (kg/m^2)		21.62	3.22	16.15	1.83	16.65	0.88	38.86	9.70	141.5	3/156	<.001
BMI maxim (kg/m^2)		23.09	3.94	21.95	3.80	21.40	2.87	39.75	9.35	77.16	3/157	<.001
BMI minim (kg/m^2)		19.77	2.22	15.19	1.85	15.44	1.78	25.65	5.17	77.94	3/156	<.001

Note. HC, healthy controls; AN-R, anorexia restrictive subtype; AN-BP, anorexia bingeing-purging subtype; BED, binge eating disorder; *SD*, standard deviation. *df*, degrees of freedom; EDI-2, Eating Disorder Inventory 2; BMI, body mass index.

Table 2 Comparison of delayed discounting and UPPS-P impulsivity traits between groups: ANOVA

	Means and standard deviation								Pairwise comparisons											
	HC $n = 80$		AN-R $n = 37$		AN-BP $n = 19$		BED $n = 24$		HC vs AN-R		HC vs AN-BP		HC vs BED		AN-R vs AN-BP		AN-R vs BED		AN-BP vs BED	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*p*	|*d*|	*p*	|*d*|	*p*	|*d*|	*p*	|*d*|	*p*	|*d*|	*p*	|*d*|
k-small	0.179	0.116	0.147	0.109	0.249	0.136	0.248	0.160	.205	0.28	.029*	0.55†	.017*	0.52†	.004*	0.82†	.002*	0.74†	.995	0.01
k-medium	0.148	0.114	0.097	0.056	0.214	0.142	0.195	0.163	.031*	0.56†	.027*	0.51†	.079	0.34	.001*	1.08†	.002*	0.81†	.607	0.12
k-large	0.107	0.096	0.075	0.055	0.187	0.174	0.161	0.124	.129	0.41	.003*	0.57†	.030*	0.55†	.001*	0.87†	.002*	0.89†	.419	0.17
k-overall	0.139	0.100	0.101	0.065	0.218	0.149	0.194	0.139	.076	0.45	.005*	0.62†	.028*	0.51†	.001*	1.02†	.001*	0.86†	.476	0.16
Premedit	21.1	4.57	19.9	5.19	21.0	7.09	23.7	5.86	.225	0.26	.919	0.02	.037*	0.52†	.446	0.18	.006*	0.70†	.096	0.42
Persever	18.9	3.67	18.9	5.21	21.4	5.69	25.0	5.05	.958	0.01	.035*	0.51†	.001*	1.38†	.050*	0.51†	.001*	1.20†	.010*	0.67†
Sensation S	28.0	7.16	24.1	6.47	24.4	7.69	21.8	7.74	.008*	0.56†	.049*	0.54†	.001*	0.83†	.888	0.04	.214	0.33	.234	0.34
P.urgency	26.1	6.13	27.2	7.99	34.3	4.83	34.0	5.27	.363	0.16	.001*	1.48†	.001*	1.39†	.001*	1.06†	.001*	1.00†	.910	0.04
N.urgency	21.3	7.28	21.7	6.58	28.9	9.45	28.6	9.42	.800	0.06	.001*	0.90†	.001*	0.87†	.002*	0.88†	.002*	0.85†	.911	0.03

Note. HC, healthy control; AN-R, anorexia restrictive; AN-BP, anorexia bingeing-purging; BED, binge eating disorder.
M, mean; SD, standard deviation.
k-square root transformation index. Premedit, lack of premeditation; Persever, lack of perseverance; sensation S, sensation seeking; P.urgency, positive urgency; N.urgency, negative urgency.
*Bold: significant pairwise comparison.
†Bold: moderate ($|d| > 0.50$) to large effect size ($|d| > 0.80$).

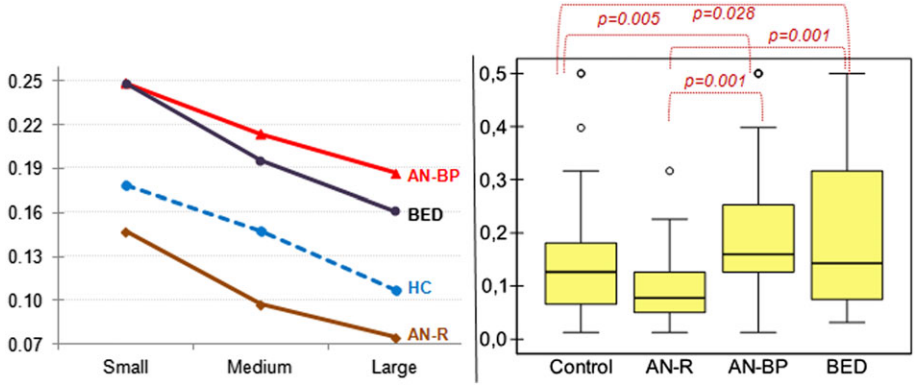

Figure 1. First panel: mean discount rate (*y*-axis) as a function of delayed reward magnitude (*x*-axis); second panel: boxplot for overall *k* values. *Note*. HC, healthy control; AN-R, anorexia restrictive; AN-BP, anorexia bingeing-purging; BED, binge eating disorder *k*-value expressed in square root. [Colour figure can be viewed at wileyonlinelibrary.com]

some of the core symptoms in bulimic spectrum disorders and could therefore represent a relevant target for intervention (Kekic *et al.*, 2016).

Contrastingly, AN-R patients presented less steep discounting rates than the other ED groups. This result coincides with past studies identifying more conservative decision making in AN patients (Decker *et al.*, 2015; Steinglass *et al.*, 2012, 2017). Clinically, patients with AN-R are often described as being more prone to excessive self-control than their AN-BP counterparts, who are characterized as being more undercontrolled (Lavender *et al.*, 2017; Wildes *et al.*, 2011). Our results indicate that these differences may also be relevant in the realm of delay discounting. Steinglass *et al.* (2012) found that the significant difference in discounting in their AN sample, in comparison with controls, was largely attributable to individuals with AN-R subtype. Although our current findings require replication, they highlight the importance of separating AN subjects by subtype in future studies.

Regarding impulsivity-related traits, patients with bulimic-spectrum disorders (AN-BP and BED) showed greater levels of positive and negative urgency, as we hypothesized. This is in line with other research that found that urgency, especially negative urgency, was associated with bingeing and purging behaviours, as well as subjective loss of control of food intake (Claes *et al.*, 2015, Claes *et al.*, 2002; Fischer *et al.*, 2003; Racine *et al.*, 2015; Wolz *et al.*, 2015). Being that neuroimaging evidence has suggested that negative affect increases the rewarding value of food (Bohon & Stice, 2012) and that emotion dysregulation is associated with excess weight (Steward *et al.*, 2016), our results lend support to the notion that bingeing behaviours could mainly

be negatively reinforcing (Berner *et al*., 2017). Other researchers have found the tendency to act rashly when experiencing strong emotions (i.e. urgency) and greater discounting of delayed monetary rewards to be associated with higher score food addiction (VanderBroek-Stice *et al*., 2017). In addition, the authors of this study found, via mediation analyses, indirect effects among urgency, delay discounting and obesity by way of food addiction. Taken the study mentioned in the preceding texts into account, these domains may represent an etiological pathway contributing to bingeing behaviours, although longitudinal studies would be needed to validate this hypothesis.

It is worth noting that we failed to identify any differences between reported positive and negative urgency between HCs and AN-R patients. These findings raise the question whether the persistent choice of inadequate caloric intake may be linked to disproportionate self-control for AN-R patients and more emotionally driven for AN-BP patients (Steinglass & Walsh, 2016). Empirical studies on the effectiveness of treatment approaches focused on these features, such as overcontrol in the case of AN-R patients (Lynch *et al*., 2013; Lynch, Hempel, & Dunkley, 2015) or impulsivity for patients with bulimic-spectrum disorders (Giner-Bartolomé *et al*., 2016; McClelland *et al*., 2016; Val-Laillet *et al*., 2015).

Limitations and future research

Although this study has its strengths, there are limitations that should be considered when interpreting its results. First, age is a significant factor in determining delay discounting and impulsivity levels. Even though we controlled for this variable in our statistical analyses, future studies should ideally aim to match control and patients as much as is practically possible. Second, delay discounting was measured through a monetary reward task. However, taking ED features into account, it would be of interest to assess delay discounting effects by using other types of reward (e.g. food). Third, context and emotional state are understood to influence decision making and delay discounting (Kaplan *et al*., 2016; Lempert & Phelps, 2016), although our study did not assess the present mood or economic situation of the subjects while they completed the study measures. Fourth, in the present study, only AN and BED were included in our sample, being that the prime focus of this study was on extreme-weight conditions. Future research should also examine other EDs (i.e. BN and other specified feeding or eating disorders). Finally, more longitudinal studies with larger samples are needed to estimate the predictive capacity of decision making and impulsivity dimensions on ED treatment outcome (Steward, Mestre-Bach, *et al*., 2016).

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Delay discounting and impulsivity traits in young and older gambling disorder patients

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HIGHLIGHTS

- Delay discounting has been linked with gambling severity in previous research.
- We assessed the association between delay discounting, impulsivity and age in patients with gambling disorder.
- No significant differences in delay discounting were identified between younger and older gambling patients.
- Positive correlations between impulsivity traits and delay discounting were found in younger patients.
- Our findings uphold the existence of differing impulsivity mechanisms in younger and older gamblers.

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ABSTRACT

Background: Impulsivity is understood to be a multidimensional construct involving aspects such as impulsive choice and impulsive traits. Delay discounting, the tendency to place greater value in immediate rewards over larger, long-term rewards, has been associated with maladaptive choices in gambling disorder (GD). Delay discounting is known to evolve with age; though no study to date has evaluated the interactions between impulsivity, GD severity and age in treatment-seeking patients.
Objectives: We aimed to examine whether associations between delay discounting and impulsivity traits differed between younger and older-aged GD patients. Secondly, we sought to untangle the mediating role of impulsivity in determining gambling behavior in these two age groups.
Methods: GD patients ($N = 335$) were evaluated using the UPPS-P Impulsive Behavior Scale and a delay discounting task. Structural Equation Modeling (SEM) was used to explore associations between impulsivity measures and gambling severity in young (18–30 years) and old (31–70) GD patients.
Results: No differences in delay discounting were found between young and old GD patients. Significant correlations between delay discounting and urgency levels (the tendency to act rashly under emotional states) were identified only in the young GD group. Path analyses also revealed both positive and negative urgency to be a mediator of GD severity levels in young GD patients.
Discussion and conclusions: Significant associations between impulsive choice and positive urgency are only present in young gamblers, suggesting that positive urgency influence choice behavior to a greater degree at younger ages. Implications for targeted interventions are discussed.

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1. Introduction

Gambling disorder (GD) is strongly linked with dysfunction across multiple cognitive domains, many of which can be considered in terms of impulsivity (Del Prete et al., 2017; Grant, Odlaug, & Chamberlain, 2016; Mackillop et al., 2014). However, due to the numerous ways by which it can be measured, impulsivity is increasingly understood to be a multidimensional construct (Evenden, 1999; Mackillop et al., 2016). Motor impulsivity is thought to reflect a dysregulation of outward behavior due to decreased inhibitory control. Contrastingly, impulsive choice is characterized as an individual's motivational and decision-making style (e.g. choosing immediate gratification over larger, delayed rewards) (Grant & Chamberlain, 2014). Lastly, impulsive personality traits are thought to be indicative of individual's ability to self-regulate dominant preferences (e.g., to act without deliberation, to give up on tasks) (Cyders & Smith, 2008b).

In recent years, given the heterogeneity of impulsivity models, attempts at developing more inclusive models have been made. For example, the UPPS-P framework identifies five separate impulsivity-related traits. These subscales are: (lack of) premeditation and perseverance, positive and negative urgency, and sensation seeking (Berg, Latzman, Bliwise, & Lilienfeld, 2015). Urgency (emotion-laden impulsivity) has specifically been found to distinguish between treatment-seeking pathological gamblers and controls, and to be linked to affective mechanisms related to problem gambling. This approach allows for a more comprehensive assessment of the associations between impulsive traits and GD (Canale, Vieno, Bowden-Jones, & Billieux, 2017; Canale, Vieno, Griffiths, Rubaltelli, & Santinello, 2015a) than general personality constructs.

Impulsive choice and urgency have been found to be strongly linked to gambling severity, though results on the existence of associations between motor impulsivity and GD severity levels are inconsistent (Brevers et al., 2012; Torres et al., 2013). This three-factor model of impulsivity has been tested in large samples and has been found to properly reflect meaningful and quantitatively discrete domains of impulsivity (Mackillop et al., 2016). Few studies to date, however, have conducted a within-subject comparison of these aspects of impulsivity in GD patients while taking factors such as age into account. Epidemiological research suggests a negative correlation between chronological age and impulsivity in non-clinical populations (Galvan, Hare, Voss, Glover, & Casey, 2007; Steinberg et al., 2008). As a majority of GD patients report first engaging in gambling behavior at a young age (Granero et al., 2013), empirical studies would be useful to gain a better understanding of whether this association between age and choice impulsivity is also present in the GD phenotype.

One of the most widely utilized indices of choice impulsivity is delay discounting (i.e. temporal discounting) (Amlung, Vedelago, Acker, Balodis, & Mackillop, 2017). Delay discounting refers to the subjective devaluation of rewards according to the temporal delay of their receipt, and is commonly measured by presenting subjects with questions in which a choice must be made between a smaller-immediate or a larger-delayed reward (e.g. 'Would you prefer € 31 now or € 85 in 7 days?') (Madden & Bickel, 2009). At each delay, indifference points are plotted and a delay discounting curve is modeled using a hyperbolic function. This function yields the derived parameter, *k*, which corresponds to an individual's discount rate. Larger *k* values indicate steeper discounting and thus, increased choice impulsivity (Kirby, Petry, & Bickel, 1999).

Multiple studies have found that GD patients present higher levels of delay discounting than control subjects (Albein-Urios, Martinez-González, Lozano, & Verdejo-Garcia, 2014; Amlung et al., 2017; Dixon, Marley, & Jacobs, 2003; Krmpotich et al., 2015; Petry, 2001), and that gamblers with steeper delay discounting show greater risk taking, poorer decision-making and higher levels of bet chasing (Kräplin et al., 2014b). Alterations in delay discounting are believed to be underpinned by a hypoactive reward system, which modify reward representations and consequently influence behavior (Madden & Bickel, 2009). Other research, however, has not found a direct association between impulsive choice and GD severity levels, though GD severity has been found to highly correlate with other impulsive traits, such as acting without proper planning (Brevers et al., 2012; Secades-Villa, Martínez-Loredo, Grande-Gosende, & Fernández-Hermida, 2016).

The neural areas associated with impulsivity continue to develop into the young adulthood (Giedd, 2004); therefore, the relationship between delay discounting and impulsive action, such as gambling behavior, could very well be distinct in younger versus older adults. Indeed, studies in young men at increased risk of engaging in HIV risk behaviors and in adolescents with bipolar disorders have identified increased monetary delay discounting to be linked to age-specific risky behavior and improvements in delay tolerance, respectively (Jones & Sullivan, 2016; Urošević, Youngstrom, Collins, Jensen, & Luciana, 2016). Another study specifically examining the mediating effects of decision-making in trait urgency and gambling problems in young adults found age-related differences, with young people tending to act rashly in response to extreme moods and having lower levels of deliberative decision-making (Canale, Vieno, Griffiths, Rubaltelli, & Santinello, 2015b). The sample in this study however only consisted of students aged 16–25 and did not explore how associations between delay discounting and gambling behavior evolved into older adulthood. Moreover, as opposed to the present study, the community-based nature of Canale et al. (2015b), does not allow for determining whether such associations hold true in a clinical setting in which GD severity levels are higher.

With excessive delay discounting identified as a process underlying a wide variety of clinical conditions, increased attention has been given to understanding how individuals' discount rates change with age. Developmental studies point to deliberative decision-making abilities maturing over time, and to emotionally-charged impulsivity (i.e. urgency) being heightened during adolescence compared to adulthood (Cyders & Smith, 2008a). Relatedly, urgency and lack of premeditation significantly correlate with each other in adolescents (Tomko, Prisciandaro, Falls, & Magid, 2016). Studies have found that relying upon decision-making processes largely based on emotion appraisal decreases adolescents ability to delay gratification, and is linked to participation delinquent behaviors including, substance use and risky sex (Wardell, Strang, & Hendershot, 2016; Wolff & Crockett, 2011).

More specifically, changes in discount rates can be interpreted from the perspective of the competing neurobehavioral decision systems theory, which describes a combination of developmental neurological and behavioral processes that account for delay discounting (Koffarnus, Jarmolowicz, Mueller, & Bickel, 2013). Younger gamblers could be less able to successfully inhibit impulsive choices that they would be unlikely to engage in if not for their vulnerability to their particular emotional state (i.e. positive and/or negative urgency). As such, disentangling the decision-making components of GD in the context of age could potentially allow for the development of targeted intervention strategies that focus on emotion regulation and impulsive control strategies (Jiménez-Murcia et al., 2013; Jiménez-Murcia et al., 2015; Kräplin et al., 2014b; Lobo et al., 2014). Recent research has highlighted the possible existence of a GD patient subgroup characterized by young age, early problem gambling onset and more dysfunctional personality traits (Granero et al., 2013); yet little is known on how choice impulsivity factors into the these age-divided subgroups.

The purpose of this research was two-fold. Our first aim was to examine whether the associations between delay discounting and impulsivity varied between younger and older treatment-seeking GD patients. Our second aim was to identify the mediating role of impulsivity factors between age and GD severity levels by means of path analysis. Being that empirically derived *k* values from delay-discounting tasks are context sensitive and are not constant across various settings (Dixon, Jacobs, & Sanders, 2006), we did not hypothesize that significant differences in choice impulsivity would exist between younger and older GD

patients. Integrating the abovementioned evidence about (1) age-dependent overlapping between decision-making styles -including choice impulsivity- and affect regulation (Berns, Laibson, & Loewenstein, 2007), (2) the heightened sensitivity of young people with gambling and other self-regulation problems to positive emotions and motives (Littlefield, Sher, & Wood, 2010; Navas et al., 2017), and (3) the prominent prognostic and diagnostic value of urgency with regard to GD (Canale et al., 2017), it is possible to build a tentative model of the relationships between age, choice impulsivity, urgency, and gambling severity. Specifically, we expect choice impulsivity to predict severity only through its shared variability with urgency, and this path – particularly its positive urgency component- to be more evident in younger gamblers.

2. Materials and methods

2.1. Participants

The sample consisted of 335 patients with a diagnosis of GD who were being treated at the Gambling Disorder Unit within the Department of Psychiatry at Bellvitge University Hospital (Barcelona, Spain). This public hospital is certified as a tertiary care center for the treatment of addictive behaviors and oversees the treatment of very complex cases. Patients were derived to the Bellvitge University Hospital Gambling Disorder Unit through general practitioners or via another healthcare professional; some patients were derived from prison health services, though their treatment was not compulsory. All the patients were consecutive referrals for assessment and treatment from July 2013 to December 2014. Experienced psychologists and psychiatrists conducted two face-to-face clinical interviews before a diagnosis was given and only patients who met DSM-5 criteria for GD (APA, 2013) were included in our sample. Sociodemographic and additional clinical information was taken, and patients individually completed all the questionnaires required for this study (requiring approximately 2 h) before initiating outpatient treatment. Only patients who sought treatment for GD as their primary health concern were admitted to this study. Exclusion criteria were: the presence of an organic mental disorder, intellectual disability, a neurodegenerative condition, such as Parkinson's disease, or an active psychotic disorder.

Participants were classified in two groups according to their chronological age: young gamblers (between 18 and 30 years-old, $n = 67$, 20.4%) versus older gamblers (31 to 70 years-old, $n = 261$, 79.6%). The reasons for selecting 30 years of age as a cut-off were: a) other studies in addiction research have used this age to divide younger and older samples (Fidler, Ferguson, Brown, Stapleton, & West, 2013); and b) neurodevelopment is generally understood to reach adulthood at the age of 30 (Mukherjee et al., 2016).

The present study was carried out in accordance with the latest version of the Declaration of Helsinki. The University Hospital of Bellvitge Ethics Committee of Clinical Research approved the study, and written informed consent was obtained from all participants.

2.2. Instruments

2.2.1. DSM-5 Criteria (APA, 2013)

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

2.2.2. South Oaks Gambling Screen (SOGS) (Lesieur & Blume, 1987)

This self-report 20-item screening questionnaire discriminates between probable pathological, problem and non-problem gamblers. The Spanish validation used in this work showed excellent internal consistency ($\alpha = 0.94$) and test-retest reliability ($r = 0.98$) (Echeburúa, Báez, Fernández, & Páez, 1994).

2.2.3. Alcohol Use Disorders Identification Test (AUDIT) (Saunders, Aasland, Babor, de la Fuente, & Grant, 1993)

This test was developed as a simple screening method for excessive alcohol consumption. Internal consistency has been found to be high, and rest-retest data have suggested a high reliability (0.86) and a sensitivity of around 0.90. Specificity in different settings and for different criteria averages 0.80 or more (Martínez, 1999). In this work, cut-off points of 8 and 20 were used to identify individuals with alcohol abuse and alcohol dependence, respectively (Reinert & Allen, 2002).

2.2.4. Impulsive Behavior Scale (UPPS-P) (Whiteside, Lynam, Miller, & Reynolds, 2001)

The UPPS-P measures five facets of impulsive behavior through self-report on 59 items: negative urgency; positive urgency; lack of premeditation; lack of perseverance; and sensation seeking. Individuals are asked to consider acts/incidents during the last 6 months when rating their behavior and attitudes. The Spanish-language adaptation shows good reliability (Cronbach's α between 0.79 and 0.93) and external validity (Verdejo-García, Lozano, Moya, Alcázar, & Pérez-García, 2010). Consistency in the study sample was between good ($\alpha = 0.75$ for lack of perseverance scale) to excellent ($\alpha = 0.92$ for positive urgency).

2.2.5. Delay discounting task (Kirby et al., 1999)

This task is a 27-item self-administered tool used to elicit individual inter-temporal discount rates *(k)*, providing a set of alternative choices between a smaller, immediate monetary reward and a larger, delayed monetary reward. Each of these questions was designed to correspond to a different *k*-value, which constitutes the measure of discounting-rate and represents the amount of discounting of the later reward that renders it equal to the smaller reward. The protocol is scored by calculating where the respondent's answers place him/her amid reference discounting curves, where placement amid steeper curves indicates higher levels of impulsivity. Point single *k* parameter-estimates can be obtained to represent the overall rate of discounting, but also for items with small, medium and large monetary rewards (Kirby et al., 1999). *k*-values can range from 0 (selection of the delayed reward option for all items, or no discounting) to 0.25 (selection of the immediate reward option for all items, or always discounting). According to many studies using the Delay Discounting Task, the distributions of *k*-values were approximately normalized using the natural log transformation (*nlog k*-values) for the statistical significance tests in this work. In addition, according to previous results showing a magnitude effect on discount rates (*k*-values decrease as the amount of the rewards increase), delay discounting was estimated for overall questionnaire and separately for three magnitude categories (Kirby, Petry, & Kirby, 2004): small delayed rewards (€25–35), medium delayed rewards (€50–60) and large delayed rewards (€75–85).

2.2.6. Other sociodemographic and clinical variables

Additional demographic, clinical, and social/family variables related to gambling were measured using a semi-structured face-to-face clinical interview described elsewhere (Jiménez-Murcia, Aymamí-Sanromà, Gómez-Peña, Álvarez-Moya, & Vallejo, 2006).

2.3. Statistical analysis

Statistical analysis was carried out using Stata13.1 for Windows. Due the strong association between sex with impulsivity measures and age, all the analyses were controlled including the participants' sex as a covariate to avoid biases due to this potential confounding factor.

First, partial correlations (R) estimated the association between positive urgency, negative urgency, and delayed discounting measures. Since significance levels for correlations coefficients are strongly related

to sample size, only coefficients with moderate (|R| > 0.24) to good (|R| > 0.30) effect size were considered as relevant in this study (Kelley & Preacher, 2012).

Second, Structural Equation Modeling (SEM) tested the hypothesized mediational model. The Maximum Likelihood method of parameter estimation was used and adequate goodness-of-fit was considered via the following criteria (Barrett, 2007): chi-square test (χ^2) with non-significant result being $p > 0.05$, Root Mean Square Error of Approximation (RMSEA) being <0.08, Bentler's Comparative Fit Index (CFI) being >0.90, Tucker-Lewis Index (TLI) being >0.90, and Standardized Root Mean Square Residual (SRMR) being <0.1. The global predictive capacity of the model was measured with the Coefficient of Determination (CD). An initial model for the total sample was estimated, and next a multiple-group model assessed the potential invariance of the participants' age group (18 to 30 versus 31 to 70).

3. Results

3.1. Sample description

Table 1 contains the frequency distribution of all the variables in the study for the total sample ($n = 328$) and a comparison of the two age groups. Significantly higher values appeared in the older age group with respect to the prevalence of previous consultation for gambling problems, gambling duration, personal income, and accumulated gambling debts. Higher mean scores in the three primary UPPS-P scales (lack of premeditation, lack of perseverance and sensation seeking) were found in the younger age group.

3.2. Distribution of discounting-rate measures

In this study, discounting-rate parameters (*k*-index) ranged from 0.00016 to 0.25 for the three rewards sizes (small-medium-large) (Table 1). 57 (17.4%) patients always chose the immediate reward for items with small reward, 58 (17.7%) for items with medium reward and 44 (13.4%) for items with large reward (for the overall questionnaire, immediate reward was always chosen by 42 patients, 12.8%). Around 15% of *k*-indexes represented participants who discounted very little (the percentage of responses choosing the later reward was 50% or higher), while around 60% represented patients who discounted high (the percentage of responses choosing the later reward was 30% or lower). Seven patients (2.09%) from the candidate sample were excluded due to inconsistent results (consistency indexes lower than 75% were considered inconsistent (Kaplan et al., 2016a)).

Fig. S1 (supplementary) shows the mean discount rate (*k*-index) for the three different reward sizes considered (small, medium and large). The mean trends in the line-graph concurred with other studies using real rewards: a *magnitude effect* emerged reflecting a decrease in discount rates as the reward amount increased.

Table 1
Descriptive for sample.

	Total ($n = 328$)		Age: 18 to 30 ($n = 67$)		Age: 31 to 70 ($n = 261$)		p-Value
Gender; *n*-%							
Males	292	89.0%	63	94.0%	229	87.7%	0.142
Origin; *n*-%							
Spain	320	97.6%	64	95.5%	256	98.1%	0.225
Education level; *n*-%							
Primary	183	55.8%	31	46.3%	152	58.2%	0.208
Secondary	111	33.8%	28	41.8%	83	31.8%	
University	34	10.4%	8	11.9%	26	10.0%	
Civil status; *n*-%							
Single	120	36.6%	50	74.6%	70	26.8%	<**0.001**
Married - with partner	175	53.4%	16	23.9%	159	60.9%	
Divorced - separated	33	10.1%	1	1.5%	32	12.3%	
Employment; *n*-%							
Employed	151	46.0%	30	44.8%	121	46.4%	0.816
Smoker; *n*-%	182	55.5%	34	50.7%	148	56.7%	0.381
Alcohol (AUDIT); *n*-%							
Null-low	281	85.7%	57	85.1%	224	85.8%	0.130
Risk	44	13.4%	8	11.9%	36	13.8%	
Dependence	3	0.9%	2	3.0%	1	0.4%	
Other drugs use-abuse; *n*-%	37	11.3%	8	11.9%	29	11.1%	0.848
Previous consultation for GD; *n*-%	61	18.6%	3	4.5%	58	22.2%	**0.001**
Age (years-old); Mean-SD	42.24	13.73	23.91	4.64	46.94	11.08	<**0.001**
Age of onset (years-old); Mean-SD	36.98	13.99	21.30	5.12	41.01	12.64	<**0.001**
Duration of gambling (years); Mean-SD	14.10	10.37	5.97	3.42	16.19	10.53	<**0.001**
Own incomes (euros); Mean-SD	1144.8	857.3	753.0	508.0	1245.4	899.6	<**0.001**
Family incomes (euros); Mean-SD	1966.8	1108.1	2021.7	1171.8	1952.7	1093.0	0.650
Bets: maximum-episode (euros); Mean-SD	1146.3	4005.3	1296.6	3925.9	1107.7	4032.0	0.731
Bets: mean-episode (euros); Mean-SD	121.3	390.9	105.2	284.3	125.4	414.2	0.705
Cumulate debs (euros); Mean-SD	12,941.9	50,211.5	2011.5	5365.6	15,747.8	55,900.8	**0.046**
UPPS-P: lack premeditation	23.95	6.32	26.12	6.13	23.40	6.26	**0.002**
UPPS-P: lack perseverance	22.29	5.36	23.76	5.50	21.91	5.27	**0.012**
UPPS-P: sensation seeking	26.88	8.44	31.88	7.84	25.60	8.12	<**0.001**
UPPS-P: positive UR	32.13	10.43	30.94	9.83	32.44	10.58	0.294
UPPS-P: negative UR	33.25	7.20	32.70	7.37	33.39	7.17	0.488
Delay discounting: k-index small	0.0941	0.0892	0.0821	0.0796	0.0971	0.0913	0.219
Delay discounting: k-index medium	0.0770	0.0916	0.0671	0.0804	0.0795	0.0943	0.323
Delay discounting: k-index large	0.0613	0.0864	0.0591	0.0778	0.0619	0.0887	0.813
Delay discounting: k-index overall	0.0727	0.0886	0.0637	0.0756	0.0750	0.0916	0.352

Note. SD: standard deviation. p-Value obtained with χ^2 test for categorical variables and *t*-test for quantitative variables.
Bold: significant comparison (0.05 level).

Table 2
Partial correlations (adjusted for sex) between delayed discounting measures with impulsivity.

	Age: 18 to 30 years-old ($n = 67$)				Age: 31 to 70 years-old ($n = 261$)			
	k-Small	k-Medium	k-Large	k-Overall	k-Small	k-Medium	k-Large	k-Overall
UPPS-P: lack premeditation	0.22	0.23	**0.32**††	**0.30**††	0.07	0.09	0.05	0.08
UPPS-P: lack perseverance	0.09	0.09	0.22	0.16	0.09	0.10	0.07	0.09
UPPS-P: sensation seeking	0.03	−0.02	−0.03	0.01	−0.01	−0.02	−0.02	−0.02
UPPS-P: positive UR	**0.28**†	0.18	**0.27**†	0.24	0.10	0.10	0.11	0.12
UPPS-P: negative UR	**0.47**††	**0.38**††	**0.42**††	**0.44**††	0.13	0.11	0.11	0.12

Note. Bold: †moderate ($|r| > 0.24$) to ††good effect size ($|r| > 0.30$).
Natural log transformation for k-index is analyzed (*nlog* k).

3.3. Association between delayed discounting with impulsivity

Table 2 contains the partial correlations (adjusted for sex) between delayed discounting and the UPPS-P. No relevant associations were found in patients in the older GD patient group. However, in the younger GD group, significant positive correlations emerged between lack of premeditation with *k*-large and *k*-overall measures, positive urgency with *k*-small and *k*-large scores, and negative urgency with all discounting scores) (Table 3).

3.4. SEM analysis

The first panel in Fig. 1 contains the path-diagram (standardized coefficients and fitting indexes) obtained in the SEM estimated for the total sample, measuring the contribution of the patients' age, delay discounting (the *k*-overall index) and urgency levels with gambling severity (number of DSM-5 total criteria). As one of the objectives of the current study was to determine age differences between associations of impulsivity and gambling severity, invariance by the participants' age was measured (see Table S1, supplementary). The second panel in Fig. 1 includes the results of the two-group SEM, which obtained adequate goodness-of-fit indexes and moderate global predictive capacity (CD around 0.16).

For the younger group, higher GD severity was directly associated with higher impulsivity levels (in both positive and negative urgency). Delay discounting scores did not directly contribute to GD severity, but indirect effects emerged through mediational paths via impulsivity: high delay discounting predicted higher positive and negative urgency levels, which also contributed to increased GD severity. For the older group, a lower number of significant paths emerged. As in the younger group, delay discounting significantly contributed to urgency levels in the older GD group; however, GD severity was only directly related to negative urgency levels. Table S2 (supplementary) contains the complete parameters for the two-group SEM, and Table S3 (supplementary), the decomposition of effects for the mediating variables of the diagram-paths in direct, indirect and total effects.

4. Discussion

This study analyzed whether there were variations in impulsivity domains between younger and older-aged treatment-seeking GD patients. More specifically, we sought to examine the interplay between GD severity, impulsive traits and delay discounting in two age groups.

Keeping with our first hypothesis, no significant differences in choice impulsivity were found between younger and older-aged GD patients. Suitable reasons as to why these two groups obtained similar results in delay discounting can be explained by taking GD severity into account. Both groups had similar GD severity levels and previous studies have reported higher levels of impulsivity choice in GD patients, suggesting that this association scales to GD severity levels (Amlung et al., 2017; Petry, 2001).

Moreover, in accordance with previous research (Mackillop et al., 2016; Michalczuk, Bowden-Jones, Verdejo-Garcia, & Clark, 2011), our findings uphold that there were positive correlations between impulsive traits and choice impulsivity in younger gamblers. Namely, the traits that showed a greater association with choice impulsivity were lack of premeditation, positive urgency and negative urgency. This is in line with other epidemiological research suggesting that negative urgency is positively associated with GD severity (Billieux et al., 2012).

Table 3
Partial correlations (adjusted for participants' sex) between impulsivity and delayed discounting with clinical measures.

	Impulsive behavior scale (UPPS-P)					Monetary change questionnaire			
	Pre-medit.	Per-sever.	Sens. seek.	Posit. UR	Negat. UR	k-Index small	k-Index medium	k-Index large	k-Index overall
Age: 18 to 30 ($n = 67$)									
Onset GD (years-old)	−0.24	**−0.41**††	−0.20	**−0.29**†	−0.09	−0.08	−0.06	−0.06	−0.08
Duration GD (years)	0.20	0.10	0.08	0.24	0.16	**0.26**†	**0.34**††	**0.25**†	**0.28**†
Maximum bets (€)	0.23	0.13	0.08	0.11	−0.04	0.17	0.20	**0.27**†	0.21
Mean bets (€)	**0.33**††	0.02	0.18	0.01	−0.04	0.09	0.16	0.16	0.17
Cumulate debts (€)	0.11	−0.05	0.05	−0.12	−0.05	0.15	0.15	0.19	0.20
SOGS: total	0.15	0.17	0.02	0.24	**0.30**††	0.09	0.10	0.14	0.11
DSM-IV criteria: total	0.12	0.09	0.05	**0.33**††	**0.34**††	0.15	0.08	0.18	0.13
Alcohol level: AUDIT total score	−0.06	0.00	**0.31**†	0.14	0.13	0.21	0.14	0.19	0.23
Age: 31 to 70 ($n = 261$)									
Onset GD (years-old)	−0.19	−0.12	−0.19	0.01	−0.08	−0.12	−0.09	−0.07	−0.09
Duration GD (years)	0.10	0.14	0.14	0.07	0.08	0.11	0.12	0.12	0.12
Maximum bets (€)	0.00	0.02	0.06	0.02	−0.05	−0.06	−0.06	−0.08	−0.07
Mean bets (€)	0.03	0.02	0.12	0.11	0.03	0.03	0.01	−0.07	−0.01
Cumulate debts (€) m	0.01	0.01	0.02	0.04	−0.06	−0.06	−0.08	−0.10	−0.07
SOGS: total	0.18	0.08	**0.29**†	0.22	**0.27**†	0.17	0.13	0.14	0.16
DSM-IV criteria: total	0.21	0.12	0.16	**0.27**†	**0.34**†	0.10	0.06	0.06	0.08
Alcohol level: AUDIT total score	0.02	0.00	−0.02	0.10	0.07	0.13	0.13	0.13	0.13

Note. Bold: †moderate ($|r| > 0.24$) to ††good effect size ($|r| > 0.30$).
Natural log transformation for k-index is analyzed (*nlog* k).
UPPS-P scales: lack of premeditation, lack of perseverance, sensation seeking, positive UR, negative UR.

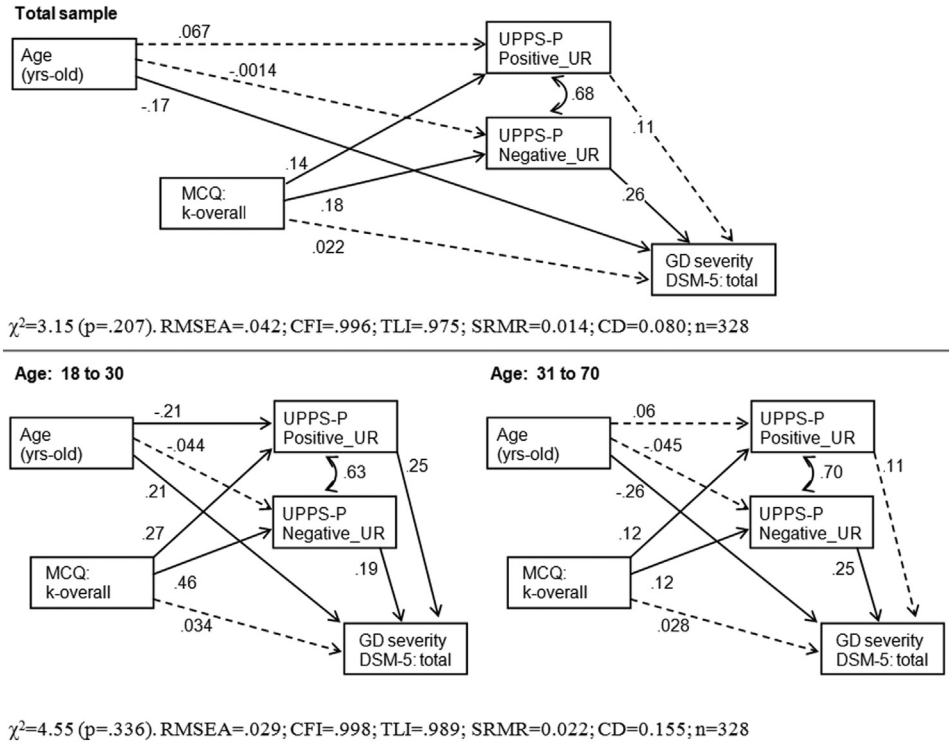

Fig. 1. SEM, standardized coefficients and goodness-of-fit indexes (results adjusted by sex). Continuous line = significant coefficient. Discontinuous line: non-significant coefficient.

This leads us to postulate that impulsive choice behavior is frequently linked to negative affective states and those with high levels of urgency are more likely to make poor choices. Relatedly, taking the arousing effects of gambling activity into account, other research supports that younger people who engage in impulsive behaviors in response to intense positive emotions are more likely to present gambling problems (Canale et al., 2015b). Other possible reasons for the positive correlation with urgency and delay discounting in young people could be related to increased emotional reactivity and reduced ability to regulate emotional experiences. These two factors are characteristic of the early stages of development and are observed in young populations (Henry, Castellini, Moses, & Scott, 2016).

Given that other research has identified noteworthy differences related to gambling motives (Clarke, 2008), action impulsivity (Kräplin et al., 2014a; Odlaug, Chamberlain, Kim, Schreiber, & Grant, 2011) and overall gambling behavior (Bischof et al., 2014; Black et al., 2015; Edgerton, Melnyk, & Roberts, 2014) in younger populations compared to older populations, our study sought to assess the mediating role of choice and trait impulsivity in determining GD severity for these two age groups via path analyses. Our analyses point to a direct association between positive urgency (i.e. the tendency to lose control over behavior or act rashly when feeling exhilarated) and GD severity levels in patients under the age of the 30, though this association was not significant in patients over the age of 30. This finding suggests that the desire to prolong or intensify positive emotions may carry more weight in the impulsive choices of younger gamblers than in older gamblers. This observation dovetails with other research in young people that found that individuals who were unable to inhibit behavior in response to extremely positive moods showed higher enhancement and coping motives, which in turn were positively related to gambling problems (Canale et al., 2015a). Furthermore, higher levels of delay discounting directly correlated with positive and negative urgency in both age groups in our path analyses, suggesting that reported higher levels of temporal discounting in GD patients is linked to a tendency to act out during heightened emotional states as opposed to engaging in rash actions at other times. This finding underscores the importance of taking context into consideration when analyzing choice impulsivity and stresses the need to examine environment-based controlling variables instead of accepting overly simple explanations for differences in delay discounting levels (Andrade & Petry, 2014; Charlton et al., 2013; Dixon et al., 2006; Halfmann, Hedgcock, & Denburg, 2013; Kaplan, Reed, & Jarmolowicz, 2016; Rung & Young, 2015).

Lastly, the present data uphold the position that lack of premeditation, understood as the tendency to act without thinking or as a failure to plan ahead, is associated with impaired decision-making in young gamblers, a feature reported in many, but not necessarily all, GD patients (Del Prete et al., 2017; Zermatten, Van der Linden, d'Acremont, Jermann, & Bechara, 2005). Younger gamblers might be more likely than older gamblers to choose smaller-immediate rewards over larger-delayed rewards, partly due to the fact that they act without proper forethought. It may be conceivable to personalize adolescent gambling treatment according to personal impulsivity-related traits.

4.1. Limitations

The present study is not without its limitations. First, the cross-sectional nature of this study prohibits arriving to conclusions regarding causality and the direction of the effects examined. Longitudinal studies are needed to provide important insights on the interplay between impulsive choice, gambling problems, and impulsive traits. Other research, for example, has suggested that delay discounting, financial mismanagement, and addictive behaviors can contribute to one another (Grant & Chamberlain, 2014). Second, delay discounting and impulsivity were assessed using self-report measures that are, in all likelihood, unable to fully capture the spontaneous, non-rational decision-making processes of GD patients (Dixon et al., 2006; Slovic & Peters, 2006). Recent studies have found that applying episodic future thinking or altering the predictability of immediate reward can change delay discounting behavior, indicating that impulsive choice should be considered as reference-dependent (Kaplan et al., 2016b; Lempert, Glimcher, & Phelps, 2015). Third, it would have been of interest to take pharmacotherapy into account, being that GD patients frequently

show comorbidities with other disorders (e.g. attention deficit hyperactivity disorder) and that the use of medications could potentially have influenced impulsivity levels (Gray & Climie, 2016). Lastly, our sample was largely made up of male GD patients and the generalizability of our results to other populations should be avoided.

5. Conclusions

This study provides greater understanding of the multidimensional construct of impulsivity. Our findings suggest that choice impulsivity is associated with impulsive personality traits in younger-aged patients. These results point to the possible existence of differing impulsivity mechanisms in younger and older gamblers, and highlight the weight of positive and negative urgency on influencing impulsive choices in younger gamblers. Ultimately, detailed information on how the three-factor model of impulsivity (Mackillop et al., 2016) acts in behavioral addictions will allow for improving prevention and integrated treatment efforts.

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Contributors

SJM, JMM, TS, GMB, RG and FFA designed the study and were involved in developing the research aims. SJM, TS, GMB, JCP, CSM, JFN, FFA and RG aided in the literature search and the framing of the Introduction and Discussion section. RG, TS and VMR conducted the statistical analysis and interpretation of the results. SJM, MB, GMB, and RG contributed to the data collection. TS, GMB, FFA, JCP, JFN, CSM, JAFF, RG and SJM were involved in writing, proofreading and approving the final manuscript. All authors aided in preparing the revised manuscript. All authors have read and approved the final manuscript.

Conflict of interest

The authors have no conflicts of interest to declare.

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Gambling and Impulsivity Traits: A Recipe for Criminal Behavior?

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Gambling disorder (GD) is a psychiatric condition that was recently recategorized as a non-substance-related addiction in the Diagnostic and Statistical Manual of Mental Health Disorders. Criminal activity is commonly associated with gambling; however, few empirical studies to date have examined sociodemographic and psychological variables in this population. In this study, we explored criminal behavior history in a sample of consecutively recruited treatment-seeking gamblers (n = 382) and compared subjects with a history of illegal acts (n = 103, 26.9%) to those with no criminal record (n = 279, 73.1%). Impulsivity and personality traits were specifically explored, along with other gambling-related severity factors. We found that gamblers who engaged in illegal activity were more likely to endorse high levels of urgency (i.e., the tendency to act out when experiencing heightened emotional states) and increased lack of premeditation. Gamblers with a history of criminal behavior also had greater GD severity levels and gambling-related debts. Additionally, these gamblers reported lower levels of self-directedness, which is characterized by difficulty in establishing and redirecting behavior toward one's goals. Likewise, gamblers who had conducted criminal acts showed a tendency to engage in greater risk-taking behavior. These results shed new light on this understudied population and provide insights for developing targeted harm-prevention interventions and treatment protocols.

Keywords: gambling disorder, impulsivity, criminal behavior, psychopathology, risk factors

INTRODUCTION

Gambling Disorder (GD) Conceptualization

Gambling disorder is characterized by a maladaptive pattern of gambling behavior that persists despite negative consequences in major areas of life functioning. It was recently recategorized as a non-substance-related addiction in the Diagnostic and Statistical Manual of Mental Health Disorders (DSM-5) (1). This disorder more frequently occurs in men (2) and is often characterized by specific personality traits, high impulsivity levels, and cognitive distortions, such as illusion of control (3–5).

One of the DSM-IV-TR diagnostic criteria for pathological gambling (6) included carrying out criminal acts in order to support gambling behavior. However, after much debate, the scientific community considered that this criterion provided little accuracy, leading to the removal of the "illegal acts" criterion from DSM-5 (1). Many researchers in the field of criminology believe that committing criminal offenses in order to finance gambling behavior should be considered as an indicator of disorder severity, instead of as an independent diagnostic criterion (7, 8). Moreover, it has been argued that GD-related criminal acts seldom occur in the absence of other GD criteria (9). However, the clinical and societal importance of this criterion has been subject to considerable discussion (10). After a classification and regression tree analysis, Themcheff et al. (11) highlighted that the "illegal acts" criterion showed high discriminative capacity between social and problem gamblers, and suggested that policy makers take this information into account. Nonetheless, this framework requires additional empirical support before informed decisions can be made.

Criminal Behavior Related to GD

The self-reported prevalence of criminal behaviors in individuals diagnosed with GD ranges from 14 to 30% (8, 12). This relatively high mismatch between results could be explained bearing in mind that crime and GD are related in a complex and multifactorial way, including high comorbidity with other disorders, the presence of associated risk behaviors, sociodemographic factors, and gambling-related circumstances (e.g., financial debts) (12–14). In an attempt to coalesce a functional theoretical framework, most of the existing body of research on this topic has focused on two main associations between these factors (15). On one hand, gambling behaviors could be part of a criminal lifestyle, related to antisocial personality disorder (16); on the other, criminal activity could be precipitated by GD, especially when money becomes scarce (13). Data suggest that the latter is more habitual, since individuals with GD usually do not have a criminal record or a history of norms transgression prior to developing gambling problems (17).

When considered within the framework of the general strain theory, gamblers who face negative events or emotions, such as extreme financial difficulties, might be more prone to turn to illegal activity to support their habit (18, 19). Likewise, these difficulties could also subsequently increase the probability of carrying out illegal acts in order to try to relieve financial hardships (20). GD-related crimes are frequently reported as being committed in desperation in order to amend financial predicaments brought about by gambling-related losses, or, in some cases, to fund additional gambling episodes (21).

Nevertheless, not all individuals with GD and financial burdens engage in criminal behavior. Several attempts have been made to explain the risk factors associated with GD-related crime in greater depth. For example, substance abuse has been found to be prevalent in patients with GD (14, 22). This frequent comorbidity adds another complex factor as to why gamblers may commit crimes, although no longitudinal studies to date have established a causal relationship between substance abuse and gambling-related criminal acts. Results from another study suggested that stimulant substance abuse may potentially facilitate gambling-related illegal acts due to their disinhibitory effects (12). Similarly, GD severity positively correlates, in most cases, with the occurrence of criminal behaviors (23). Therefore, engagement in criminal acts to support one's gambling behavior is, in all likelihood reflective of GD severity reaching its nadir (8, 12, 21, 24, 25). During early stages of the disorder, crime is commonly reported to be carried out with remorse, and gamblers often claim that they have the intention of returning fraudulently obtained goods when their debts, derived from gambling behavior, have been settled. This logic for justifying criminal behavior greatly differs from others who commit crimes such as petty theft or fraud (26). However, when GD is consolidated and debts are increased, an individual with GD has more difficulties regulating their behavior according to their basic moral principles and signs of repentance are blurred (21, 27).

In addition to GD comorbidity and other clinical factors, sociodemographic and personality features are also associated with crime (12). One study identified different subtypes of GD patients who committed crimes, taking sociodemographic variables, personality traits and clinical information related to GD into account (28). Psychopathology levels and poor impulse control were some of the main characteristics that best distinguished GD groups with a criminal record. Although some findings in the criminology literature have suggested that GD patients present different typologies of criminal behavior, obtaining money to finance gambling behavior is usually the primary motive for these crimes (29). Specifically, the most common criminal offenses in this population are petty theft, theft, fraud and forgery (30). GD patients do not usually show a propensity for violent behavior; however, financially motivated violent crimes do occasionally occur in this population (31).

Assuming the "generality of deviance" perspective (32), which suggests that varied forms of risk-taking behaviors tend to cooccur among individuals, the spectrum of deviant and criminal behaviors appears to have a common denominator: the tendency to seek immediate reward or relief without concern for long-term negative consequences (33). Therefore, the authors suggest that self-control is a main factor in determining the likelihood of engaging in criminal acts (34). These behavioral patterns, such as personality traits associated with risk (sensation seeking, impulsivity and low self-control) and multiple domains of risky attitudes, are also common in patients with GD (35–37). The authors highlight the existence of a key wedge factor of common variance "the generality of deviance" in gamblers, suggesting that shared personality traits, such as greater risk taking, may be a driver of deviant behavior (38). In this vein, Mishra et al. (39) suggested that GD was strongly associated with progambling and risk-taking attitudes.

Impulsivity is increasingly understood to be an early risk factor for the development of both GD (40) and delinquency (41). Impulsivity is a multidimensional construct encompassing facets such as the dysregulation of outward behavior due to decreased inhibitory control or a prejudicial decision-making style (e.g., choosing immediate gratification over larger, delayed rewards) (35). In recent years, the UPPS-P framework of impulsivity has become one of the most utilized models of impulsivity in psychiatric research. This questionnaire divides impulsivity levels into

five subscales: lack of premeditation, lack of perseverance, positive and negative urgency, and sensation seeking (42). Specifically, urgency, defined as emotionally charged impulsive behaviors in response to positive or negative moods, has been found to be crucial in distinguishing between clinically dysfunctional GD patients and recreational gamblers (43).

During adolescence (the age at which most individuals begin to gamble) (44), cognitive impulsivity has also been found to be associated with a more rapid acceleration into criminal behavior (41). Likewise, urgency and lack of premeditation are known to significantly correlate with each other in adolescents (45). Researchers have also observed that an impulsive decision-making style and high levels of urgency are associated with an increased acceptance of erroneous beliefs (e.g., believing that a series of losses must be followed by a win) during gambling behavior, thereby worsening economic consequences (46, 47). Given that gamblers encompass a very heterogeneous group of patients, one might postulate that gambling-related illegal acts could be more commonplace in younger, impulsive gamblers than in older gamblers whose gambling motivations might be driven by altered emotion regulation capacity (29, 35). To our knowledge, however, no studies to date have examined the role that impulsivity plays in criminal behavior within the context of gambling.

GD, Criminal Behavior, and the Spanish Court System

Within Spanish civil law/civil code, legal mechanisms exist which aim to limit the capacity of an individual with GD to inflict financial damage onto themselves or others. Namely, revoking legal guardianship or declaring civil incapacity allows for capital losses resulting from GD to be protected (48). Similarly, GD patients have the option to voluntarily bar themselves access to gambling establishments, either online or land-based, as part of a state-sponsored harm reduction program. Enrollment in the program can be indefinite; although participants may opt out of it at any time.

The Spanish Criminal Code does not specifically mention gambling as a mitigating or extenuating circumstance capable of reducing the gravity of an offense with regards to sentencing or moral opprobrium. However, in practice, the Spanish court system tends to apply discretion by imposing minimum penalties in cases characterized by reduced freewill that exhibit a clear causal relationship between the committed crime and gambling addiction (17).

Aims and Hypothesis

The primary aim of this study was to compare impulsivity traits in a sample of treatment-seeking GD patients who committed illegal acts to those who did not. Furthermore, we aimed to explore differences between these groups in terms of sociodemographic and psychological variables, and the type of illegal act committed in order to ascertain which variable(s) best predicted the presence of a history of criminal behavior.

As stated above, high levels of debt and significant financial problems because of gambling behavior is often indicated a primary motive for committing a crime (21); therefore, we hypothesized that the GD patients with a history of criminal behavior would present higher levels of debt than those without a criminal record. We also hypothesized that GD patients with a history of criminal behavior would be characterized by greater levels of GD severity, impulsivity, and overall psychopathology (8, 12). Likewise, we hypothesized that those gamblers with a history of committing multiple offenses would present increased psychopathology, GD severity and levels of accumulated debt (49).

MATERIALS AND METHODS

Participants and Procedure

The sample consisted of 382 patients with a diagnosis of GD who were being treated at the Gambling Disorder Unit within the Department of Psychiatry at Bellvitge University Hospital (Barcelona, Spain). This public hospital is certified as a tertiary care center for the treatment of addictive behaviors and oversees the treatment of very complex cases. Patients were derived to the Bellvitge University Hospital Gambling Disorder Unit through general practitioners or *via* another healthcare professional; some patients were derived from prison health services, though their treatment was not compulsory in the majority of cases. Nonetheless, in a few cases, a judge may have dictated the need for specific GD treatment at our unit. All treatment services for GD within the public Spanish healthcare system are provided free of charge.

Sociodemographic, clinical and criminal additional information was taken, and patients individually completed all the questionnaires required for this study (requiring approximately 2 h) before initiating outpatient treatment. Only patients who sought treatment for GD as their primary mental health concern and who met DSM-5 criteria for GD (1) were included in our sample. Exclusion criteria were: the presence of an organic mental disorder, intellectual disability, a neurodegenerative condition, such as Parkinson's disease, or an active psychotic disorder. Participants were classified in two groups according the presence ($n = 279$) or absence ($n = 103$) of criminal behaviors related to GD. Criminal behavior was assessed *via* a structured interview with a staff clinical psychologist.

The present study was carried out in accordance with the latest version of the Declaration of Helsinki. The University Hospital of Bellvitge Ethics Committee of Clinical Research approved the study, and written informed consent was obtained from all participants.

Measures

GD Severity

DSM-5 Criteria (1)

Patients were diagnosed with pathological gambling if they met DSM-IV-TR criteria (6). It should be noted that with the release of the DSM-5 (1), the term pathological gambling was replaced with GD. All patient diagnoses were reassessed and recodified *post hoc* and only patients who met DSM-5 criteria for GD were included in our analysis.

South Oaks Gambling Screen (SOGS) (50)
This self-report 20-item screening questionnaire discriminates between probable pathological, problem and non-problem gamblers. The Spanish validation used in this work showed excellent internal consistency ($\alpha = 0.94$) and test–retest reliability ($r = 0.98$) (51).

Impulsivity Traits

Impulsive Behavior Scale (UPPS-P) (52)
The UPPS-P measures five facets of impulsive behavior through self-report on 59 items: negative urgency; positive urgency; lack of premeditation; lack of perseverance; and sensation seeking. Individuals are asked to consider acts/incidents during the last 6 months when rating their behavior and attitudes. The Spanish-language adaptation shows good reliability (Cronbach's α between 0.79 and 0.93) and external validity (53).

Psychopathology

Symptom Checklist-Revised (SCL-90-R) (54)
This is a 90-item questionnaire measuring psychological distress and psychopathology. The items assess nine symptom dimensions: somatization, obsessive-compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, and psychoticism. The global score [Global Severity Index (GSI)] is a widely used index of psychopathological distress and was the only variable from this questionnaire used in this study. The Spanish adapted version was used in this study (55).

Personality

Temperament and Character Inventory-Revised (TCI-R) (56)
The TCI-R is a reliable and valid 240-item questionnaire measured on a 5-point Likert-type scale to evaluate personality traits. It is structured using seven primary personality dimensions: four temperamental factors (novelty seeking, harm avoidance, reward dependence, and persistence) and three character dimensions (self-directedness, cooperativeness, and self transcendence). The Spanish revised version used in this study (57) showed adequate internal consistency (Cronbach's alpha a mean value of 0.87).

Alcohol and Other Drugs use-abuse

Alcohol Use Disorders Identification Test (AUDIT) (58)
This test was developed as a simple screening method for excessive alcohol consumption. Internal consistency has been found to be high, and test–retest data have suggested a high reliability (0.86) and a sensitivity of around 0.90. Specificity in different settings and for different criteria averages 0.80 or more (59). In this work, cutoff points of 8 and 20 were used to identify individuals with alcohol abuse and alcohol dependence, respectively (60).

Drug Use Disorders Identification Test (DUDIT) (61)
The DUDIT is an 11-item screening instrument developed to identify non-alcohol drug use patterns and various drug-related problems in the general public, as well as in individuals in clinical settings who are likely to meet criteria for a substance dependence diagnosis (61). The first nine items are scored on a 5-point Likert scale ranging from 0 to 4, and the last two are scored on 3-point scales (values of 0, 2, 4). Total scores can range from 0 to 44, with higher scores being indicative of a more severe drug problem. The following risk levels have been suggested for DUDIT scores: no drug-related problems (total scores 0–5/1); possible drug-related problems, that is, risky or harmful drug habits that might be diagnosed as substance abuse/harmful use or dependence (6/2–24); likely heavily dependent on drugs (scores ≥ 25) (61).

Other Sociodemographic and Clinical Variables

Additional demographic, clinical, and social/family variables related to gambling were measured using a semi-structured face-to-face clinical interview described elsewhere (62). The gambling behavior variables covered included the age of onset of gambling behavior and of gambling-related problems, the average amount of money spent in a single gambling episode, the maximum amount ever bet in a single episode, and the total amount of accumulated gambling debts. In addition, the interview explored lifetime criminal activity related to GD in order to supplement the information obtained through the eighth DSM-IV-TR criterion (6). Crime-centered typologies were used to group subjects into three categories: those who conducted petty theft (the most frequent criminal behavior in our clinical population); those who committed other offenses (including counterfeiting or crimes against the public, among others); and those with multiple types of offenses.

Statistical Analyses

Statistical analyses were carried out with Stata 13.1. Comparison between groups was based on chi-square tests (χ^2) for categorical variables, *t*-test procedures for two mean comparisons in independent groups, and analysis of variance for mean comparisons in three or more independent groups.

The predictive capacity of impulsivity (UPPS-P raw scores) for the presence of illegal acts was based on binary logistic regression (adjusted for the covariates age of onset, GD duration, cumulate debts from gambling and GD severity). Goodness of fit was assessed through Hosmer–Lemeshow test ($p > 0.05$ was considered adequate fitting), global predictive capacity through Nagelkerke's pseudo-R^2 coefficient and global discriminative capacity through the area under the ROC curve.

Increases in Type-I error due to multiple statistical comparisons was controlled through Finner's correction, a procedure included in Familywise error rate stepwise procedures which offers more powerful results than Bonferroni correction (63). Effect size for comparisons between groups was estimated through Cohen's-*d* coefficient (moderate effect size was considered for $|d| > 0.50$ and good for $|d| > 0.80$), and through the 95% confidence interval (95% CI) for the logistic regression.

Since this study was planned posterior to the data recruitment, the calculation of the required sample was not possible. However, a power calculation for statistical analysis based on two independent mean comparisons was carried out with the following parameters: total sample size equal to $n = 382$, bilateral contrasts and expected mean values for the groups equal to 50 and 55 (these means were selected based on T-standardized scores commonly employed in clinical research, whose distributions include the parameters: mean $\mu = 50$ and SD $\sigma = 10$ in community samples). Estimated power resulted in 0.983 (risk $\beta = 0.017$, less than 2%).

For the chi-square test which compares two independent proportions (set at 60 and 75%), the power estimated resulted in 0.870 (risk $\beta = 0.130$).

RESULTS

Sample Description

The first section of **Table 1** includes the sociodemographic characteristics of the sample stratified by the presence/absence of a history of illegal behavior. Most participants were born in Spain (95.3%), had finished primary school (57.6%), were single or separated/divorced (59.2%), were employed (55.5%) and were in a middle-low to low socioeconomic status level (51.3%) (Hollingshead, Unpublished manuscript)[1]. No statistically significant differences in sociodemographic characteristics between patient groups were found.

The second section of **Table 1** includes GD-related variables. No differences in chronological age, monthly income, and mean amount spent per gambling episode between groups were found. However, patients who reported engaging in illegal activities endorsed a younger age of gambling onset and longer duration of GD. Patients with a criminal record also had higher GD severity levels on the SOGS as well as greater gambling-related debts.

[1]Hollingshead, A. A. *Four-factor index of social status*. Unpublished manuscript, Yale University, New Haven, CT (1975).

Comparison between Patients with and without a History of Criminal Behavior

Table 2 includes a comparison of impulsivity/personality traits, psychopathology, and substance use behaviors in patients who reported a history of engaging in illegal activity. Patients with a criminal history reported higher levels in positive and negative urgency, lack of premeditation and lack of perseverance compared to GD patients with no criminal record. GD patients who reported having committed gambling-related crimes also had higher levels of psychopathology (according to the SCL-90-R). In terms of personality traits, GD patients with a criminal record presented higher levels of novelty seeking and lower levels of self-directedness and cooperativeness compared to GD patients without a criminal record. No differences between groups were found with regards to substance use/abuse.

Predictive Capacity of Impulsivity Levels on Criminal Behavior

The upper part of **Table 3** includes the logistic regression measuring the predictive capacity of impulsivity levels (measured through the UPPS-P scales) on the presence of illegal acts in the

TABLE 1 | Sample description.

	No illegal acts (n = 279)		Illegal acts (n =103)				
	n	%	*n*	%	χ^2	*df*	*p*
Nationality							
Spain	267	95.7	97	94.2	0.39	1	0.533
Other	12	4.3	6	5.8			
Education level							
Primary	163	58.4	57	55.3	1.97	2	0.373
Secondary	96	34.4	34	33.0			
University	20	7.2	12	11.7			
Civil status							
Single or divorced	168	60.2	58	56.3	0.48	1	0.491
With a partner (married)	111	39.8	45	43.7			
Employment							
Unemployed	119	42.7	51	49.5	1.43	1	0.231
Employed	160	57.3	52	50.5			
Socioeconomic status							
High	5	1.8	2	1.9	2.10	2	0.349
Mean	137	49.1	42	40.8			
Low	137	49.1	59	57.3			

Numeric variables	No illegal acts (n = 279)					Illegal acts (n = 103)					$T_{(df = 380)}$	SE	*p*
	Min	Max	Median	Mean	SD	Min	Max	Median	Mean	SD			
Age (years old)	18	75	42	42.70	14.08	19	75	39	39.73	12.25	1.89	1.47	0.059
Age of GD onset (years old)	12	70	28	30.23	12.12	13	67	26	26.79	10.07	2.49	1.27	0.013[a]
GD duration (years)	1	27	3	5.86	6.38	1	25	6	8.27	7.42	3.03	0.85	0.003[a]
Monthly income (€)	0	30,000	1,200	1,409	2,270	0	21,000	1,100	1,296	2,170	0.42	265.46	0.677
Maximum spent in a episode (€)	20	60,000	400	1,197	4,287	10	60,000	750	2,659	7,945	2.30	635.56	0.022[a]
Average spent per episode (€)	10	5,000	25	155	512	3	5,000	30	171	516	0.27	59.12	0.787
Cumulate debts (€)	0	60,000	675	6,256	12,404	0	60,000	2,175	13,348	19,148	3.95	1794.46	<0.001[a]
DSM-5 total criteria (α = 0.834)	4	9	7	6.45	2.26	4	9	8	7.77	1.33	5.58	0.24	<0.001[a]
SOGS total score (α = 0.800)	2	17	10	10.17	3.02	4	19	13	12.57	2.76	7.01	0.34	<0.001[a]

[a]*Significant comparison (0.05 level).*

Min, minimum; Max, maximum; df, degrees of freedom; α, Cronbach's alpha in the sample.

TABLE 2 | Clinical comparison between patients with and without illegal acts.

	α	No illegal acts (n =279)		Illegal acts (n =103)		$T_{(df=380)}$	SE	p	|d|	Power
		Mean	SD	Mean	SD					
Impulsivity: UPPS-P subscales										
Lack of premeditation	0.852	23.07	6.39	25.77	6.54	3.64	0.742	<0.001[a]	0.42	0.953
Lack of perseverance	0.852	21.47	5.27	23.16	6.14	2.65	0.636	0.008[a]	0.29	0.753
Sensation seeking	0.778	27.29	8.59	28.56	8.91	1.28	1.000	0.203	0.15	0.753
Positive urgency	0.851	31.01	10.44	34.46	10.14	2.88	1.195	0.004[a]	0.33	0.820
Negative urgency	0.922	32.30	7.05	34.09	7.01	2.21	0.812	0.028[a]	0.25	0.795
Psychopathology: SCL-90R										
GSI score	0.860	0.92	0.63	1.28	0.76	4.73	0.077	<0.001[a]	0.52[b]	0.997
Personality traits: TCI-R scales										
Novelty seeking	0.705	108.05	12.97	114.29	11.36	3.92	1.594	<0.001[a]	0.51[b]	0.974
Harm avoidance	0.808	99.12	16.76	100.50	15.85	0.72	1.906	0.470	0.08	0.888
Reward dependence	0.788	98.90	14.83	98.25	15.27	0.37	1.726	0.710	0.04	0.934
Persistence	0.885	107.94	20.46	107.46	22.51	0.20	2.427	0.844	0.02	0.946
Self-directedness	0.862	133.86	20.34	120.05	21.24	5.81	2.376	<0.001[a]	0.66[b]	0.908
Cooperativeness	0.797	132.03	14.48	126.85	18.09	2.89	1.793	0.004[a]	0.32	0.821
Self-Transcendence	0.818	60.61	13.70	63.26	15.40	1.62	1.636	0.106	0.18	0.634
Substances: use-abuse		***n***	**%**	***N***	**%**	χ^2	***df***	***p***	|d|	**Power**
Tobacco use		159	57.0	59	57.3	0.00	1	0.959	0.01	0.053
Alcohol: AUDIT total		5.26	6.44	5.86	6.81	0.59	1	0.557	0.09	0.060
Other drugs: DUDIT total		3.31	7.15	3.64	6.74	0.296	1	0.768	0.05	0.060

p includes Bonferroni–Finner correction for multiple comparisons.

[a]*Significant comparison.*

[b]*Effect size in the moderate (|d| > 0.50) to high (|d| > 0.80) range.*

df, degrees of freedom; |d|, Cohens'-d measuring effect size; α, Cronbach's alpha in the sample.

TABLE 3 | Predictive capacity of impulsivity profile (UPPS-P scores) on the presence of illegal acts: logistic regression adjusted for age of gambling disorder onset and GD duration.

	B	SE	Wald	*p*	OR	95%CI (OR)	
Covariates							
Age of GD onset	−0.018	0.012	2.173	0.140	0.982	0.959	1.006
GD duration (years)	0.052	0.018	8.490	0.004[a]	1.053	1.017	1.090
UPPS-P							
Lack of premeditation	0.059	0.026	5.261	0.022[a]	1.061	1.009	1.116
Lack of perseverance	−0.018	0.029	0.375	0.540	0.982	0.928	1.040
Sensation seeking	0.003	0.016	0.036	0.850	1.003	0.973	1.034
Positive urgency	0.044	0.018	5.639	0.018[a]	1.045	1.008	1.083
Negative urgency	−0.017	0.028	0.363	0.547	0.983	0.931	1.039
Fitting indexes: H-L; ΔR^2; AUC	0.167	0.121	0.684				

[a]*Significant parameter. N = 382.*

H-L, Hosmer–Lemeshow test (p-value); ΔR^2, increase in the Nagelkerke's R^2 coefficient comparing blocks 1 and 2; AUC, area under the ROC curve.

entire sample. The model was carried out in two blocks/steps: the first block included and set the covariates age of onset and GD duration and second block added the five UPPS-P subscales. After adjusting for the covariates, the odds of having a history of criminal behavior was increased for patients with higher scores in the lack of premeditation and positive urgency impulsivity subscales. Goodness of fit was obtained (Hosmer–Lemeshow: $p = 0.167$), and the model showed moderate predictive capacity (the increase/change in the R^2 coefficient comparing first and second block was $\Delta R^2 = 0.12$) and moderate discriminative capacity (AUC = 0.68).

Table S1 in Supplementary Material contains a new predictive model including also two additional GD-related measures as covariates into the first block: cumulate debts and disorder severity (SOGS total score). In the resulting logistic predictive regression, UPPS-P positive urgency raw score remained a significant predictor.

Comparison Based on Type of Illegal Act

Table 4 contains a comparison between the $n = 103$ GD patients who reported a history of illegal activity based on the type of crime(s) committed (theft, other, or multiple). A number of patients ($n = 25$) chose not to specify which type of gambling-related illegal act they committed and these patients were excluded from this analysis. Patients who reported committing multiple types of illegal acts obtained the highest means in cumulate debts due to gambling, and higher GD severity levels according to the SOGS.

DISCUSSION

This study analyzed differences in impulsivity and personality traits between treatment-seeking GD patients who committed illegal acts and those who did not. Moreover, we sought to examine the interplay between criminal typology, sociodemographic features, and psychological variables.

Regarding the multidimensional nature of risk factors for engaging in crime, as suggested by previous studies, sociodemographic (especially gender and age) (64), education (65), and economic factors (such as socioeconomic status) (12) were determinants of the incidence of crime. In Western populations, the

TABLE 4 | Clinical comparison for patients based on type of illegal act committed.

	Petty Theft		Other		Multiple		Petty theft vs. Other		Petty theft vs. multiple		Other vs. multiple	
	n =38		*n* =29		*n* =11							
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	***p***	**|*d*|**	***p***	**|*d*|**	***p***	**|*d*|**
Gambling: duration-severity												
Age (years-old)	38.53	15.90	40.45	8.57	38.45	6.12	0.536	0.15	0.987	0.01	0.655	0.27
GD onset (years-old)	26.86	12.82	26.05	7.14	24.22	8.38	0.760	0.08	0.502	0.24	0.650	0.23
GD duration (years)	7.92	7.61	8.25	6.95	11.00	9.15	0.862	0.05	0.277	0.37	0.346	0.34
Maximum spent/episode (€)	1,493	2,645	3,657	1,1055	1,503	2,911	0.220	0.27	0.997	0.00	0.393	0.27
Mean amount spent/episode (€)	110	183	326	921	79	113	0.134	0.33	0.877	0.20	0.233	0.38
Cumulate debts (€)	3,083	8,314	21,593	23,680	26,380	26,480	0.001[a]	1.04[b]	0.001[a]	1.19[b]	0.491	0.19
DSM-5 total criteria	7.68	1.36	7.55	1.48	7.36	1.36	0.703	0.09	0.507	0.24	0.706	0.13
SOGS total score	11.84	2.63	12.45	3.42	14.27	1.42	0.389	0.20	0.015[a]	1.15[b]	0.074	0.70[b]
Substances: use-abuse	***n***	**%**	***n***	**%**	***N***	**%**	***p***	**|*d*|**	***p***	**|*d*|**	***p***	**|*d*|**
Tobacco use	20	52.6%	16	55.2%	5	45.5%	0.836	0.05	0.675	0.14	0.583	0.20
Alcohol use-abuse	6	15.8%	5	17.2%	2	18.2%	0.874	0.04	0.850	0.06	0.944	0.02
Other drugs use-abuse	9	23.7%	5	17.2%	1	9.1%	0.520	0.16	0.290	0.40	0.519	0.24

|d|, Cohens'-d measuring effect size.

p includes Bonferroni–Finner correction for multiple comparisons.

[a]*Significant comparison.*

[b]*Effect size in the moderate (|d| > 0.50) to high (|d| > 0.80) range.*

association between age and crime mainly follows a bell-shaped pattern, known as the age-of-crime curve, showing a reduction in criminal activity as an individual progress into adulthood (66, 67). Surprisingly, no differences were found between GD patients who committed crimes and those who did not, even though we hypothesized that the GD patients with a criminal record would be younger. It is worth noting, however, that our sample was made up patients voluntarily seeking treatment for GD and that we did not explore at what age these patients began engaging in illegal activity to finance their gambling behavior.

On the other hand, earlier studies have shown that education may counteract the risk of committing crimes, being that those with a higher level of education have higher expectations regarding the amount of income they can derived from legal ventures (65). Moreover, the inverse relationship between social stratification and delinquency turns out to be one of the main points of interest in criminology (68). However, contrary to expectations, this study did not find significant differences between groups in years of schooling. These results may partly be explained by the fact that our sample consisted of gamblers who sought treatment of their own volition and therefore our results are not necessarily representative of gamblers as a whole. Similar issues arise in the case of substance abuse as most individuals report first using drugs at a younger age and not seeking treatment until they are often much older (69). In this vein, an additional explanation could be that only crimes related to gambling behavior have been evaluated and those subjects whose main clinical problem was exclusively GD were included in the study.

Keeping with our hypothesis, patients who committed GD-related crimes reported greater GD severity, higher maximum bets and more cumulated debts in comparison with those who did not. This result dovetails with previous studies also reporting that GD patients with gambling-related crimes experienced more severe gambling symptoms than did other gamblers (15, 16, 21, 27). These findings suggest that greater gambling-related economic expenditures (more money spent during gambling episodes and more overall gambling-related debts) would increase an individual's likelihood of resorting to illegal behaviors in order to obtain money rapidly and, consequently, to be able to continue addictive-like gambling behavior.

Another finding to emerge from the present study is the difference in age of onset of GD between both groups, showing earlier onset in the illegal acts group. In our study, the measure to determine "onset" referred to the moment when the patients identified that gambling behavior had become harmful and uncontrollable. In this vein, previous studies showed that several factors are associated with early GD onset, including higher trait impulsivity and substance use disorders (70, 71).

Relatedly, our stepwise analyses identified both positive urgency and lack of premeditation to be predictors of the presence of illegal activity in GD patients. Both of these impulsivity traits have been found to commonly be higher in younger individuals and could potentially be seen as a risk factor, though longitudinal are needed to support this claim (35, 72). With regards to personality traits, GD patients with a history of criminal behaviors also reported lower levels of self-directedness. Self-directedness is characterized by possessing an external locus of control and, therefore, encountering more difficulties in planning, decision-making and achieving goals (56). This finding is consistent with other studies highlighting low levels of self-directedness across psychiatric disorders (73–75). Contrary to our hypothesis, no differences were found in substance use/abuse prevalence between GD patients who did and did not report committing gambling-related crimes. This may be partly due to the fact that we only assessed current substance-use patterns in our sample and that all of our patients were voluntarily seeking treatment.

Although some demographic risk factors have been identified for criminal recidivism (in particular gender, age, and race), in recent years there has been much debate about whether sociodemographic factors in themselves can fully account for the complexity

behind reoccurring criminal behaviors (76, 77). In our sample, GD patients who had committed multiple offenses endorsed greater GD severity levels and greater amounts of gambling-related debts. These results coincide with other studies supporting the existence of subgroups of gamblers that are distinguishable according to their gambling-related criminal behaviors (27).

Ethical Issues Raised by the Study

Our analysis seems to prompt at least two important moral issues. The first pertains to autonomy. If GD patients with a history of criminal behavior tend to report lower levels of self-directedness, it can be argued that their capacity for autonomous action is, in some sense, diminished. This is important because autonomy is tied to responsibility. The less autonomous an individual is, the less responsible we hold them for their actions. If GD patients who engaged in illegal acts tend to display lower levels of autonomy, we should take this fact into account when making attributions of responsibility. This overlaps with our previous discussion of the Spanish court system and its *de facto* concern for gambling-related instances of reduced free will. The second issue arises once we realize that both positive urgency and lack of premeditation are predictors of the presence of illegal activity in GD patients. Given the serious risk of adding stigmatization to this population, we should set a high bar in terms of predictive value before using such variables as proxy for policy-making. And if this becomes unavoidable, then efforts should be made to minimize the risk of stigmatization as much as possible. However, given the self-acknowledged limitations of this analysis, this should be considered (i.e., whether such predictors are robust enough for determining future policies) an open question.

Limitations

Our results must be interpreted in light of their limitations. The main weakness of this study was that exploring criminal behaviors through self-report in a clinical interview and not administering a validated psychometric instrument may have generated false negatives and limited the thoroughness of the obtained information. Second, our sample was made up exclusively of male GD patients, and taking into account that male gender is one of the indicators most associated with gambling-related crimes (12), the generalizability of the results to other populations is discouraged (78). Finally, the present study was focused exclusively on criminal behaviors carried out with the aim of financing debts derived from gambling or ensuring the continuity of gambling behavior. Future studies should consider the full scope of illegal behaviors carried out by GD patients, even those not directly related to gambling.

CONCLUSION

This study provides greater empirical understanding of the associations between GD, impulsivity, and criminal behavior. Our findings suggest that high levels of trait impulsivity, especially lack of premeditation and positive urgency, are predictors of the occurrence of crime in those who gamble. Further research should be undertaken to examine the effectiveness of interventions targeting impulse traits and recidivism risk management in gambling populations. Such detailed information would be useful in improving GD treatment and harm reduction interventions.

AUTHOR CONTRIBUTIONS

GM-B, TS, FF-A, RG, JM, and SJ-M designed the experiment based on previous results and the clinical experience of M-TN, AC, MB, LM, AP-G, NA, MG-P, CV-A, and NM-B. RG, GM-B, TS, FF-A, and SJ-M conducted the experiment, analyzed the data, and wrote a first draft of the manuscript. SJ-M, TS, GM-B, RG, PM, and FF-A further modified the manuscript.

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SUPPLEMENTARY MATERIAL

Supplementary Material for this article can be found online at http://www.frontiersin.org/articles/10.3389/fpsyt.2018.00006/full#supplementary-material.

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Original article

The predictive capacity of DSM-5 symptom severity and impulsivity on response to cognitive-behavioral therapy for gambling disorder: A 2-year longitudinal study

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ABSTRACT

Background: DSM-5 proposed a new operational system by using the number of fulfilled criteria as an indicator of gambling disorder severity. This method has proven to be controversial among researchers and clinicians alike, due to the lack of studies indicating whether severity, as measured by these criteria, is clinically relevant in terms of treatment outcome. Additionally, numerous studies have highlighted the associations between gambling disorder and impulsivity, though few have examined the impact of impulsivity on long-term treatment outcomes.
Methods: In this study, we aimed to assess the predictive value of DSM-5 severity levels on response to cognitive-behavioral therapy (CBT) in a sample of male adults seeking treatment for gambling disorder (n = 398). Furthermore, we explored longitudinal predictors of CBT treatment response at a follow-up, considering UPPS-P impulsivity traits.
Results: Our study failed to identify differences in treatment outcomes between patients categorized by DSM-5 severity levels. Higher baseline scores in negative urgency predicted relapse during CBT treatment, and higher levels of sensation seeking were predictive of drop-out from short-term treatment, as well as of drop-out at 24-months.
Conclusions: These noteworthy findings raise questions regarding the clinical utility of DSM-5 severity categories and lend support to the implementation of dimensional approaches for gambling disorder.

1. Introduction

Gambling disorder (GD) constitutes a psychiatric condition categorized in the latest version of the Diagnostic and Statistical Manual of Mental Health Disorders (DSM-5) [1] as a non-substance-related addiction. This disorder is characterized by a recurrent and persistent pattern of gambling behavior that leads to clinically significant distress. Patients with GD often suffer from

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cognitive distortions, such as illusions of control [2,3], high psychopathology levels [4–6], and dysfunctional personality traits (such as high novelty seeking) [7–9].

In addition to this clinical symptomatology, numerous studies have highlighted the associations between GD and impulsivity [10–13]. Specifically, there is evidence to support that trait impulsivity affects both the aetiology and maintenance of this behavioral addiction [14,15]. The most used framework in recent years for the study of GD has been the UPPS-P [16,17]. It categorizes impulsivity into five independent dimensions: sensation seeking, which refers to one's disposition to seek exciting experiences; (lack of) perseverance, that reflects the tendency to not persist in an activity that can be arduous; (lack of) premeditation shows the tendency to act without considering the consequences of the behavior; and positive and negative urgency, understood as emotionally charged impulsive behaviors in response to positive or negative moods [18,19].

In the case of GD, the scales that best distinguish treatment-seeking patients from healthy controls are lack of perseverance and positive and negative urgency, with GD patients endorsing greater levels in all three measures [15,20]. It is common for patients with GD to report using gambling behavior to mitigate states of anxiety or depression, possibly due to impaired emotion regulation mechanisms [20–22]. The role of sensation seeking, as assessed by the UPPS-P, is not clear in the case of GD and some studies do not support higher levels of this trait in comparison with healthy controls [20,23,24]. Finally, lack of premeditation has been shown to be associated with poor decision-making abilities, which is a common feature in patients with GD [16,17,25].

According to the DSM-5, the greater presence of GD symptomatology increases the severity of the disorder [1]. In this vein, existing research recognizes the bond between impulsivity and GD severity [26–28]. In view of this association and in order to carry out classification from a dimensional point of view, the DSM-5 proposed a new operationalization of clinical severity by numbering criteria. This system is used as an indicator of GD severity and is divided into three levels: mild (four to five criteria), moderate (six to seven), and severe (eight or nine) [1,29]. However, this new classification has proven to be controversial among researchers and clinicians alike, highlighting the need to assess whether severity, as measured by these criteria, is clinically relevant [29–31].

A wide range of treatment options are available for GD, including various psychological approaches (e.g. self-help groups and peer-support interventions) and pharmacological treatment [32]. However, not all patients with GD obtain long-term benefits from psychological interventions, with success rates at a 6-month 1-year follow-up ranging anywhere from 30% and to 71% [33–36]. A recent systematic review of evidence relating to pre-treatment predictors of gambling outcomes following psychological treatment identified older age, lower gambling symptom severity, lower levels of gambling behaviors and alcohol use, and higher treatment session attendance as likely predictors of successful treatment outcome [37]. Additionally, higher levels of sensation seeking (though not as measured by the UPPS-P) were associated with negative treatment outcomes at post-treatment or medium-term follow-up [37]. Findings such as these are practical for clinicians in choosing treatment strategies by allowing them to take into account the characteristics of the individual seeking treatment. Nonetheless, evidence regarding the clinical utility of current working definition of GD symptom severity boundaries is scare [29,31] and recent calls have been made to incorporate broader outcome domains that extend beyond disorder-specific symptoms in order to develop a single comprehensive to measure all aspects of gambling recovery [38].

Therefore, taking into account the findings described above, the aims of this study were threefold: 1) to explore the association between gambling-related variables and impulsivity traits in a sample of adult men who met criteria for GD; b) to estimate the predictive capacity of the impulsivity measures on GD treatment outcome (after 4 months of CBT treatment and at a two-year follow-up), namely considering relapse and dropout as outcome measures; and c) to examine the associations between DSM-5 severity categories on treatment outcome.

2. Material and methods

2.1. Participants and procedure

An initial sample of 519 patients diagnosed with GD from the Department of Psychiatry at a University Hospital, recruited between March 2013 and July 2017, was considered. They were voluntarily derived to the Gambling Disorder Unit through general practitioners or via other healthcare professionals. From this sample, 112 cases were excluded due to the fact that they decided not to enter treatment. Moreover, female patients (n = 8) and one case an incomplete evaluation were excluded. A total of 398 male patients were included in the final sample. Exclusion criteria for the study were the presence of a mental disorder (i.e. schizophrenia or other psychotic disorders) or intellectual disability. Patients were screened via a structured interview by experienced clinical psychologists and psychiatrists before being included in the study sample. These same therapists carried out the CBT therapy intervention.

The present study was carried out in accordance with the latest version of the Declaration of Helsinki. The University Hospital Clinical Research Ethics Committee approved the study, and written informed consent was obtained from all participants.

2.2. Treatment

The cognitive-behavioral therapy (CBT) group treatment program used in this study consisted of 16 weekly outpatient sessions at a University Hospital, lasting 90 min each. The follow-up period of visits included evaluations at 1, 3, 6, 12 and 24 months. CBT groups were led by an experienced clinical psychologist as well as a licensed co-therapist. To ensure treatment fidelity, treatment providers were trained on how to adhere closely to the treatment manual [39]. The goal of this treatment plan was to educate patients on how to implement CBT strategies in order to minimize all types of gambling behavior in order to eventually obtain full abstinence. The topics addressed in the treatment plan included: psychoeducation regarding the disorder (its course, vulnerability factors, diagnostic criteria, etc.), stimulus control (money management, avoidance of potential triggers, self-exclusion programs, etc.), response prevention (alternative and compensatory behaviors), cognitive restructuring focused on illusions of control over gambling and magical thinking, emotion-regulation skills training, and other relapse prevention techniques. This treatment program has already been described elsewhere [39] and its short and medium-term effectiveness has been reported in other studies [36,40,41]. Throughout treatment, attendance to treatment sessions, control of spending and the occurrence of relapses were recorded weekly on an observation sheet. A relapse was defined as the occurrence of a gambling episode once treatment had begun. This is common for many studies carried out with patients who meet criteria for GD [41–43]. Failure to attend three consecutive CBT sessions was considered a criterion for dropout.

2.3. Instruments

2.3.1. DSM-5 Criteria [1]

Patients were diagnosed with pathological gambling if they met DSM-IV-TR criteria for this disorder [44]. It should be noted that with the release of the DSM-5 [1], the term pathological gambling was replaced with GD. All patient diagnoses were reassessed and recodified *post hoc* and only patients who met DSM-5 criteria for GD were included in our analysis.

2.3.2. South oaks gambling screen (SOGS) [45]

This 20-item screening questionnaire discriminates between probable pathological, problem and non-problem gamblers based on the frequency and nature of gambling behaviors. The Spanish validation used in this work showed excellent internal consistency ($\alpha = 0.94$) and test-retest reliability ($r = 0.98$) [46].

2.3.3. Impulsive behavior scale (UPPS-P) [47]

The UPPS-P measures five facets of impulsivity through self-report on 59 items: negative urgency; positive urgency; lack of premeditation; lack of perseverance; and sensation seeking. Individuals are asked to consider acts/incidents during the last 6 months when rating their behaviors and attitudes. The Spanis H-L anguage adaptation showed good reliability (Cronbach's α between 0.79 and 0.93) and external validity [19]. Consistency in the study sample was between good ($\alpha = 0.75$ for lack of perseverance scale) to excellent ($\alpha = 0.92$ for positive urgency).

2.3.4. Other sociodemographic and clinical variables

Additional sociodemographic and variables related to gambling were measured using a semi-structured, face-to-face clinical interview described elsewhere [39].

2.4. Statistics

Statistical analyses were carried out with Stata15 for Windows. Firstly, the predictive capacity of GD severity (according to DSM-5 criteria) and UPPS-P impulsivity levels on relapse during CBT treatment, dropout during CBT and dropout in completing patients at the 24-month follow-up was assessed with binary logistic regression adjusted for the patients' age. These models were adjusted into two blocks: a) first block entered and fixed the covariate age; b) second block added the predictive independent variables through the ENTER method. The Hosmer-Lemeshow test assessed goodness-of-fit ($p > .05$ was considered adequate fit), global predictive capacity for the predictive variables entered into the second block was assessed through the changes in Nagelkerke's pseudo-R^2 coefficient (ΔR^2), and the global discriminative capacity of the final model was estimated via the area under the ROC curve (AUC).

Comparison between UPPS-P scores at baseline between the categorical GD severity groups (using DSM-5 criteria) was based on analysis of variance (ANOVA), adjusted for the participants' age, including pairwise comparisons to assess differences between the groups.

Finally, survival analyses measured the time to dropout and the first relapse during the CBT intervention, as well as the comparison of the GD severity groups at baseline. This study obtained the Kaplan-Meier (product-limit) estimator and used the Cox's regression adjusted for the participants' age to compare the survival cumulate curves between the three GD severity groups (i.e. mild, moderate, and severe). The survival function is a method used to measure the probability of patients *"living"* (surviving without the presence of the outcome, in this study without dropout and without the presence of gambling relapses) for a certain amount of time after the intervention. One of the most relevant advantages of this procedure is that it allows for the modeling of censored data, which occurs if patients withdraws from the study [48,49].

3. Results

3.1. Description of the sample

The mean age of the study sample was 41.5 years (SD = 13.1), the mean age of GD onset was 28.5 years (SD = 10.8), with a mean duration of 6.5 years (SD = 6.4). Table 1 includes a complete sociodemographic and clinical description of study sample.

3.2. Predictive capacity of GD severity and impulsivity levels treatment outcome

The number of participants who dropout during the CBT program was n = 182 (risk of dropout equal to 45.7%; 95% confidence interval, 95%CI: 40.8% to 50.6%) and the participants who reported gambling episodes during the course of the treatment was n = 119 (risk of relapses: 29.9%; 95% CI: 25.4% to 34.4%). The attrition from treatment completion to the 24-month follow-up was high (risk of dropout during the 2 years follow-up equal to 89.8%: 95%CI: 85.8% to 93.8%). Table 2 includes the binary logistic regression models assessing the predictive capacity of baseline GD severity (the number of DSM-5 criteria) and UPPS-P impulsivity levels on treatment outcome (all the models are adjusted for the covariate age). All models in this table obtained good fitting indexes ($p > .05$ in the H-L test).

Table 1
Sample description (n = 398).

Sociodemographic variables	*n*	%	Clinical variables	α	Mean	SD
Origin*Spain*	375	94.2%	Age (years-old)		41.52	13.12
Other country	23	5.8%	Gambling disorder onset (years)		28.48	10.76
Civil status*Single*	196	49.2%	Duration of gambling (years)		6.53	6.44
Married-partner	156	39.2%	Mean bets per episode (euros)		149.9	491.2
Separated-divorced	46	11.6%	Largest bet in an episode (euros)		1607.1	5301.8
Education level*Primary*	227	57.0%	Cumulate debts, at present (euros)		22,048.8	164228.9
Secondary	142	35.7%	DSM-5 total criteria	.744	7.27	1.52
University	29	7.3%	SOGS total criteria	.740	11.26	2.74
Employment*Unemployed*	173	43.5%	UPPS-P Lack of premeditation	.846	24.40	6.57
Employed	225	56.5%	UPPS-P Lack of perseverance	.778	22.13	5.64
			UPPS-P Sensation seeking	.860	27.63	8.89
			UPPS-P Positive urgency	.918	32.18	10.55
			UPPS-P Negative urgency	.806	33.14	7.10

Note. SD: standard deviation. Cronbach's alpha in the sample. SOGS: South Oaks Gambling Screen.

Table 2
Predictive capacity of DSM-5 GD severity and the UPPS-P scores on treatment outcome (second block of the regressions adjusted for age).

	B	*SE*	*Wald*	*p*	*OR*	*95%CI(OR)*		ΔR^2	H-L	AUC
Drop out during CBT										
Age (years-old)	*−0.017*	*0.009*	*3.728*	*.054*	*0.98*	*0.97*	*1.00*	.047	.083	.658
Severity of GD (DSM-5 total)	−0.062	0.079	0.606	.436	0.94	0.81	1.10			
UPPS-P Lack of premeditation	−0.001	0.021	0.003	.956	1.00	0.96	1.04			
UPPS-P Lack of perseverance	0.051	0.024	4.745	**.029***	1.05	1.01	1.10			
UPPS-P Sensation seeking	0.049	0.013	13.517	**<.001***	1.05	1.02	1.08			
UPPS-P Positive urgency	−0.002	0.015	0.012	.914	1.00	0.97	1.03			
UPPS-P Negative urgency	0.002	0.022	0.007	.936	1.00	0.96	1.05			
Relapses during CBT										
Age (years-old)	*−0.008*	*0.009*	*0.815*	*.367*	*0.99*	*0.97*	*1.01*	.026	.516	.602
Severity of GD (DSM-5 total)	−0.025	0.085	0.083	.773	0.98	0.83	1.15			
UPPS-P Lack of premeditation	−0.012	0.021	0.319	.572	0.99	0.95	1.03			
UPPS-P Lack of perseverance	0.036	0.025	2.097	.148	1.04	0.99	1.09			
UPPS-P Sensation seeking	0.014	0.014	0.983	.322	1.01	0.99	1.04			
UPPS-P Positive urgency	−0.012	0.015	0.569	.451	0.99	0.96	1.02			
UPPS-P Negative urgency	0.052	0.024	4.825	**.028***	1.05	1.01	1.10			
[1]Drop-out at 24-month follow-up										
Age (years-old)	*−0.026*	*0.019*	*1.856*	*.173*	*0.965*	*0.940*	*1.011*	.062	.331	.682
Severity of GD (DSM-5 total)	*−0.040*	*0.184*	*0.047*	*.828*	*0.961*	*0.671*	*1.377*			
UPPS-P Lack of premeditation	−0.058	0.051	1.305	.253	0.944	0.854	1.042			
UPPS-P Lack of perseverance	0.081	0.055	2.183	.140	1.085	0.974	1.208			
UPPS-P Sensation seeking	0.070	0.035	3.938	**.047***	1.072	1.001	1.149			
UPPS-P Positive urgency	−0.014	0.033	0.182	.670	0.986	0.924	1.052			
UPPS-P Negative urgency	−0.048	0.053	0.827	.363	0.953	0.859	1.057			

Note. [1]Model for patients who finished CBT treatment ($n = 216$).
ΔR^2: increase in the Nagelkerke's pseudo R^2 comparing blocks 1 and 2. H-L: Hosmer and Lemeshow test (*p-value*). AUC: area under the ROC.
* Bold: significant parameter (.05 level). Italics: coefficients for the covariate age. (Sample size: $n = 398$).

The risk of drop out during the CBT program (the first model in Table 1) was higher for participants who reported higher lack of perseverance and sensation seeking scores. The risk of having a gambling episode (relapsing) during CBT treatment was higher for participants with higher negative urgency levels (the second model in Table 2). Finally, the risk of drop out during the two-year follow-up after the CBT program (the third model in Table 2, obtained for the subsample of patients who finished CBT treatment therapy without dropout) was increased for patients who reported higher scores in sensation seeking.

3.3. Comparison of UPPS-P impulsivity levels between DSM-5 GD severity groups

Table 3 includes the ANOVA comparison, adjusted for age, comparing baseline UPPS-P impulsivity levels between the three GD severity groups (mild, moderate, and severe) (Table S1, Supplementary material, includes comparisons for additional clinical measures of these groups). As a whole, mean positive and negative urgency levels increased with GD severity.

3.4. Survival analysis comparing DSM-5 GD severity groups

Fig. 1 contains the survival function estimated with the Kaplan-Meier method for the rate of dropout and relapses during the CBT program, stratified by DSM-5 gambling severity group (mild, moderate and severe). No statistical differences for these outcomes were found comparing the three groups: Cox's regression adjusted for the participants' age obtained χ^2-wald = 0.02, $df = 1$, $p = .892$ for dropout and χ^2-wald = 0.02, $df = 1$, $p = .892$ for relapses.

4. Discussion

The present study estimated, in a sample of male patients seeking treatment for GD, the predictive capacity of impulsivity traits and gambling severity on treatment outcome, namely considering relapse and dropout. We also sought to examine the associations between impulsivity, GD severity and treatment response.

Regarding the predictive model, sensation seeking was a predictor of dropout, both during treatment and in follow-up

Table 3
Comparison of UPPS-P scores based on DSM-5 GD severity categories: ANOVA adjusted for patients' age.

GD severity →	Mild (4-5 criteria) ($n = 65$)		Moderate (6-7 criteria) ($n = 133$)		Severe (8-9 criteria) ($n = 200$)		Pairwise comparisons: Mild vs moderate		Mild vs severe		Moderate vs severe	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*p*	*|d|*	*p*	*|d|*	*p*	*|d|*
Lack of premeditation	22.60	6.81	23.76	6.45	25.42	6.34	.228	0.18	**.002***	0.43	**.023***	0.26
Lack of perseverance	20.86	6.24	21.59	5.70	22.91	5.30	.389	0.12	**.012***	0.35	**.038***	0.24
Sensation seeking	26.26	9.00	26.44	8.37	28.87	8.89	.886	0.02	**.032***	0.29	**.011***	0.28
Positive urgency	25.19	8.68	30.17	10.19	35.78	9.99	**.001***	**0.53**[†]	**<.001***	**1.13**[†]	**<.001***	**0.56**[†]
Negative urgency	27.70	6.81	31.86	6.29	35.76	6.51	**<.001***	**0.63**[†]	**<.001***	**1.21**[†]	**<.001***	**0.61**[†]

Note. SD: standard deviation. *Bold: significant comparison (.05 level).
[†] Bold: effect size into the moderate ($|d|>0.50$) to high range ($|d|>0.80$).

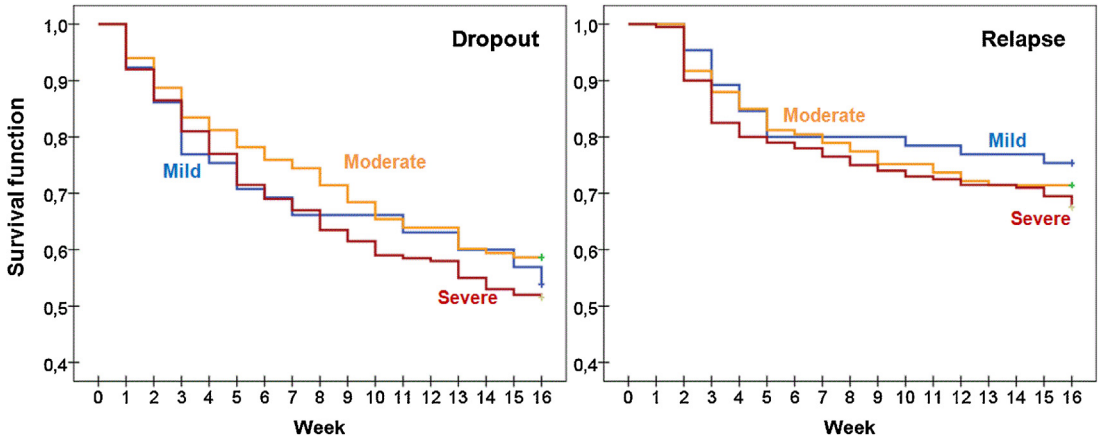

Fig. 1. Cumulative survival functions for dropout and relapse during the 16-week CBT program.

stages. To date, there is a paucity of scientific literature analyzing the association of this construct with GD treatment outcome. However, previous studies in the field suggest that patients with high levels of sensation present a clinical phenotype that could interfere with adherence to treatment guidelines [37,50,51]. These patients may be especially motivated at the start of treatment to become involved in a treatment program with the expectation of receiving the benefits of abstinence, but this interest in the novelty of treatment often quickly fades due to their personality profile [52]. Relatedly, lack of perseverance was another predictor of dropout during treatment and in the follow-up period. Other addiction studies have provided similar evidence, finding that treatment completers had significantly higher persistence levels than those who abandon therapy [53].

Finally, negative urgency was identified as a predictor of relapse during treatment in the present study. This finding broadly supports the results of other studies in addictions linking high levels of impulsivity with short-term and mid-term relapses [54]. More specifically, negative urgency has been associated with poorer therapy outcomes [55] and greater relapse risk. This leads us to postulate that patients with GD are more vulnerable to making rash decisions when experiencing negative mood states, such as frustration or anxiety, leading to more frequent relapses. Gambling behavior, in these cases, is therefore likely used as a means of negative reinforcement in order to regulate affective states. Moreover, it is known that in GD, as the disorder progresses, behavior is increasingly maintained by a pattern of negative reinforcement than positive reinforcement [56]. Therefore, impulsiveness could arise from seeking out relief from negative emotional states rather than from a need to obtain immediate reward [57]. From a phenomenological perspective, it is feasible that disinhibition plays a mediating role between these two dimensions [58,59], with numerous studies suggesting that inhibition is impaired in some patients with GD and that disinhibition, in turn, can be a risk factor for relapse [60,61].

Another finding to emerge from the present study is the difference in urgency levels bearing in mind DSM-5 severity categories (mild, moderate and severe). Specifically, the present data uphold the position that in those cases in which the severity of GD is greater, levels of urgency are also higher. This observation dovetails with other research that found that impulsivity was a predictor of GD severity and poor prognosis [62,63].

Although other studies have associated greater GD severity with poorer response to treatment [37], our study failed to indentify differences in treatment response using DSM-5 GD severity categorizations. The DSM-5 provides nine diagnostic criteria for GD and it is pre-assumed that all criteria have an equal diagnostic impact [31]. One of the drawbacks of this dichotomous approach is that factors, such as the frequency and the level of distress brought about by gambling behaviors [29,59]. Our findings raise further questions regarding the clinical validity of merely summing the number of criteria endorsed by an individual and whether DSM-5 GD severity categories accurately reflect actual GD symptom severity, if each is weighted equally. In the line of the study by Bottesi et al. [58], future studies should consider contrasting dimensional measures with DSM-5 categories in order to determine which best serves as a predictor of treatment response. Doing so could aid clinicians in shifting away from categorical definitions of gambling and allow for more tailored treatment programs that bear in mind the patients' individual features that place them at greatest risk.

4.1. Limitations

The present study is not without its limitations. First, all data were collected from men who sought treatment and future studies would benefit from including women with GD. Second, impulsivity traits were assessed using self-report measures that are, in all likelihood, unable to fully capture the multi-factorial nature of impulsivity in GD patients. Third, our study only examined the effectiveness of one type of intervention and it would be useful to know if similar results are present using a multiple-arm study design [64]. Finally, it would have been of interest to take pharmacotherapy into account, being that GD patients frequently show comorbidities with other disorders (e.g. depression, attention deficit hyperactivity disorder) and that the use of medications could potentially have influenced impulsivity levels.

5. Conclusions

This study aimed to identify short- and long-term predictors of response to treatment in sample of treatment-seeking patients with GD. In concordance with other studies, our findings indicate that increased sensation-seeking levels were a predictor of abandoning treatment, along with greater lack of perseverance scores. Furthermore, we found that greater negative urgency scores increased the risk of relapsing during the 16-week CBT treatment program. However, contrary to our initial hypothesis, increased severity, as categorized by the DSM-5, was not indicative of poorer response to treatment. These results raise doubts with

respect to the clinical utility of such severity categories and support the use of dimensional approaches in future studies.

Declarations of interest

None.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.eurpsy.2018.09.002.

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