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ORIGINAL ARTICLE

Decision-Making Deficits Among Young Adults With Food and Alcohol Disturbance: Insights From The Iowa Gambling Task

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Abstract

We measured decision-making impairments, a cornerstone symptom of addictive/eating disorders, in food and alcohol disturbance (FAD). Forty-five University students presenting FAD (35 females, mean age: 18.42yo) and 45 matched non-FAD individuals (33 females, mean age: 18.24yo) performed the Iowa Gambling Task (IGT), measuring decision-making under uncertainty/risk. We compared individuals with/without FAD, but also two subtypes of FAD, namely alcohol-compensation (FAD-COM) and alcohol-enhancement (FAD-ENH) behaviors. Individuals with FAD showed preserved decision-making when compared to individuals without FAD [$F(1,88) = 2.05; p = .156$]. However, a contrast emerged between preserved decision-making in FAD-COM [$F(1,73) < 2.44$, $p > .122$ for all IGT indexes] and biased decision-making in FAD-ENH, as shown by altered results on three variables indexing the ability to develop efficient strategies throughout the IGT [$F(1,73) > 4.40$; $p < .040$]. FAD is not globally associated with decision-making deficits, but individuals restricting caloric intakes to enhance alcohol intoxication present marked decision-making difficulties. The unitary approach of FAD should thus be overcome to explore the cognitive correlates of the distinct profiles it encompasses.

Highlights

- We measured decision-making in FAD using the Iowa Gambling Task in 90 adults.
- FAD as a whole is not associated with decision-making deficits.
- FAD individuals with alcohol-enhancement motives present reduced IGT performance.

Keywords Drunkorexia · Alcohol use disorder · Executive functions · Impulsivity · Iowa gambling task · Eating disorders

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Introduction Food and Alcohol Disturbance (FAD)

FAD, previously called “drunkorexia”, refers to the co-occurrence and functional relationship between disordered eating and alcohol use, involving shared motivations (Choquette et al., 2018). Dysregulated eating behaviors in FAD are indeed directly related to two main motivations and behaviors associated with alcohol consumption (Berry et al., 2024; Chambers, 2008), namely to mitigate alcohol-related caloric intakes (“alcohol compensation”, e.g., exercising, reducing food intakes or vomiting after drinking to compensate for the alcohol-related calories) and/or to enhance the effects of alcohol intoxication (“alcohol enhancement”, e.g., lowering food intakes before drinking to boost acute intoxication). FAD is highly prevalent in young adults (Moeck & Thomas, 2021), particularly in University students (Lupi et al., 2017), being frequently characterized by combined binge eating/compensatory exercise habits (Ritz et al., 2023) and binge drinking (Peralta et al., 2019). FAD has been widely explored during the past 20 years, generating large knowledge on its related expectancies and motivations (e.g., Berry & Looby, 2024; Looby et al., 2025), but also on its specific epidemiology, psychological/social predictors and measures. Theoretical models have confirmed that FAD is more than the mere comorbidity between disordered eating and excessive alcohol use (Thomson-Memmer et al., 2019). The psychosocial factors related to FAD have also been documented, showing associations with other substance-related or behavioral addictive states (e.g., social media use, Foster et al., 2022), psychopathological states (e.g., anxiety, Malaeb et al., 2022; stress, Hill & Mazurek, 2023) or interpersonal difficulties (e.g., peer pressure; Hill et al., 2021).

Neuropsychological Correlates of FAD

In striking contrast, the neuropsychological correlates of FAD remain totally unexplored, which appears surprising in view of the largely established cerebral and neuropsychological consequences of eating disorders (Prince et al., 2022) and hazardous alcohol consumption (Peréz-Garcia et al., 2022) in young adults. Both eating disorders and binge drinking (i.e., the most frequent alcohol consumption pattern in University students, characterized by the repeated alternation between intense intoxication episodes and abstinence periods, Maurage et al., 2020) are associated with reduced attentional (Bollen et al., 2020; Werthmann et al., 2019), memory (Carbia et al., 2017; Ritchie et al., 2019) and executive abilities (Salas-Gomez et al., 2016; Svaldi et al., 2015), favoring the worsening of these disorders (Bates et al., 2002; Eichen et al., 2017). FAD might hence be associated with large-scale neurocognitive deficits through the combination of the respective impacts related to disordered eating and alcohol use. Beyond this mere additive effect of eating and alcohol use disorders, FAD presents some specific characteristics that could lead to a multiplicative effect on cognition and brain functioning. Particularly, FAD could lead to higher acute alcohol intoxication than isolated binge drinking because of the food deprivation, promoting faster and higher peaks of alcohol levels in the brain (Szynal et al., 2022). As it is established that more frequent and intense alcohol intoxications generate stronger neurocognitive impact, FAD could thus generate greater impairments than eating and alcohol use disorders alone, but the current absence of data hampers to document this assumption. Moreover, FAD might be associated with specific pre-existing neurocognitive vulnerabilities (e.g., reduced inhibition abilities) favoring the initial engagement in this habit and its persistence. A vicious circle, already suggested in eating and alcohol use disorders, might be at stake in FAD, where pre-existing impaired cognitive abilities would initially promote the appearance of the first stages of this behavior, its rapid and massive impact on brain functioning (through the combination of food deprivation and binge drinking) then favoring its persistence by reducing the cognitive abilities involved in behavior regulation (e.g., planification, inhibition, memory). The current total lack of knowledge on the neurocognitive profile of young adults with FAD is detrimental, particularly regarding the cognitive functions directly involved in its expansion. Indeed, understanding the presence and extent of the cognitive and cerebral consequences of FAD would: (1) at the experimental level, allow to better understand the neuropsychological profile resulting from this behavior, to identify the most vulnerable cognitive abilities among individuals presenting FAD, and to renew the models describing the neurocognitive deficits related to eating and alcohol use disorders, which have up to now been developed in isolation; (2) at the clinical level, pave the way for neuropsychological prevention programs and interventions specifically targeting FAD and hence reducing the abovementioned vicious circle, as the currently available therapeutic proposals consider dysregulated eating and excessive alcohol use separately, failing to intervene jointly on these two disorders.

Decision-Making and the Iowa Gambling Task (IGT)

Among the cognitive functions potentially related to FAD, decision-making constitutes a key cognitive function involved in the development and persistence of both disordered eating and excessive alcohol use (Guillaume et al., 2015). It is defined as the ability to evaluate the costs and benefits of each alternative in a situation where a choice must be made, in order to reach decisions that maximize both personal and social outcomes (Barned et al., 2021). Eating and addictive disorders are decision-making diseases, being characterized by persisting engagement in eating behaviors or substance abuse despite harmful consequences (Verdejo-Garcia et al., 2018). Neurocognitive models, both in eating and alcohol use disorders, thus offer a central position to decision-making (Lindgren et al., 2019; Van Malderen et al., 2020), and large-scale impairments of this function have been reported in these conditions (Guillaume et al., 2015).

The IGT (Bechara et al., 1994, 1997) is the most used neuropsychological assessment for evaluating decision-making abilities in psychiatric states (Gowin et al., 2018; Kovacs et al., 2017), and notably in alcohol-related disorders (Gilbertson et al., 2019; Xiao et al., 2009). It assesses the ability to make adapted decisions under conditions of uncertainty/risk, as well as the capacity to gradually learn and apply the most effective strategy to improve performance. In this task, participants start with an amount of money and select cards from four decks, each card being associated with specific wins and/or losses, aiming to maximize their total gains. Two of these decks are disadvantageous (offering high rewards but also high losses, resulting in a net negative outcome over time) and two are advantageous (providing smaller gains with lower losses, ultimately leading to a net positive outcome). Participants begin the task without knowledge of the win/loss patterns across the decks and must learn these patterns progressively to refine their strategy for optimal gains.

Aims of the Study

As no previous study explored the presence of neurocognitive deficits in FAD, we used the IGT to offer the first insights regarding decision-making in young adults with FAD (this habit being particularly prevalent in this population, Lupi et al., 2017; Moeck & Thomas, 2021), this ability constituting a pivotal characteristic of eating and addictive disorders. To explore the specific impact of FAD as compared to isolated alcohol consumption, and to control the influence of biasing variables, we compared University students presenting FAD with a group of alcohol drinkers without FAD. We strictly matched these groups on demographic, psychopathological and substance-consumption variables. This highly controlled design allowed to address two unexplored questions, namely (1) Is FAD related to specific decision-making deficits? In other words, is FAD related to stronger cognitive impairments than isolated alcohol consumption?; (2) Are the previously described two main sub-dimensions of FAD associated with distinct decision-making profiles? As FAD is characterized by two main motivations and associated behaviors, namely to mitigate alcohol-related caloric intakes (alcohol compensation) and/or to boost alcohol intoxication (alcohol enhancement), we explored the relationship between these two subdimensions and decision-making.

Methods

Participants

We selected 90 first-year students at the Caen-Normandy University (22 males and 68 females, reflecting the higher proportion of women among first-year university students in France), as this population is particularly at risk for excessive alcohol use and FAD, divided into two groups of 45 individuals: a control group (CTRL) presenting regular alcohol consumption without FAD and an experimental group (FAD) of individuals with FAD. We indeed reasoned that comparing individuals presenting FAD with no/low alcohol drinkers would hamper to determine the specific influence of FAD on decision-making, beyond the impact of excessive alcohol consumption. A group composed of individuals presenting regular alcohol consumption without FAD behaviors thus constituted the best control group to address our research questions. These data are part of a larger research project developed at Caen-Normandy University between 2021 and 2024 ("Alcohol and Drugs at Caen-Normandy University"), inviting all University students to complete an online study exploring their demographics, psychopathological symptoms, and substance-consumption habits (Mange et al., 2021). Two hundred and fourteen students completed a neuropsychological evaluation in the laboratory, including the IGT and other cognitive tasks. Among them, we first selected participants fulfilling the following criteria:

(1) Being a first-year student at Caen-Normandy University (i.e., having 12 years of education level since starting primary school) and being between 18 and 21 years of age;
(2) Being regular alcohol drinker (i.e., having consumed alcohol at least once per month during the last 12 months) without presenting a high/very high-risk consumption or severe alcohol use disorder (i.e., having an AUDIT score between 1 and 15, see below the description of the AUDIT questionnaire).
(3) Having no family history of severe alcohol/cannabis use disorder (parents, siblings);
(4) Having no current psychiatric/neurological disorder;
(5) Having no consumption of psychotropic medication or drug (excluding alcohol, cannabis and tobacco) during the last 12 months;
(6) Having no acute (in the last 12 h) cannabis (assessed by a salivary test) or alcohol (assessed by a breathalyzer test) consumption;

(7) Presenting preserved cognitive abilities, namely a score of 15 or higher at the cognitive total score of the BEARNI (Brief evaluation of alcohol-related neuropsychological impairment, Ritz et al., 2015; Maximum score: 30);
(8) Being fluent in French.

Group Composition and Procedure

After applying the abovementioned selection criteria, we selected our participants and divided them into the two groups according to their score at the French version of the Compensatory Eating and Behaviors in Response to Alcohol Consumption Scale (CEBRACS; Ritz et al., 2023, see the "Questionnaires and cognitive measure" section below), measuring FAD. Participants with negative answers for all items of the CEBRACS (total score = 21) were considered as controls, participants with at least a positive answer on one item of the CEBRACS (total score > 21) were considered as presenting FAD. To avoid any influence of biasing variables on the results, we then constituted the final groups by matching them on:

(1) *demographics*, namely age, sex and education level;
(2) *psychopathological variables*, namely state/trait anxiety (measured through the State-Trait Anxiety Inventory, STAI-A/STAI-B, Spielberger & Gorsuch, 1983), depression (measured through the Beck Depression Inventory, BDI, Beck et al., 1961) and impulsivity (measured through the Urgency-Premeditation-Perseverance-Sensation Seeking-Positive Urgency, UPPS-P, Billieux et al., 2012);
(3) *alcohol consumption*, measured through the Alcohol Use Disorders Identification Test score (AUDIT, Saunders et al., 1993, evaluating alcohol consumption, drinking behaviors and alcohol-related problems, score range: 0–40, with the following thresholds: < 8 = low-risk consumption; 8–15 = hazardous drinking/moderate risk; 16–19 = harmful drinking/high risk; > 19 = probable alcohol dependence/very high risk);
(4) *binge drinking habits*, based on three questions adapted (Maurage et al., 2020) from the Alcohol Use Questionnaire (Mehrabian & Russell, 1978), respectively measuring consumption speed ["What is your consumption speed (number of doses per hour) during a typical drinking occasion?"], drunkenness frequency ("How many times have you been moderately or strongly drunk during the past 6 months?") and drunkenness percentage ("When you drink alcohol, what is the percentage of times you get moderately or strongly drunk?"). On this basis, we computed a binge drinking score (Townshend & Duka, 2005) through the following formula: 4 X consumption speed in units/hour + drunkenness frequency (number of drunkenness episodes during the last 6 months) + 0.2*drunkenness percentage (percentage of times being drunk compared to all drinking occasions)]. The cut-off scores (Townshend & Duka, 2005) distinguish non-binge drinkers (score ≤ 16) and binge drinkers (scores ≥ 24);
(5) *tobacco consumption*, measured through the Fagerström test score (Svicher et al., 2018), estimating tobacco dependence (score range: 0–10);
(6) *cannabis consumption*, measured through the Cannabis Abuse Screening Test score (CAST, Legleye et al., 2011) evaluating problematic cannabis use (score range: 0–24).

All participants gave their written consent before starting the survey. The research protocol obtained the approval of the Research Ethics Committee of the Caen-Normandie

University and Caen University Hospital (Number: 20250116165527000000220000433). We strictly followed the Declaration of Helsinki (2008) and the ethical standards set by the American Psychological Association Ethical Principles of Psychologists and the Code of Conduct for the ethical treatment of human participants. We debriefed participants about the study's objectives and procedure, and they received a financial compensation.

Assessments

Questionnaires: Demographic, Substance Consumption and Psychopathological Variables

In the laboratory, participants completed questionnaires measuring:

(1) *demographical variables*, namely age, sex and education;
(2) *substance consumption*, namely for alcohol consumption, the AUDIT score and the Binge Drinking Score, and for tobacco/cannabis consumption, the Fagerström/CAST tests, respectively;
(3) *psychopathological variables*, namely state-trait anxiety (STAI-A/STAI-B), depression (BDI) and impulsivity (UPPS-P);
(4) *eating disorders* with the SCOFF (Garcia et al., 2010) measuring the risk of developing eating disorders in at-risk and student populations (score range: 0–5).

Questionnaires: FAD

We measured FAD using the CEBRACS, a 21-item Likert scale investigating compensatory eating behaviors related to alcohol consumption over the past three months. Compensatory behaviors were assessed separately for three time periods (i.e., before/during/after drinking) with items including eating less than usual, skipping meals or entire days of eating, eating low-fat or low-calorie food, exercising, vomiting, and using diuretics or laxatives. Each item evaluated the behavior's frequency (from 1 = never to 5 = nearly always). The total score (α = .94) ranges from 21 to 105, a score higher than 21 reflecting engagement in FAD behavior (Knight et al., 2017; Moeck & Thomas, 2021; Pietrabissa et al., 2018; Rahal et al., 2012). The CEBRACS is divided into four subscales (Ritz et al., 2023): "alcohol effects" (α = .97); "dietary restraint and exercising" (α = .93), "purging" (α = .92) and "extreme fasting and vomiting" (α = .79). We addressed our second research question by constituting two subgroups of FAD individuals, respectively presenting a positive answer to at least one item of the "dietary restraint and exercising", "purging" or "extreme fasting and vomiting" subscales (hence presenting behaviors based on the compensation of alcohol-related calories intake and involved in compensation-related FAD; FAD-COM, N = 30) and a positive answer to at least one item of the "alcohol effect" subscale (hence presenting behaviors based on the enhancement of alcohol intoxication and involved in enhancement-related FAD; FAD-ENH, N = 30), following the identification of two main motivations/behaviors in the CEBRACS proposed in earlier studies (Berry et al., 2024; Chambers, 2008). As positive answers for these two subdimensions can be reported by the same individuals, 15 participants from the FAD group were included in both FAD-COM and FAD-ENH subgroups. We then compared these two subgroups of 30 individuals with the control group.

Cognitive Evaluation

Participants completed an evaluation of their global cognitive abilities through the BEARNI (Ritz et al., 2015), a screening tool specifically developed to measure the key cognitive functions frequently impaired in addictive states (visuospatial abilities, executive functions, ataxia, verbal episodic memory, and verbal working memory).

Experimental Measure: IGT

We administered a 100-trial paper-and-pencil version of the IGT, a format shown to boost motivation and performance compared to its computerized counterpart (Overman & Pierce, 2013). Participants were told they would play a card-drawing game where each draw would result in either a monetary gain and/or loss. As explained in the instructions, the goal was to maximize net income (balance of gains and losses). Participants were free to switch decks between trials, and they were informed that the gain/loss ratios differed across the decks and were not random, with some decks yielding more favorable outcomes. Each participant started with 2000 euros (in facsimile money) and was presented with four decks of 40 cards each (A, B, C, D). On each trial, participants selected a card from one of the decks; each card presented a monetary gain (e.g., "you win 50 euros") and potentially a monetary loss (e.g., "you lose 250 euros"). Immediately after each draw, the experimenter adjusted the participant's total money based on the win or loss, allowing participants to continuously monitor their accumulated amount. No feedback on overall performance was given throughout the task. Without the participants' knowledge, decks A-B were disadvantageous, offering high gains (100 euros/card drawn) but even higher potential losses (ranging from 150–350 euros for 20 cards in deck A, and 1250 euros for four cards in deck B), leading to a negative net outcome. In contrast, decks C-D were advantageous, yielding lower gains (50 euros/card) but also lower potential losses (25–75 euros for 20 cards in deck C and 250 euros for four cards in deck D), resulting in a positive net outcome (Table 1).

To provide a detailed analysis of the results, we computed:

(1) the overall IGT score, following standard practice, by subtracting the total number of cards drawn from disadvantageous decks (A + B) from the total drawn from advantageous decks (C + D). Additionally, we computed subscores by applying this same formula to specific segments of the task (i.e., trials 1–20, 21–40, 41–60, 61–80, and 81–100), as well as total gains, total losses, and net gains;

Table 1 Gain per card, lost probability, minimum/maximum/mean amount lost per trial, mean net amount won per trial and total amount won for the four decks of the IGT

	A	B	C	D
Gain per card	100	100	50	50
Loss probability	50%	10%	50%	10%
Minimum amount lost	150	1250	25	250
Maximum amount lost	350	1250	75	250
Mean amount lost per trial	125	125	25	25
Mean net amount won per trial	−25	−25	25	25
Total amount won for the 40 cards	−1000	−1000	1000	1000

(2) a comparison between the initial and later parts of the task to distinguish decision-making under uncertainty (first 40 trials) from decision-making under risk (last 40 trials), following the approach of Brevers et al. (2014) and Maurage et al. (2018);

(3) Additional indices (Ligneul, 2019; Worthy et al., 2013) further characterizing the strategy used by participants: Win-Stay (i.e., the proportion of trials in which participants selected the same deck after a trial with no loss), Lose-Shift (i.e., the proportion of trials in which participants switched decks after a loss), MI-Successive choices (a measure of choice autocorrelation, where higher scores imply that the choice in trial X + 1 is more predictable based on the choice in trial X), H-choice [a measure of entropy in deck choice across the task, where higher scores (range: 0–2) indicate more evenly distributed deck selections, with a score of 2 representing equal use of all decks (25 cards per deck) and 0 indicating repeated selection of a single deck], and Directed Exploration (DE), representing participants' exploratory tendency, specifically the frequency of selecting three different decks over three consecutive trials (DE3, chance level = .333) or four different decks over four consecutive trials (DE4, chance level = .094).

Statistical Analyses

We performed statistical analyses using IBM SPSS Statistics (Version 25.0; IBM Corp., Armonk, NY). To address our first research question, one-way analyses of variance (ANOVAs) were first conducted to perform between-group comparisons (CTRL, FAD) on demographic, substance-consumption and psychopathological variables. Regarding experimental variables, we first performed two repeated-measures ANOVAs, both with groups (CTRL, FAD) as between-subject factor: one with the five subscores related to IGT parts (i.e., IGT scores for trials 0–20, 21–40, 41–60, 61–80, 81–100) as within-subject factors, and one with decision-making under uncertainty (i.e., IGT scores 0–40) and decision-making under risk (i.e., IGT scores 61–100) as within-subject factors. For the sake of clarity, we only report results related to our main objective, namely group comparisons. The results related to the main subscore effect (i.e., differences between subparts of the IGT on the whole sample, without group differences) are reported in the Supplementary Materials. We then ran one-way ANOVAs to perform between-group comparisons on the new IGT indexes. As sex differences have been reported on IGT performance (Zanini et al., 2024), we also conducted one-way ANOVAs to explore sex differences in all our experimental measures. We also performed uncorrected exploratory correlational analyses using Pearson's correlations to explore the links between experimental scores and substance-consumption as well as psychopathological variables on the whole sample. Then, to address our second research question, we conducted the same analyses than those related to the CTRL-FAD comparison but on the distinct comparisons between CTRL and FAD-COM/FAD-ENH subgroups (i.e., one-way ANOVAs on demographic, substance-consumption and psychopathological variables; two-repeated-measures ANOVAs on the five subscores and on the decision-making under uncertainty/risk; one-way ANOVAs on the new IGT indexes). Alpha level was set at.05 for all analyses.

Results

(Fig. 1and Table 2).

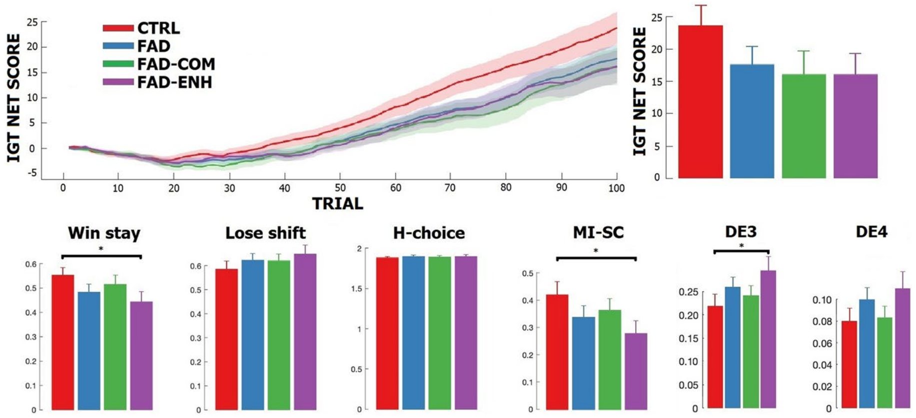

Fig. 1 Mean (SD) for the Iowa Gambling Task (IGT) indexes among the four groups (Controls, CTRL; individuals with Food and Alcohol Disturbance, FAD; FAD individuals with compensation-related motives, FAD-COM; FAD individuals with enhancement-related motives, FAD-ENH): Net score after each trial (upper left part of the Figure), Total net score (upper right part) and complementary indexes (lower part, presenting Win stay, Lose shift, H-choice, MI-Successive choices and Directed Exploration values). *p < .05

Comparisons Between CTRL and All FAD

Demographic, Psychopathological and Consumption Variables

As a result of the matching procedure, groups did not significantly differ regarding age, sex, education level (12 years since starting primary school for all participants), state anxiety, trait anxiety, depression, cognitive abilities evaluated by the BEARNI cognitive total score and impulsivity subscores. Moreover, our matching also led to an absence of significant differences between groups for AUDIT, binge drinking, tobacco/Fagerström and cannabis/CAST scores. These results confirm that the potential group differences found on the IGT cannot be explained by the influence of differences regarding demographic, psychopathological or substance-consumption variables. Conversely and as expected, FAD showed significantly higher scores than CTRL on SCOFF and CEBRACS scores, confirming that our experimental group indeed presented FAD.

Experimental Results (IGT)

The repeated-measures ANOVAs with groups (CTRL, FAD) as between-subject factor and the five subscores of the IGT as within-subject variables revealed no main Group effect [$F(1,88) = 2.05$; $p = .156$; $\eta^2_p = .023$] nor Group X Subscore interaction [$F(4,352) = .48$; $p = .749$; $\eta^2_p = .005$]. The repeated-measures ANOVAs with groups as between-subject factor and the two parts of the IGT (decision-making under uncertainty versus risk) as within-subject variables revealed no main Group effect [$F(1,88) = 2.19$; $p = .143$; $\eta^2_p = .024$] nor Group X Subscore interaction [$F(1,88) = .003$; $p = .956$; $\eta^2_p = .000$]. Regarding the new IGT indexes, we found no significant group differences for Total Gain, Total Loss, Net Gain, Win-Stay, Lose-Shift, MI-Successive choices, H-choices, DE3 and DE4. Finally, we found no significant effect of sex on any IGT index (all $F < 2.82$; $p > .096$). In summary, FAD did not differ from CTRL in any index related to the IGT, suggesting an absence of decision-making deficit in FAD.

Table 2 Sample characteristics and group comparisons on sociodemographic, substance consumption, psychopathological and experimental measures [M (SD)]

	CTRL (N = 45)	FAD (N = 45)	FAD-COM (N = 30)	FAD-ENH (N = 30)	Group Comparisons		
					CTRL vs. FAD	CTRL vs. FAD-COM	CTRL vs. FAD-ENH
Demographic measures							
Age	18.24 (0.48)	18.42 (0.78)	18.43 (0.86)	18.53 (0.86)	NS [$F(1,88) = 1.68$; $p = .200$; $\eta^2_p = .019$]	NS [$F(1,73) = 1.48$; $p = .228$; $\eta^2_p = .020$]	NS [$F(1,73) = 3.45$; $p = .067$; $\eta^2_p = .045$]
Sex ratio (female/male)	33/12	35/10	22/8	26/4	NS [$\chi^2(1,90) = .24$; $p = .62$]	NS [$\chi^2(1,75) = .0$; $p = 1$]	NS [$\chi^2(1,75) = 1.91$; $p = .17$]
Alcohol consumption							
AUDIT score	7.76 (4.42)	9.20 (4.27)	8.97 (4.06)	10.07 (4.10)	NS [$F(1,88) = 2.48$; $p = .119$; $\eta^2_p = .027$]	NS [$F(1,73) = 1.44$; $p = .234$; $\eta^2_p = .019$]	NS [$F(1,73) = 3.68$; $p = .067$; $\eta^2_p = .039$]
Binge drinking score	25.71 (18.42)	22.85 (16.06)	21.92 (11.76)	24.74 (17.32)	NS [$F(1,88) = 0.62$; $p = .435$; $\eta^2_p = .007$]	NS [$F(1,73) = 0.99$; $p = .322$; $\eta^2_p = .013$]	NS [$F(1,73) = 0.05$; $p = .820$; $\eta^2_p = .001$]
Eating disorder and FAD							
SCOFF score	0.71 (0.89)	1.67 (1.41)	1.93 (1.46)	1.93 (1.55)	**FAD > CTRL [$F(1,88) = 14.70$; $p < .001$; $\eta^2_p = .143$]**	**FAD-COM > CTRL [$F(1,73) = 20.21$; $p < .001$; $\eta^2_p = .217$]**	**FAD-ENH > CTRL [$F(1,73) = 18.67$; $p < .001$; $\eta^2_p = .204$]**
CEBRACS score	21.00 (0.00)	28.93 (8.29)	29.83 (9.23)	31.47 (9.02)	**FAD > CTRL [$F(1,88) = 41.25$; $p < .001$; $\eta^2_p = .319$]**	**FAD-COM > CTRL [$F(1,73) = 41.54$; $p < .001$; $\eta^2_p = .363$]**	**FAD-ENH > CTRL [$F(1,73) = 61.06$; $p < .001$; $\eta^2_p = .455$]**
Tobacco/Cannabis consumption							
Fagerström score	0.40 (1.23)	0.58 (1.29)	0.60 (1.22)	0.80 (1.49)	NS [$F(1,88) = .45$; $p = .505$; $\eta^2_p = .005$]	NS [$F(1,73) = 0.48$; $p = .492$; $\eta^2_p = .007$]	NS [$F(1,73) = 1.60$; $p = .210$; $\eta^2_p = .021$]
CAST score	0.49 (1.56)	1.02 (3.23)	1.47 (3.89)	1.53 (3.88)	NS [$F(1,88) = .99$; $p = .321$; $\eta^2_p = .011$]	NS [$F(1,73) = 2.29$; $p = .134$; $\eta^2_p = .031$]	NS [$F(1,73) = 2.64$; $p = .108$; $\eta^2_p = .035$]

Table 2 (continued)

	CTRL (N = 45)	FAD (N = 45)	FAD-COM (N = 30)	FAD-ENH (N = 30)	Group Comparisons		
					CTRL vs. FAD	CTRL vs. FAD-COM	CTRL vs. FAD-ENH
Psychopathological and cognitive measures							
BDI	6.60 (4.98)	8.20 (5.96)	9.20 (6.64)	8.47 (6.03)	NS [$F(1,88) = 1.91$; $p = .170$; $\eta^2_p = .021$]	NS [$F(1,73) = 3.75$; $p = .057$; $\eta^2_p = .049$]	NS [$F(1,73) = 2.13$; $p = .149$; $\eta^2_p = .028$]
STAI-A	39.95 (12.54)	40.00 (11.34)	41.33 (11.74)	39.63 (11.07)	NS [$F(1,88) = 0.00$; $p = .999$; $\eta^2_p = .000$]	NS [$F(1,73) = 0.29$; $p = .634$; $\eta^2_p = .003$]	NS [$F(1,73) = 0.01$; $p = .909$; $\eta^2_p = .000$]
STAI-B	47.98 (11.04)	49.04 (12.06)	51.00 (12.64)	48.43 (11.57)	NS [$F(1,88) = .19$; $p = .663$; $\eta^2_p = .002$]	NS [$F(1,73) = 1.20$; $p = .277$; $\eta^2_p = .016$]	NS [$F(1,73) = 0.03$; $p = .864$; $\eta^2_p = .000$]
UPPS-P							
Negative urgency	9.62 (2.53)	9.78 (2.85)	9.93 (3.03)	9.73 (2.61)	NS [$F(1,88) = 0.08$; $p = .785$; $\eta^2_p = .001$]	NS [$F(1,73) = 0.23$; $p = .632$; $\eta^2_p = .003$]	NS [$F(1,73) = 0.03$; $p = .855$; $\eta^2_p = .000$]
Positive urgency	10.89 (2.05)	11.44 (2.22)	11.63 (2.16)	11.70 (2.32)	NS [$F(1,88) = 1.52$; $p = .221$; $\eta^2_p = .017$]	NS[$F(1,73) = 2.28$; $p = .135$; $\eta^2_p = .030$]	NS [$F(1,73) = 2.54$; $p = .116$; $\eta^2_p = .034$]
Lack of premeditation	7.44 (2.88)	7.47 (2.55)	7.67 (2.78)	7.17 (2.65)	NS [$F(1,88) = 0.00$; $p = .969$; $\eta^2_p = .000$]	NS [$F(1,73) = 0.11$; $p = .741$; $\eta^2_p = .001$]	NS [$F(1,73) = 0.18$; $p = .675$; $\eta^2_p = .002$]
Lack of perseverance	7.22 (1.99)	7.49 (2.46)	7.93 (2.46)	7.23 (2.58)	NS [$F(1,88) = 0.32$; $p = .573$; $\eta^2_p = .004$]	NS [$F(1,73) = 1.89$; $p = .173$; $\eta^2_p = .025$]	NS [$F(1,73) = 0.00$; $p = .983$; $\eta^2_p = .000$]
Sensation seeking	10.76 (2.84)	11.71 (2.63)	11.73 (2.61)	11.90 (2.67)	NS [$F(1,88) = 2.75$; $p = .101$; $\eta^2_p = .030$]	NS [$F(1,73) = 2.28$; $p = .136$; $\eta^2_p = .030$]	NS [$F(1,73) = 3.07$; $p = .084$; $\eta^2_p = .040$]
BEARNI Total Score	20.95 (3.03)	21.05 (3.58)	20.72 (3.65)	20.76 (3.67)	NS [$F(1,88) = 0.02$; $p = .898$; $\eta^2_p = .000$]	NS [$F(1,73) = 0.09$; $p = .763$; $\eta^2_p = .001$]	NS [$F(1,73) = 0.06$; $p = .807$; $\eta^2_p = .001$]
IGT							
Total score	23.82 (21.25)	17.73 (19.07)	16.20 (19.85)	16.20 (17.84)	NS [$F(1,88) = 2.05$; $p = .156$; $\eta^2_p = .023$]	NS [$F(1,73) = 2.44$; $p = .123$; $\eta^2_p = .032$]	NS [$F(1,73) = 2.62$; $p = .110$; $\eta^2_p = .035$]
Trials 1–20	−2.27 (5.78)	−2.93 (4.54)	−3.60 (4.94)	−2.87 (4.41)	NS [$F(1,88) = 0.37$; $p = .545$; $\eta^2_p = .004$]	NS [$F(1,73) = 1.07$; $p = .304$; $\eta^2_p = .014$]	NS [$F(1,73) = 0.23$; $p = .631$; $\eta^2_p = .003$]

Table 2 (continued)

	CTRL (N = 45)	FAD (N = 45)	FAD-COM (N = 30)	FAD-ENH (N = 30)	Group Comparisons		
					CTRL vs. FAD	CTRL vs. FAD-COM	CTRL vs. FAD-ENH
Trials 21–40	3.56 (7.32)	1.82 (5.73)	2.33 (6.10)	1.33 (5.10)	NS [$F(1,88)=1.56$; $p=.215$; $\eta^2_p=.017$]	NS [$F(1,73)=0.57$; $p=.452$; $\eta^2_p=.008$]	NS [$F(1,73)=2.08$; $p=.153$; $\eta^2_p=.028$]
Trials 41–60	6.84 (7.04)	5.73 (7.08)	4.87 (7.20)	5.53 (7.25)	NS [$F(1,88)=0.56$; $p=.457$; $\eta^2_p=.006$]	NS [$F(1,73)=1.40$; $p=.241$; $\eta^2_p=.019$]	NS [$F(1,73)=0.61$; $p=.437$; $\eta^2_p=.008$]
Trials 61–80	7.91 (7.52)	5.33 (8.29)	4.20 (8.90)	6.13 (7.56)	NS [$F(1,88)=2.39$; $p=.126$; $\eta^2_p=.026$]	NS [$F(1,73)=3.78$; $p=.056$; $\eta^2_p=.049$]	NS [$F(1,73)=1.00$; $p=.320$; $\eta^2_p=.014$]
Trials 81–100	7.78 (8.38)	7.78 (9.61)	8.40 (9.86)	6.07 (9.06)	NS [$F(1,88)=0.00$; $p=1$; $\eta^2_p=.000$]	NS [$F(1,73)=0.09$; $p=.770$; $\eta^2_p=.001$]	NS [$F(1,73)=0.70$; $p=.404$; $\eta^2_p=.010$]
Trials 0–40	1.29 (8.52)	−1.11 (6.19)	−1.27 (7.25)	−1.53 (5.40)	NS [$F(1,88)=2.33$; $p=.130$; $\eta^2_p=.026$]	NS [$F(1,73)=1.82$; $p=.182$; $\eta^2_p=.024$]	NS [$F(1,73)=2.59$; $p=.112$; $\eta^2_p=.034$]
Trials 60–100	15.69 (12.80)	13.11 (14.43)	12.60 (14.62)	12.20 (13.69)	NS [$F(1,88)=0.80$; $p=.372$; $\eta^2_p=.009$]	NS [$F(1,73)=0.94$; $p=.337$; $\eta^2_p=.013$]	NS [$F(1,73)=1.27$; $p=.264$; $\eta^2_p=.017$]
Total gain	6904 (531.27)	7056 (476.80)	7095 (496.25)	7095 (445.93)	NS [$F(1,88)=2.05$; $p=.156$; $\eta^2_p=.023$]	NS [$F(1,73)=2.44$; $p=.123$; $\eta^2_p=.032$]	NS [$F(1,73)=2.62$; $p=.110$; $\eta^2_p=.035$]
Total loss	6859 (1225.49)	7124 (1045.91)	7215 (1064.16)	7171 (1094.63)	NS [$F(1,88)=1.22$; $p=.272$; $\eta^2_p=.014$]	NS [$F(1,73)=1.69$; $p=.198$; $\eta^2_p=.023$]	NS [$F(1,73)=1.28$; $p=.263$; $\eta^2_p=.017$]
Final Money (Net Gain)	2045 (767.79)	1932 (640.50)	1880 (654.57)	1923 (708.84)	NS [$F(1,88)=0.58$; $p=.449$; $\eta^2_p=.007$]	NS [$F(1,73)=0.94$; $p=.336$; $\eta^2_p=.013$]	NS [$F(1,73)=.49$; $p=.489$; $\eta^2_p=.007$]
Win-Stay	0.56 (0.20)	0.49 (0.22)	0.53 (0.20)	0.45 (0.21)	NS [$F(1,88)=2.62$; $p=.109$; $\eta^2_p=.029$]	NS [$F(1,73)=0.66$; $p=.420$; $\eta^2_p=.009$]	**FAD-ENH < CTRL [$F(1,73)=5.33$; $p=.024$; $\eta^2_p=.068$]**
Lose-Shift	0.59 (0.22)	0.63 (0.17)	0.62 (0.15)	0.65 (0.18)	NS [$F(1,88)=0.76$; $p=.387$; $\eta^2_p=.009$]	NS [$F(1,73)=0.54$; $p=.467$; $\eta^2_p=.007$]	NS [$F(1,73)=1.74$; $p=.191$; $\eta^2_p=.023$]
MI-successive choices	0.42 (0.28)	0.34 (0.24)	0.36 (0.23)	0.28 (0.23)	NS [$F(1,88)=2.05$; $p=.156$; $\eta^2_p=.023$]	NS [$F(1,73)=0.92$; $p=.342$; $\eta^2_p=.012$]	**FAD-ENH < CTRL [$F(1,73)=5.04$; $p=.028$; $\eta^2_p=.065$]**
H-choices	1.89 (0.08)	1.91 (0.07)	1.91 (0.07)	1.92 (0.06)	NS [$F(1,88)=1.30$; $p=.257$; $\eta^2_p=.015$]	NS [$F(1,73)=0.65$; $p=.423$; $\eta^2_p=.009$]	NS [$F(1,73)=2.19$; $p=.143$; $\eta^2_p=.029$]

Table 2 (continued)

	CTRL (N = 45)	FAD (N = 45)	FAD-COM (N = 30)	FAD-ENH (N = 30)	Group Comparisons		
					CTRL vs. FAD	CTRL vs. FAD-COM	CTRL vs. FAD-ENH
DE3	0.22 (0.14)	0.26 (0.15)	0.24 (0.11)	0.29 (0.16)	NS [$F(1,88) = 2.40$; $p = .125$; $\eta^2_p = .027$]	NS [$F(1,73) = 0.49$; $p = .485$; $\eta^2_p = .007$]	**FAD-ENH > CTRL [$F(1,73) = 4.41$; $p = .039$; $\eta^2_p = .057$]**
DE4	0.08 (0.08)	0.10 (0.07)	0.08 (0.05)	0.11 (0.08)	NS [$F(1,88) = 0.88$; $p = .351$; $\eta^2_p = .010$]	NS [$F(1,73) = 0.04$; $p = .843$; $\eta^2_p = .001$]	NS [$F(1,88) = 1.94$; $p = .168$; $\eta^2_p = .026$]

AUDIT, Alcohol Use Disorders Identification Test; *CEBRACS*: Compensatory Eating and Behaviors in Response to Alcohol Consumption Scale; *BDI*, Beck Depression Inventory; *BEARNI*, Brief evaluation of alcohol-related neuropsychological impairment; *CAST*, Cannabis Abuse Screening Test; *IGT*, Iowa Gambling Task; *NS*, Non-significant; *STAI*, State-Trait Anxiety Inventory; *UPPS-P*, Urgency-Premeditation-Perseverance-Sensation Seeking-Positive Urgency. Significant group differences are in bold text

Pearson Correlations

Correlations performed on the whole sample (Table 3) revealed significant links between (1) the AUDIT score and total IGT score, Total Gain, Total Loss and Net Gain; (2) the CEBRACS score and total IGT score, Total Gain, Total Loss, Net Gain and Lose-Shift; (3) Fagerström scores and Total Loss/Net Gain, as well as CAST score and Total score/Total Gain; (4) Depression scores and total IGT score, Total Gain and Total Loss; (5) Positive urgency and IGT total score, Total Gain, Total Loss and Net Gain; (6) Lack of perseverance and IGT total score, Total Gain, Total Loss, and Net Gain. In summary, IGT performance was negatively correlated with FAD habits (as measured by the CEBRACS) but also with depression (BDI), impulsivity (positive urgency and lack of perseverance), as well as alcohol (AUDIT), tobacco (Fagerström Test) and cannabis (CAST) consumption.

Comparisons Between CTRL and FAD-COM/FAD-ENH

CTRL Versus FAD/COM

The comparison between CTRL and FAD-COM led to the following results: (1) Groups did not significantly differ for demographic, psychopathological, cognitive and substance-consumption measures, confirming the matching described for the general group comparison; (2) The repeated-measures ANOVAs with groups (CTRL, FAD-COM) as between-subject factor and the five subscores of the IGT as within-subject variables revealed no main Group effect [$F(1,73)=2.44$; $p=.123$; $\eta^2_p=.032$] nor Group X Subscore interaction [$F(4,292)=.93$; $p=.447$; $\eta^2_p=.013$]; (3) The repeated-measures ANOVAs with groups as between-subject factor and the two parts of the IGT as within-subject variables revealed no main Group effect $F(1,73)=2.11$; $p=.151$; $\eta^2_p=.028$] nor Group X Subscore interaction [$F(1,73)=.02$; $p=.881$; $\eta^2_p=.000$]; (4) The new IGT indexes did not lead to significant group differences. In summary, FAD-COM did not differ from CTRL in any index related to the IGT, suggesting an absence of decision-making deficit in FAD-COM.

CTRL Versus FAD/ENH

The comparison between CTRL and FAD-ENH led to the following results: (1) No group differences for all demographic/psychopathological measures (except for SCOFF and CEBRACS); (2) For the repeated-measures ANOVAs on the five subscores/two parts of the IGT, no main Group effect [$F(1,73)=2.62$; $p=.110$; $\eta^2_p=.035$ and $F(1,73)=2.86$; $p=.095$; $\eta^2_p=.038$, respectively] nor Group X Subscore interaction [$F(4,292)=.15$; $p=.961$; $\eta^2_p=.002$ and $F(1,73)=.04$; $p=.845$; $\eta^2_p=.001$, respectively]; (3) Regarding the new IGT indexes, we found no significant group differences for Total Gain, Total Loss, Net Gain, Lose-Shift, H-choices and DE4, but FAD-ENH had significantly lower scores than CTRL for Win-Stay and MI-Successive choices, and significantly higher scores than CTRL for DE3. In summary, in comparison with CTRL, FAD-ENH presented a less stable and more erratic strategy at the IGT, characterized by a reduced probability to keep choosing the same deck after a winning trial, a higher inter-trial variability in the deck chosen and a higher exploratory tendency. These indexes suggest that FAD-ENH present biased and less efficient decision-making abilities than CTRL.

Table 3 Pearson's correlations between IGT score/indexes and substance consumption, psychopathological and cognitive measures in the whole experimental sample (N = 90) [*r* (p)]

	AUDIT	BINGE	SCOFF	CEBRACS	FAGER STROM	CAST	BDI	STAI-A	STAI-B	UPPS-NU	UPPS-PU	UPPS-LPREM	UPPS-LPERS	UPPS-SS	BEARNI
IGT															
Total Score	***r* = -.26 (p = .015)**	*r* = -.18 (p = .090)	*r* = -.02 (p = .848)	***r* = -.24 (p = .022)**	*r* = -.20 (p = .063)	***r* = -.25 (p = .016)**	***r* = -.26 (p = .013)**	*r* = -.08 (p = .479)	*r* = -.16 (p = .145)	*r* = -.03 (p = .795)	***r* = -.21 (p = .046)**	*r* = -.10 (p = .342)	***r* = -.31 (p = .003)**	*r* = -.04 (p = .715)	*r* = .04 (p = .739)
Total gain	***r* = .26 (p = .015)**	*r* = .18 (p = .090)	*r* = .02 (p = .848)	***r* = .24 (p = .022)**	*r* = .20 (p = .063)	***r* = .25 (p = .016)**	***r* = .26 (p = .013)**	*r* = .08 (p = .479)	*r* = .16 (p = .145)	*r* = .03 (p = .795)	***r* = .21 (p = .046)**	*r* = .10 (p = .342)	***r* = .31 (p = .003)**	*r* = .04 (p = .715)	*r* = -.04 (p = .739)
Total loss	***r* = .24 (p = .021)**	*r* = .19 (p = .071)	*r* = -.03 (p = .784)	***r* = .25 (p = .020)**	***r* = .23 (p = .027)**	*r* = .21 (p = .053)	***r* = .24 (p = .025)**	*r* = .09 (p = .373)	*r* = .17 (p = .118)	*r* = .08 (p = .472)	***r* = .25 (p = .017)**	*r* = .15 (p = .171)	***r* = .35 (p = .001)**	*r* = −01. (p = .892)	*r* = -.05 (p = .676)
Net gain	***r* = -.21 (p = .049)**	*r* = -.18 (p = .091)	*r* = .06 (p = .560)	***r* = -.22 (p = .035)**	***r* = -.24 (p = .026)**	*r* = -.15 (p = .164)	*r* = -.20 (p = .065)	*r* = -.10 (p = .352)	*r* = -.16 (p = .139)	*r* = -.10 (p = .329)	***r* = -.25 (p = .016)**	*r* = -.16 (p = .126)	***r* = -.34 (p = .001)**	*r* = .05 (p = .630)	*r* = .05 (p = .664)
Win-Stay	*r* = -.15 (p = .174)	*r* = -.05 (p = .650)	*r* = .01 (p = .957)	*r* = -.08 (p = .451)	*r* = -.15 (p = .149)	*r* = -.02 (p = .829)	*r* = .13 (p = .235)	*r* = .02 (p = .832)	*r* = -.04 (p = .722)	*r* = .14 (p = .177)	*r* = .09 (p = .404)	*r* = -.06 (p = .557)	*r* = -.04 (p = .735)	*r* = .10 (p = .328)	*r* = .12 (p = .285)
Lose-Shift	*r* = .17 (p = .117)	*r* = .08 (p = .469)	*r* = .01 (p = .959)	***r* = .23 (p = .032)**	*r* = .20 (p = .062)	*r* = .03 (p = .800)	*r* = .02 (p = .888)	*r* = .04 (p = .678)	*r* = .14 (p = .187)	*r* = .03 (p = .767)	*r* = .09 (p = .392)	*r* = .14 (p = .182)	*r* = .15 (p = .150)	*r* = -.17 (p = .114)	*r* = -.19 (p = .077)
MI—successive choices	*r* = -.17 (p = .121)	*r* = -.09 (p = .422)	*r* = .01 (p = .942)	*r* = -.13 (p = .222)	*r* = -.16 (p = .132)	*r* = -.05 (p = .639)	*r* = -.00 (p = .978)	*r* = -.01 (p = .957)	*r* = -.09 (p = .416)	*r* = .08 (p = .438)	*r* = .05 (p = .615)	*r* = -.04 (p = .718)	*r* = .01 (p = .931)	*r* = .11 (p = .325)	*r* = .17 (p = .286)
H-choices	*r* = .19 (p = .070)	*r* = .17 (p = .110)	*r* = -.01 (p = .901)	*r* = .12 (p = .243)	*r* = .08 (p = .473)	*r* = .16 (p = .136)	*r* = .05 (p = .644)	*r* = .05 (p = .634)	*r* = .09 (p = .382)	*r* = .12 (p = .266)	*r* = .14 (p = .178)	*r* = .03 (p = .761)	*r* = .16 (p = .136)	*r* = -.06 (p = .589)	*r* = .04 (p = .705)
DE3	*r* = .17 (p = .109)	*r* = .06 (p = .589)	*r* = -.05 (p = .634)	*r* = .17 (p = .278)	*r* = .13 (p = .234)	*r* = -.03 (p = .814)	*r* = -.13 (p = .216)	*r* = .03 (p = .752)	*r* = .05 (p = .641)	*r* = -.11 (p = .303)	*r* = -.04 (p = .731)	*r* = .11 (p = .32)	*r* = .10 (p = .347)	*r* = -.12 (p = .267)	*r* = -.06 (p = .575)
DE4	*r* = .13 (p = .212)	*r* = .06 (p = .592)	*r* = -.06 (p = .549)	*r* = .07 (p = .509)	*r* = .10 (p = .345)	*r* = -.04 (p = .684)	*r* = -.10 (p = .368)	*r* = .11 (p = .299)	*r* = .10 (p = .343)	*r* = -.03 (p = .803)	*r* = -.07 (p = .531)	*r* = .03 (p = .749)	*r* = .09 (p = .388)	*r* = -.15 (p = .156)	*r* = -.03 (p = .806)

AUDIT, Alcohol Use Disorders Identification Test; *BD*, Binge drinking; *BDI*, Beck Depression Inventory; *BEARNI*, Brief evaluation of alcohol-related neuropsychological impairment; *CAST*, Cannabis Abuse Screening Test; *IGT*, Iowa Gambling Task; *LPERS*, Lack of Perseverance; *LPREM*, Lack of Premeditation; *NU*, Negative Urgency; *PU*, Positive Urgency; *STAI-A/B*, State-Trait Anxiety Inventory; *SS*, Sensation Seeking; *UPPS*, Urgency-Premeditation-Perseverance-Sensation Seeking-Positive Urgency. Significant correlations are in bold text

Discussion

The present study offers the first results exploring the cognitive deficits associated with FAD, and more specifically the modification of decision-making processes in comparison with drinkers not presenting FAD. We used a largely validated decision-making task and applied it to groups strictly matched for variables potentially influencing decision-making, encompassing demographic and psychopathological factors as well as substance consumption. This controlled approach ensured that the group differences reported were unambiguously related to the functional association between alcohol consumption and disordered eating which characterizes FAD, and not to the more global alcohol consumption nor to biasing variables frequently uncontrolled in previous studies exploring cognition in addictive and eating disorders. We addressed two main questions, respectively related to the presence of decision-making modifications in FAD when considered as a unitary phenomenon (i.e., comparison between FAD individuals and matched non-FAD individuals) and to the differential decision-making profiles observed across the two main categories of behaviors related to FAD, namely actions respectively reducing (compensation of alcohol-related calories, FAD-COM) or increasing (alcohol enhancement, FAD-ENH) alcohol effects. Our results generated two main insights.

First, our statistical analyses coherently showed across all IGT indexes that, when confounding factors are controlled for (i.e., when groups are matched on these factors), individuals with FAD do not present significant decision-making impairments in comparison with matched individuals presenting a similar alcohol consumption pattern. Impaired IGT performance has been largely reported in a wide range of psychopathological conditions (Puddephatt et al., 2022), but FAD does not appear, when considered globally, to generate specific decision-making impairments beyond the one related to alcohol consumption. As our control group was constituted of individuals with regular alcohol consumption, in line with our aim to explore the specific decision-making impact of FAD beyond alcohol consumption per se, we do not argue that FAD individuals have totally preserved decision-making as compared to no/low drinkers. Our data rather show that adding disordered eating on an already hazardous alcohol consumption pattern does not increase decision-making consequences when FAD is considered as a unitary phenomenon. Nevertheless, this result does not imply that all cognitive functions are preserved in FAD, nor does it suggest that FAD has no deleterious impact on decision-making in the long run: we only included young adults (first-year University students) with potentially quite recent FAD habits and with a high cognitive reserve, hence able to compensate for decision-making deficits by mobilizing other intact neurocognitive resources [as proposed by the compensation hypothesis (Lannoy et al., 2019)]. Future studies should thus, notably in view of the exploratory correlations we observed between CEBRACS scores and IGT indexes, explore decision-making abilities in populations presenting lower cognitive abilities, more long-term FAD behaviors or other forms of problematic alcohol consumption patterns (as we found significant negative correlations between IGT performance and AUDIT scores) to confirm and extend our findings.

Second, there is an emerging consensus in the literature (Berry et al., 2024) to propose that FAD should no more be considered a unitary state but should rather be dissociated in two subgroups according to its main motivations/behaviors. This led us to our second research question, based on the distinction between FAD individuals mostly driven by alcohol compensation (i.e., adopting purging/fasting/vomiting behaviors or exercise, mostly after acute alcohol consumption, to counterbalance the calories intakes related to recent intoxication episodes) versus alcohol enhancement (i.e., boosting the acute effects of alcohol by reducing calories intake, mostly before the acute consumption episode) behaviors (Chambers, 2008). Exploring decision-making abilities in these two subgroups led to contrasting results: while FAD-COM was not related to any decision-making deficit compared to controls, in line with what we found in the global FAD group, FAD-ENH was associated with specific modifications in IGT indexes. Indeed, individuals with FAD habits mostly related to enhancement behaviors, while not presenting deficits in the classical IGT indexes, showed three changes compared to controls in the new IGT indexes, allowing a more granulated exploration of decision-making, as they had (1) a reduced tendency, after obtaining a win, to select the same deck in the next trial (i.e., lower Win-Stay index); (2) a reduced autocorrelation across successive choices (i.e., lower MI-Successive choices); (3) a higher tendency to switch across decks during the task (i.e., higher DE3). These three results coherently suggest that individuals with FAD-ENH present a more random/variable strategy when performing the IGT, as they are less inclined to stick with a deck generating positive outcomes, preferring to keep on exploring the different decks in an unplanned manner. While this did not lead to massive decision-making deficits as we did not find significantly lower scores in this subgroup at the classical IGT indexes (potentially due to the strong intra-group heterogeneity on IGT results, despite quite large mean score differences at the descriptive level), these results offer the first empirical evidence that enhancement behaviors in FAD have cognitive correlates and centrally reduce the ability to develop an efficient and stable strategy optimizing choices in decision-making tasks. Beyond showing the interest of deeper analyses through innovative indexes when processing IGT results to go beyond classical analyses, these results suggest that FAD is an umbrella term encompassing very different profiles, at motivational, behavioral and hence also cognitive levels.

At least two main interpretations can be proposed to explain such impaired decision-making in FAD-ENH compared to controls but also to unimpaired FAD-COM. First, FAD-ENH, in contrast with FAD-COM, might be characterized by eating behaviors increasing the well-established brain and cognitive consequences of alcohol consumption. Indeed, by restricting their food intakes in the hours or day preceding acute intoxication episodes, they would hamper the progressive absorption of ethanol in the body occurring when food is present in the digestive system, and hence generate a higher peak of brain alcohol intoxication, generating higher cognitive consequences as observed in binge drinking (Peréz-Garcia et al., 2022). This proposal aligns with the previous report of higher alcohol-related consequences in individuals reducing their caloric intakes before alcohol intoxication episodes, such restriction being related to higher self-reported drunkenness but also stronger memory impact (Giles et al., 2009). In contrast, FAD-COM habits are related with disordered eating behaviors occurring mostly after the acute intoxication episode, hence not modulating alcohol absorption during this episode. Second, as our results are cross-sectional, it could be hypothesized that the decision-making impairments observed in FAD-ENH might pre-exist and constitute vulnerability factors for the development of FAD. Reduced decision-making abilities, in link with a lower ability to develop healthy strategic behaviors, would then lead individuals with FAD-ENH to have less planned and stable nutrition, leading them to more frequently drink alcohol without previous food intakes, potentially in relation with impulsivity (i.e., increased positive urgency or reduced perseverance, as observed in our correlational analyses). In comparison, individuals with FAD-COM habits would be able, thanks to good pre-existing or preserved decision-making abilities, to compensate the effects of excessive alcohol consumption, hence limiting its impact on weight or well-being (even though such compensation behaviors can lead to strong physical and psychological consequences, hence not constituting healthy habits, Szynal et al., 2022). Beyond these interpretations, it is important to underline that these group differences cannot be explained by disparities in demographic, psychopathological or substance consumption, as groups were matched on these variables, as well as on their alcohol consumption profile.

In conclusion, the key asset of our study is to offer the first experimental exploration of cognitive deficits in FAD. Our sound experimental approach generated clear results: when biasing variables are controlled for, FAD does not lead to decision-making impairments in comparison with matched alcohol drinkers without disordered eating. However, when exploring FAD subcomponents, we showed that individuals presenting FAD in relation to alcohol-enhancement behaviors have specific decision-making modifications, characterized by a reduced ability to develop efficient strategy optimizing choices in decision-making under uncertainty or risk, which is not found in individuals using FAD behaviors to compensate for alcohol caloric intakes. Such results should be replicated in other populations (e.g., adolescents, older adults, groups with various socio-economic backgrounds and sex ratio). They should also be extended by exploring the role of other key psychological variables in FAD, like drinking motives (to explore the link between motivations and actual enhancement/compensation behaviors) or cognitive abilities (e.g., memory, other executive functions). However, they already carry some key implications. At the experimental level, they show that going beyond the classical IGT results by using new IGT indexes allows to clarify the complex and various cognitive mechanisms underlying decision-making, and to spot the precise impairments presented in psychopathological populations. At the theoretical level, they suggest that considering FAD as a unitary construct/population is outdated, as FAD is rather gathering individuals with various behaviors and cognitive impairments. FAD subgroups should thus be considered separately when exploring cognitive abilities in neuropsychological approaches. Finally, at the clinical level, the decision-making impairments we revealed in individuals presenting FAD-ENH should promote the development of specific cognitive remediation approaches in this population, as improving decision-making, and more globally executive functions, could reduce alcohol enhancement habits.

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Data Availability The data that support the findings of this study are available on request from the corresponding author.

Declarations

Conflict of Interest The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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