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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 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 Impulsive Behavior Scale (UPPS-P) 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 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.

1. Introduction

Gambling disorder (GD) is strongly linked with dysfunction across multiple cognitive domains, many of which can be considered in terms of impulsivity (1,2). However, due to the numerous ways by which it can be measured, impulsivity is increasingly understood to be a multidimensional construct (3,4). Impulsive action is understood 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) (5). 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) (6). These latter two dimensions of impulsivity 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 (7). 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 (3). 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.

One of the most widely utilized indices of choice impulsivity is delay discounting (i.e. temporal discounting) (8). 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?') (9). 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 (10).

Multiple studies have found that GD patients present higher levels of delay discounting than control subjects (11), and that gamblers with steeper delay discounting show greater risk taking, poorer decision-making skills and higher levels of bet chasing (12). These alterations in delay discounting are believed to be underpinned by a hypoactive reward system, which modify reward representations and consequently influence behavior (9). 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 (13). These findings suggest that gamblers manifest impulsivity in specific ways according to their degree of severity, and that GD patients are characterized by both impulsive choice and impulsive traits (i.e. an inability to disengage from gambling behavior).

The neural areas associated with impulsivity continue to develop into the young adulthood (14); 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 (15,16). Another study specifically examining the mediating effects of decision-making in trait urgency and gambling problems in young adults also found age-related differences, with young people tending to act rashly in response to extreme moods and having lower levels of deliberative decision-making (17). The sample of this study however was only comprised of participants aged 16-25 and did not explore how associations between delay discounting and gambling behavior evolved into older adulthood.

Being that excessive delay discounting is a process that underlies the choice behavior co-occurring with a wide variety of clinical conditions, increased attention has been given to understanding how individuals' discount rates change with age. These 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 (18). 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 focusing on issues such as emotion regulation and control strategies (12).

The purpose of this research was two-fold. As much existing research has solely focused on the correlates of trait-level impulsivity and delay discounting with gambling behavior, 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 (19), we did not hypothesize that significant differences in choice impulsivity would exist between younger and older GD patients. Rather, we hypothesized that differences would emerge in the associations between trait impulsivity levels, delay discounting and GD severity between our two age groups.

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. 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 (30) (*n*=328) were included in our sample. The distribution of the GD severity: low level *n*=79 (24.1%, 4-5 DSM-5 criteria), moderate *n*=148 (45.1%, 6-7 criteria) and severe *n*=101 (30.8% 8-9 criteria). 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 (20); and b) neurodevelopment is generally understood to reach adulthood at the age of 30 (21).

2.2. Instruments

2.2.1. South Oaks Gambling Screen (SOGS) (22)

Self-report 20-item screening questionnaire that 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) (23).

2.2.2. Alcohol Use Disorders Identification Test (AUDIT) (24)

This test was developed as a simple screening method for excessive alcohol consumption. It includes 10 questions about the level of consumption, symptoms of dependence, and alcohol-related consequences. 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 (25). In this work, cut-off points of 8 and 20 were used to identify individuals with alcohol abuse and alcohol dependence, respectively (26).

2.2.3. Impulsive Behavior Scale (UPPS-P) (27)

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 translation shows good reliability (Cronbach's α between 0.79 and 0.93) and external validity (28). Consistency in the study sample was between good (α=0.75 for lack of perseverance scale) to excellent (α=0.92 for positive urgency).

2.2.4. Delay discounting task (10)

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 (10). *k*-values can range from 0 (selection of the delayed reward option for all items, or no discounting) to .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 (29): small delayed rewards (€25–35), medium delayed rewards (€50–60) and large delayed rewards (€75–85).

2.2.5. 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 (30). Some of the GD behavior variables covered included the mean and maximum monetary investment in a single episode of gambling, and the total accumulated debts.

2.3. Procedure

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.

2.4. 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 into the moderate ($|R|>0.24$) to good ($|R|>0.30$) effect size will be considered as relevant in this study (31).

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 (32): chi-square test (χ^2) with non-significant result being $p>.05$, Root Mean Square Error of Approximation (RMSEA) being <.08, Bentler's Comparative Fit Index (CFI) being >.90, Tucker-Lewis Index (TLI) being >.90, and Standardized Root Mean Square Residual (SRMR) being <.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 by the participants' group of age (18 to 30 versus 31 to 70).

3. Results

3.1. Sample description

Table 1 contains the frequency distribution of all the variables of the study, for the total sample (*n*=328) and a comparison of the two age groups. Comparing 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 for the younger age group.

--- Insert Table 1 ---

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 on the Delay Discounting Task (consistency indexes lower than 75% were considered inconsistent (33)).

Figure S1 (supplementary) shows the mean discount rate (*k*-index) for the three different reward sizes considered in this work (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 amount of the rewards increases.

--- Insert Figure 1 ---

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 younger GD patient 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.

--- Insert Table 2 ---

3.4 SEM analysis

The first panel in Figure 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 of Figure 2 includes the results of the two-group SEM, which achieved 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 measures). Delay discounting scores did not directly contribute to the 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 increase the GD severity. For the older group, a lower number of significant paths emerged. As in the younger group, delay discounting significantly contributed to the urgency levels in the older GD patient 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 into direct, indirect and total effects.

--- Insert Figure 1 ---

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 showed similar GD severity levels and previous studies have reported higher levels of impulsivity choice in GD patients, suggesting that this association scales to level of GD severity (8,11).

Moreover, in accordance with previous research (3,34), our findings uphold that there were positive correlations between impulsive traits and choice impulsivity in younger-aged patients. 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 specifically is positively associated with GD (35). 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 gambling effects into account, other research supports that younger people who tend to engage in impulsive behaviors in response to intense positive emotions are more likely to present gambling problems (17). However, no significant direct correlations between impulsivity traits and delay discounting were found for patients in the older group. Possible reasons for the positive correlation with urgency and delay discounting in young people are most likely 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 observable also in young population (36). Finally, the present data support the position that lack of premeditation, understood as the tendency to act without thinking before or as a failure to plan ahead, is associated with impaired decision-making, a feature of GD (37).

Given that other research has identified noteworthy differences related to gambling motives (38), action impulsivity (39,40) and overall gambling behavior (41–43) 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 is in line 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 (44). 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 may be 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 (19,45–49).

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 (5). 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 (19,50). 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 (45,51). 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 impulsivity construct. 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 (3) acts in behavioral addictions will allow for improving prevention and integrated treatment efforts.

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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%	.142
Origin*; n-%*	*Spain*	320	97.6%	64	95.5%	256	98.1%	.225
Education level*; n-%*	*Primary*	183	55.8%	31	46.3%	152	58.2%	.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%	**<.001**
	Married - in couple	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%	.816
Smoker*; n-%*		182	55.5%	34	50.7%	148	56.7%	.381
Alcohol (AUDIT) *; n-%*	*Null-low*	281	85.7%	57	85.1%	224	85.8%	.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%	.848
Previous consultation for GD*; n-%*		61	18.6%	3	4.5%	58	22.2%	**.001**
Age (years-old)*; Mean-SD*		42.24	13.73	23.91	4.64	46.94	11.08	**<.001**
Age of onset (years-old)*; Mean-SD*		36.98	13.99	21.30	5.12	41.01	12.64	**<.001**
Duration of gambling (years)*; Mean-SD*		14.10	10.37	5.97	3.42	16.19	10.53	**<.001**
Own incomes (euros)*; Mean-SD*		1144.8	857.3	753.0	508.0	1245.4	899.6	**<.001**
Family incomes (euros)*; Mean-SD*		1966.8	1108.1	2021.7	1171.8	1952.7	1093.0	.650
Bets: maximum- episode (euros)*; Mean-SD*		1146.3	4005.3	1296.6	3925.9	1107.7	4032.0	.731
Bets: mean- episode (euros)*; Mean-SD*		121.3	390.9	105.2	284.3	125.4	414.2	.705
Cumulate debs (euros)*; Mean-SD*		12941.9	50211.5	2011.5	5365.6	15747.8	55900.8	**.046**
UPPS-P: Lack premeditation		23.95	6.32	26.12	6.13	23.40	6.26	**.002**
UPPS-P: Lack perseverance		22.29	5.36	23.76	5.50	21.91	5.27	**.012**
UPPS-P: Sensation seeking		26.88	8.44	31.88	7.84	25.60	8.12	**<.001**
UPPS-P: Positive UR		32.13	10.43	30.94	9.83	32.44	10.58	.294
UPPS-P: Negative UR		33.25	7.20	32.70	7.37	33.39	7.17	.488
MCQ: k-index small		0.0941	0.0892	0.0821	0.0796	0.0971	0.0913	.219
MCQ: k-index medium		0.0770	0.0916	0.0671	0.0804	0.0795	0.0943	.323
MCQ: k-index large		0.0613	0.0864	0.0591	0.0778	0.0619	0.0887	.813
MCQ: k-index overall		0.0727	0.0886	0.0637	0.0756	0.0750	0.0916	.352

Note. SD: standard deviation. *p-value* obtained with χ^2 test for categorical variables and T-TEST for quantitative.

Bold: significant comparison (.05 level).

Table 2

Partial correlations (adjusted by 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*|>.24) to ††good effect size (|*r*|>.30).

Natural log transformation for k-index is analyzed (*nlog* k).

Table 3

Partial correlations (adjusted by 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)	-.24	**-.41††**	-.20	**-.29†**	-.09	-.08	-.06	-.06	-.08
Duration GD(years)	.20	.10	.08	.24	.16	**.26†**	**.34††**	**.25†**	**.28†**
Maximum bets (€)	.23	.13	.08	.11	-.04	.17	.20	**.27†**	.21
Mean bets (€)	**.33††**	.02	.18	.01	-.04	.09	.16	.16	.17
Cumulate debts (€)	.11	-.05	.05	-.12	-.05	.15	.15	.19	.20
SOGS: total	.15	.17	.02	.24	**.30††**	.09	.10	.14	.11
DSM-IV criteria: total	.12	.09	.05	**.33††**	**.34††**	.15	.08	.18	.13
Alcohol level: AUDIT total score	-.06	.00	**.31†**	.14	.13	.21	.14	.19	.23
Age: 31 to 70 (n=261)									
Onset GD (years-old)	-.19	-.12	-.19	.01	-.08	-.12	-.09	-.07	-.09
Duration GD(years)	.10	.14	.14	.07	.08	.11	.12	.12	.12
Maximum bets (€)	.00	.02	.06	.02	-.05	-.06	-.06	-.08	-.07
Mean bets (€)	.03	.02	.12	.11	.03	.03	.01	-.07	-.01
Cumulate debts (€)	.01	.01	.02	.04	-.06	-.06	-.08	-.10	-.07
SOGS: total	.18	.08	**.29†**	.22	**.27†**	.17	.13	.14	.16
DSM-IV criteria: total	.21	.12	.16	**.27†**	**.34†**	.10	.06	.06	.08
Alcohol level: AUDIT total score	.02	.00	-.02	.10	.07	.13	.13	.13	.13

Note. Bold: †moderate (|*r*|>.24) to ††good effect size (|*r*|>.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.

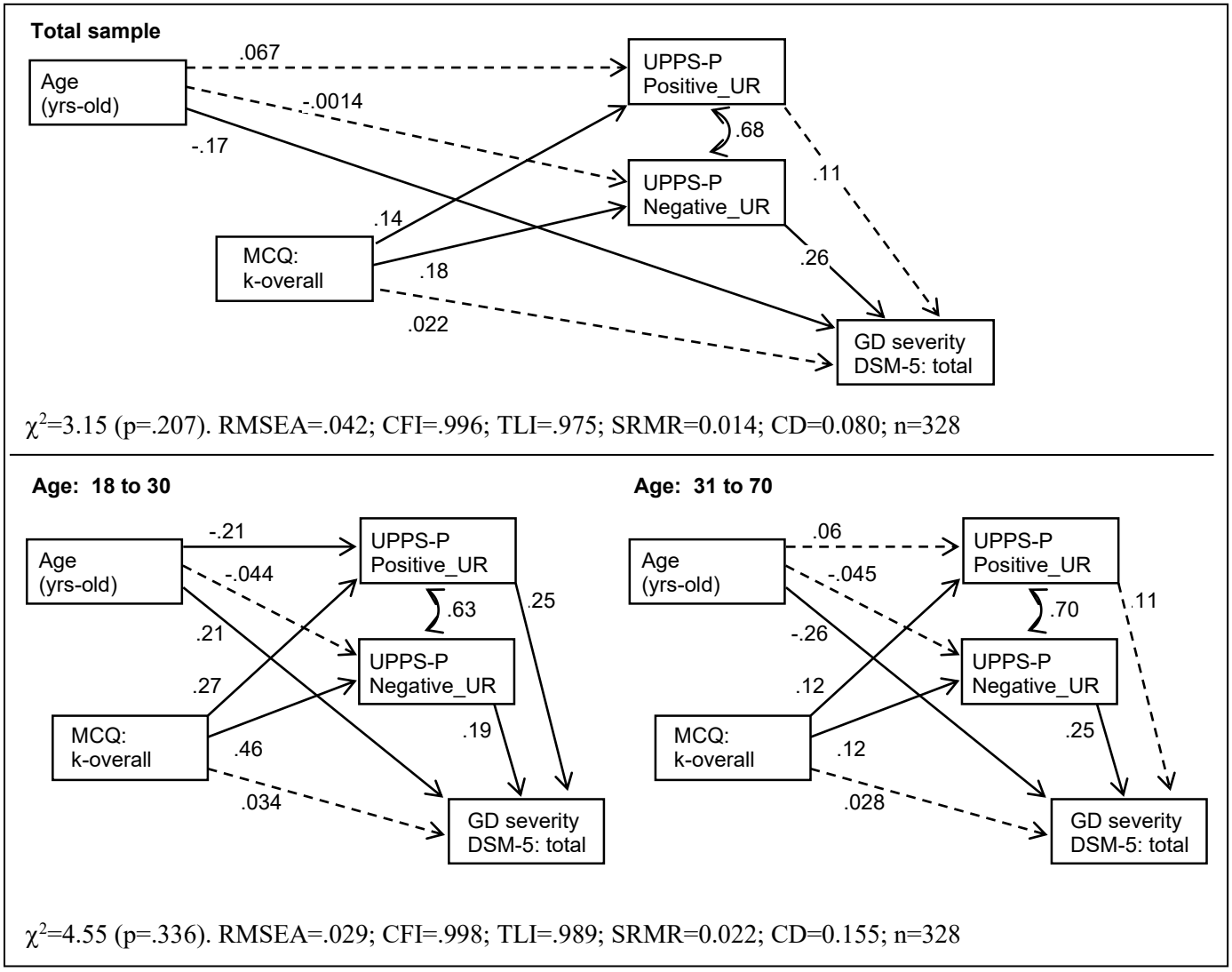

Figure 1

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

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**
	MCQ k-overall	1.538	.215
Negative_UR	Age (years-old)	0.052	.820
	MCQ k-overall	8.654	**.003**
DSM-5 criteria	Positive-UR	0.852	.356
	Negative-UR	0.112	.738
	Age (years-old)	7.296	**.007**
	MCQ k-overall	0.181	.671

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

Table S2 (supplementary)

Structural equation model; grouping variable: group of age

			Coeff.	SE	z	*p*	95%CI coeff.	
Positive_UR	Age (years-old)	18-30 yrs-old	-0.2071	0.1122	-1.96	**0.050**	-0.4269	-0.0028
		31-70 yrs-old	0.0599	0.0612	0.98	0.328	-0.0601	0.1799
	MCQk-overall	18-30 yrs-old	0.2666	0.1097	2.43	0.015	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	-0.0438	0.1090	-0.40	0.688	-0.2574	0.1698
		31-70 yrs-old	-0.0450	0.0613	-0.73	0.463	-0.1651	0.0751
	MCQ 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	-0.0453	0.2615
	Negative_UR	18-30 yrs-old	0.1942	0.1587	1.22	0.221	-0.1169	0.5053
		31-70 yrs-old	0.2516	0.0778	3.23	**0.001**	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	-0.2626	0.0533	-4.93	**<0.001**	-0.3671	-0.1582
	MCQ k-overall	18-30 yrs-old	-0.0338	0.1253	-0.27	0.787	-0.2795	0.2118
		31-70 yrs-old	0.0279	0.0559	0.50	0.618	-0.0818	0.1375
Cov	e.Pos_UR,e.Neg-UR	18-30 yrs-old	0.6306	0.0736	8.57	**<0.001**	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
MCQ 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
MCQ 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
MCQ 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).