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Cognitive correlates of Food and Alcohol Disturbance: an integrated neuropsychological exploration

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Author contributions

All authors have approved the final manuscript.

Ludivine Ritz: data analyses, writing; Nicolas Mauny: methodology, review and editing; Charlotte Montcharmont: methodology, inclusion of the participants; H el ene Beaunieux: study design, conceptualization; Pierre Maurage: supervision, writing (review and editing).

Declaration of interest statement

The authors declare no conflict of interest.

Data availability

Data and measures are available: <https://osf.io/5nfs8/>

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Abstract

Food and Alcohol Disturbance (FAD) is a combination of problematic alcohol use and disordered eating behaviors in which individuals modify their eating habits to enhance alcohol intoxication and/or compensate alcohol-related caloric intakes. FAD is prevalent in youth, being reported in more than 50% of University students consuming alcohol. While the biopsychosocial correlates of FAD are documented, its specific cognitive counterparts remain unexplored, despite a large literature describing the distinct neurocognitive consequences of alcohol consumption and eating disorders. We hence determined whether FAD is associated with cognitive impairments in University students and examined whether different FAD sub-dimensions relate to distinct cognitive profiles. We assessed FAD in 130 University students (through the CEBRACS scale) and tested them using an extensive neuropsychological battery (measuring visuospatial abilities, episodic memory and executive functions). We first compared cognitive performances between FAD/non-FAD students, and then conducted multivariate regression analyses identifying the variation of cognitive profiles across CEBRACS subscales. The general comparison between FAD/non-FAD students did not reveal significant differences. Conversely, CEBRACS subscales analyses identified specific patterns as (1) dietary restraint was associated with poorer visuospatial abilities and verbal episodic memory; (2) purging behaviors were associated with lower executive functioning but increased visual episodic memory; (3) extreme fasting and self-induced vomiting were associated with poorer visual episodic memory performance but higher executive functioning. These findings suggest that FAD is an umbrella term masking various cognitive profiles according to the distinct eating behaviors involved, and thus highlight the importance of considering the subcomponents of FAD when exploring its neurocognitive correlates.

Keywords: food and alcohol disturbance, drunkorexia, alcohol, eating disorders, cognitive functioning

Highlights

- Food and Alcohol Disturbance (FAD) is prevalent in youth, but its cognitive correlates are unknown
- We compared 130 FAD (measured with the CEBRACS) vs non-FAD students on a neuropsychological battery
- FAD/non-FAD students did not differ on visuospatial abilities, memory or executive functions
- The various FAD behaviors (restraint/fasting/purging) generated distinct cognitive profiles
- FAD is an umbrella term with varying motivations/behaviors, related to distinct cognitive correlates

1. Introduction

Food and Alcohol Disturbance (FAD) refers to the engagement in compensatory behaviors before, during and/or after excessive alcohol consumption, to enhance (e.g., restricting eating to boost intoxication) or reduce (e.g., purging to reduce alcohol-related calories intakes) its consequences (Choquette, Rancourt, et al., 2018; Shepherd et al., 2021). The relationship between alcohol use and eating disorders (ED) is documented in youth. The prevalence of FAD is associated with both (1) excessive alcohol consumption (Shepherd et al., 2021), including binge drinking (BD, Burke et al., 2010; Peralta et al., 2019; Rahal et al., 2012) ; (2) eating disorders (Hunt & Forbush, 2016; Pietrabissa et al., 2018; Pompili & Laghi, 2018; Ritz et al., 2023). Importantly, FAD is not only characterized by the mere comorbidity between excessive alcohol use, mostly following a BD pattern, and ED, as it implies a functional relationship between these behaviors (Berry et al., 2024), involving intertwined motivations and planned mechanisms where one condition promotes the other, and reciprocally (Choquette et al., 2018).

FAD is not a unitary phenomenon as it varies both in terms of behaviors (e.g., caloric restriction, diet, dysfunctional exercise, purging, self-induced vomiting) and motivations (e.g., caloric compensation, alcohol enhancement motives). These FAD subtypes are related to distinct prevalence, biopsychosocial correlates and consequences (Berry et al., 2024). The scientific exploration of FAD has bloomed recently, generating crucial insights regarding its epidemiology, predictors, conceptualization and measure (Berry et al., 2024; Shepherd et al., 2021). However, the specific cognitive correlates of this disorder remain unexplored, as only one study suggested increased memory loss and blackouts among students engaged in FAD, due to higher alcohol intoxication (Giles et al., 2009). This absence of data on FAD's cognitive profiles is surprising in view of the large literature describing the distinct neurocognitive and psychological consequences of excessive alcohol consumption (e.g., BD

Carbia et al., 2018; Lannoy et al., 2021) and ED (e.g., Prince et al., 2022; Rylander et al., 2020), showing large scale impairments on visuospatial (Carbia et al., 2018; Eichen et al., 2017; Fox et al., 2000; Stedal et al., 2012; Sullivan et al., 2000; Weider et al., 2015), memory (Carbia et al., 2017; Jáuregui-Lobera, 2013; Mota et al., 2013; Nandrino et al., 2006, 2017; Noël et al., 2012; Stedal et al., 2012; Weider et al., 2015), attentional, and executive functions (Carbia et al., 2018; Eichen et al., 2017; Kessler et al., 2016; Le Berre et al., 2017; Van den Eynde et al., 2011).

As both BD and ED are associated with neuropsychological deficits, the cognitive correlates of FAD might be widespread, combining the respective impacts related to alcohol use/ED but also potentially generating specific effects (e.g., greater brain damage through increased alcohol intoxication; Szydal et al., 2022). More specifically, FAD behaviors might be associated both with greater pre-existing cognitive vulnerability (explaining why individuals engage in FAD) and with greater neurocognitive consequences (resulting from excessive alcohol use and maladaptive eating behaviors), particularly in youth. We thus provided a deeper understanding of FAD by investigating cognitive abilities in this population with two aims: (1) determining whether FAD is associated with cognitive impairments in University students using a cross-sectional design to compare FAD and non-FAD individuals; (2) examining whether the different sub-dimensions of FAD (i.e., in terms of motives and behaviors) are associated with distinct cognitive profiles, through the identification of the particular relationships between FAD sub-dimensions and cognitive performance.

2. Material and Methods

2.1. Participants

We included 130 freshmen volunteer students at the University of Caen Normandy (France). We recruited them on willingness and individually invited them to take part in the experiment in a laboratory room. All participants were between 18-22 years old, were native French speakers and did not have any medical history (i.e., neurological, psychiatric, endocrine and/or infectious disease) impacting cognition. All participants were alcohol consumers (i.e., having consumed alcohol at least once in the past year) and had abstained from alcohol during the 12 hours preceding the experiment (as confirmed through a breathalyzer test). They were interviewed on their alcohol consumption with the French version of the Alcohol Use Disorders Identification Test (AUDIT; Gache et al., 2005; French validation: Demartini & Carey, 2012). Students were also asked about the age at which they first drank alcohol, their alcohol consumption per week (in standard drinks, a standard drink corresponding to 10 g of pure ethanol) and their frequency of drinking during a typical week (from 1 to 7 days). Participants were assessed with the SCOFF questionnaire, designed to screen the risk of developing ED (Garcia et al., 2010, 2011) and composed of five dichotomous questions (“yes”/“no”, total score 0-5). Descriptive statistics are presented in Table 1.

2.2. Ethics

This study is part of a larger research program exploring substance consumption among young adults (ADUC; Alcohol and Drugs at University of Caen, France). All participants were informed about the study (approved by the research ethics committee of the Caen University n°2025011616552700000220000433) prior to their inclusion and provided written informed consent. We respected the Ethical Principles of Psychologists and Code of Conduct of the American Psychological Association (American Psychological Association, 2016) for the ethical treatment of human participants.

2.3. Measures

2.3.1. FAD

We assessed FAD with the French version of the Compensatory Eating and Behaviors in Response to Alcohol Consumption Scale (CEBRACS; Ritz et al., 2023), a 21-item Likert scale investigating compensatory eating behaviors before/during/after alcohol consumption over the past three months. Each of the three time periods (before/during/after drinking) assessed the same compensatory behaviors 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. For each item, participants indicated the frequency of the behavior (1=never; 2=rarely (25% of occasions); 3=sometimes (50% of occasions); 4=often (75% of occasions); 5=nearly always).

The total score ($\alpha=0.94$) ranges from 21 to 105. A CEBRACS total score >21 points (i.e., at least one infrequent engagement in FAD on at least one item) reflects FAD behavior, as previously reported (Knight et al., 2017; Moeck & Thomas, 2021; Pietrabissa et al., 2018; Rahal et al., 2012; Ritz et al., 2023). The CEBRACS comprises four subscales (Ritz et al., 2023): “alcohol effects” (7-35; $\alpha=0.97$); “dietary restraint/exercising” (7-35; $\alpha=0.93$), “purging” (5-25 points; $\alpha=0.92$) and “extreme fasting/vomiting” (2-10 points; $\alpha=0.79$).

2.3.2. Cognitive testing

We administered an extensive neuropsychological battery assessing (1) *verbal episodic memory* with the French adaptation of the California Verbal Learning Test (CVLT; Delis et al., 1988); (2) *visuospatial abilities* and *visual episodic memory* with the Rey-Osterrieth Complex Figure (ROCF; Osterrieth, 1944); (3) *executive functions* with the Stroop test (Stroop, 1935) for inhibition, the Trail Making Test (Reitan, 1955) for reactive flexibility, the Ruff Figural Fluency Test (RFFT; (Foster et al., 2005) for spontaneous flexibility and the

Wisconsin Card Sorting Test (WCST; Heaton et al., 1993) for conceptual flexibility. The scores retained for each test are summarized in Table 1.

2.4. Statistical analyses

To determine whether FAD is associated with specific cognitive performances, participants with a CEBRACS total score higher than 21 were categorized as FAD (N=70; 54%), while participants with a CEBRACS total score of 21 were categorized as non-FAD (N=60; 46%). We compared scores of the cognitive battery (Table 2) between FAD and non-FAD students with ANOVAs. The AUDIT/SCOFF scores were secondly entered as covariates in ANCOVAs to estimate the specific impact of FAD on cognition, beyond the respective contributions of alcohol use and ED. We used the Levene's test to examine the homogeneity of the variances and applied Bonferroni correction to prevent type I-error ($p \leq 0.003$ for 14 comparisons).

To examine whether the distinct motives and behaviors in FAD were associated with specific cognitive profiles, we distinguished three groups for each of the four CEBRACS subscales: (1) Globally negative CEBRACS (C-, total score = 21, this group being used as a comparison group for all subscales); (2) Negative CEBRACS for this subscale (FAD-), i.e. FAD individuals who declare never engaging in behaviors related to the subscale; (3) Positive CEBRACS for this subscale (FAD+), i.e. FAD individuals who declare engaging in behaviors related to the subscale, hence scoring at least one item ≥ 2 ; Pinna et al., 2024)

The CEBRACS subscales were dichotomized as they are ordinal measures and are not normally distributed (all skewness and kurtosis parameters $> |2|$). We then conducted a multivariate regression analysis in all participants with the cognitive measures as dependent variables and the dichotomized CEBRACS subscales ("alcohol effect", "dietary restraint/exercising", "purging" and "extreme fasting/vomiting"; three groups for each

subscale: C-, FAD-, FAD+) as predictors. To prevent type I error and to account for the interrelationships between dependent variables, we conducted multivariate regression analyses rather than separate univariate regression analyses for each cognitive measure. We used Tukey tests as post-hoc. Due to the relatively small sample size, we applied a bootstrap with 1000 replicates with a method of 95% CI. We conducted statistical analyses with SPSS software.

3. Results

FAD/non-FAD students did not significantly differ regarding age ($t_{(128)}=0.57$; $p=0.57$) and sex ratio ($\text{Chi}^2=0.49$; $p=0.48$) but, as expected, FAD and non-FAD students were not matched on AUDIT ($t_{(128)}=5.72$; $p\leq 0.001$) and SCOFF scores ($t_{(128)}=5.29$; $p\leq 0.001$), FAD students having higher scores than non-FAD students (Table 1; Ritz et al., 2024; Roosen & Mills, 2015).

3.1. FAD / non-FAD comparison on cognitive performance

Statistical comparisons conducted between FAD and non-FAD participants with ANOVAs on cognitive measures did not show significant results with/without Bonferroni correction ($p>0.003$ and $p>0.05$ respectively) (Table 3), with very small effect sizes (partial η^2 inferior to equal to .02). In the FAD group, the coefficients of variation for each cognitive measure were large, ranging from 5% (only for one measure, the copy accuracy of the ROCF) to 508%, suggesting a great heterogeneity in cognitive performances.

When including AUDIT and SCOFF scores as covariates, results remained unchanged (all $p>0.05$). The covariates were not statistically significant (all $p >0.05$), except for the SCOFF score ($p=0.02$; partial $\eta^2=0.04$) in the comparison between FAD and non-FAD students on copy accuracy of the ROCF, where FAD students showed reduced performance. AUDIT and SCOFF scores thus had no effect on cognitive performance in FAD, and these variables were not included in the subsequent analyses.

3.2. Distinct cognitive profiles across FAD subdimensions (Table 4 and Figure 1)

Among FAD individuals (N=70), 76% (N=53) engage in FAD for alcohol motives, 71% (N=50) for dietary restraint/exercising motives, 4% (N=3) for purging motives and 24% (N=17) for extreme fasting/vomiting motives.

The *CEBRACS* “*alcohol enhancement*” dichotomized subscale was never a significant predictor of cognitive performance (all $p>0.05$). The *CEBRACS* “*dietary restraint/exercising*” dichotomized subscale was a significant predictor of the copy accuracy of the ROCF (with a small effect size), the number of learning errors and delayed free recall errors of the CVLT (with small effect sizes). Post-hoc comparisons revealed that FAD- performed better than FAD+ (higher copy accuracy on the ROCF; fewer errors on the CVLT) and C- (i.e., fewer errors for the delayed recall of the CVLT) (Figure 1A). The *CEBRACS* “*purging*” dichotomized subscale was a significant predictor of the delayed recall of the ROCF and the total strategy design of the RFFT (with small effect sizes). Post-hoc comparisons showed that FAD+ performed better than C- (greater copy accuracy of the ROCF) but lower than FAD- (fewer strategy designs on the RFFT) (Figure 1B). The *CEBRACS* “*extreme fasting and vomiting*” dichotomized subscale was a significant predictor of the delayed recall of the ROCF as well as the number of errors on the Stroop and maintenance of categories on the WCST (with small effect sizes). Post-hoc comparisons showed that FAD+ performed lower than FAD- on visual memory (lower recall of the ROCF) but better than FAD- (fewer errors on the Stroop and greater card sorting on the WCST) and C- (fewer errors on the Stroop) on executive functions (Figure 1C).

4. Discussion

We explored the yet unexplored neuropsychological correlates of FAD in University students. We went beyond the mere comparison between individuals presenting FAD or not to consider FAD as a multi-dimensional construct, each sub-component (i.e., alcohol effects, dietary restraint/exercising, purging and extreme fasting/vomiting), being related to distinct motivations and behaviors, potentially generating dissociated cognitive correlates.

4.1. FAD: an umbrella term lacking cognitive profile differentiation

We did not find significant differences between FAD and non-FAD students on cognitive abilities, suggesting that FAD behaviors are not globally associated with neurocognitive deficits (Szynal et al., 2022), even after controlling for alcohol consumption and ED. However, such results, in line with numerous ones found in BD, might be related to the fact that the individuals with FAD we included, being young University students, have a high cognitive reserve, potentially allowing them to compensate for the cognitive and brain effects of alcohol and ED in the early stages of the disorders (as stated in the compensation hypothesis proposed in BD, e.g., Campanella et al., 2013; Crego et al., 2012), resulting in the difficulty to identify the still subtle cognitive deficits.

Findings also reveal a great heterogeneity in the cognitive performance within the FAD group. FAD brings together different clinical realities, characterized by distinct motives and behaviors as well as different psychological vulnerabilities (Ritz et al., 2024), which may be each related with a specific cognitive profile. Thus, FAD may constitute an umbrella term, and the CEBRACS total score might hide a strong cognitive heterogeneity across the various motives and behaviors found in FAD individuals.

4.2. The distinct FAD motives/behaviors are associated with specific cognitive profiles

Findings reveal the heterogeneity in the relationship between the distinct FAD motives/behaviors and cognitive performance among University students. Differences observed in the cognitive profile suggest that FAD behaviors and motives are not unilaterally associated with cognitive deficits but are rather related to modified cognitive functioning, with some increased and some decreased abilities compared to controls

Surprisingly, FAD's motive for enhancing alcohol intoxication is not related to cognitive functioning in university students, contrary to what might be expected with regard to the literature on BD (Carbia et al., 2018; Czapla et al., 2015; Salas-Gomez et al., 2016; Winward et al., 2014) and AUD (Fox et al., 2000; Müller-Oehring et al., 2009; Pitel et al., 2007). Contrary to AUD, FAD is a planned behaviour of restricting eating in anticipation of alcohol consumption to maximise the intoxicating effects, which may explain why students who engage in FAD for alcohol motives do not have poorer cognitive functioning than non-FAD students.

Conversely, dietary restraint to avoid weight gain, self-induced vomiting and purging behaviors observed in FAD-students seems to have a detrimental effect on visuospatial abilities, episodic memory and executive strategies, as reported in ED patients (Jáuregui-Lobera, 2013; Nandrino et al., 2006; Sherman et al., 2006; Stedal et al., 2012; Weider et al., 2015). Visuospatial disabilities have been mainly reported in ED patients (Jones et al., 1991; Kingston et al., 1996), with difficulties in disengaging from local to global treatment, resulting on focusing on the details rather than on the global information, in agreement with the central coherence default reported (Eichen et al., 2017; Lang et al., 2016; Lopez, Tchanturia, Stahl, Booth, et al., 2008; Lopez, Tchanturia, Stahl, & Treasure, 2008; Roberts et al., 2013; Stedal et al., 2012). This poor global integration (i.e. weak coherence) results in the focus on details related to disordered eating such as shape and weight rather than overall health (Roberts et al., 2016), hence contributing to disease progression (Kingston et al., 1996).

Similarly, in ED patients, recurrent images related to memories of adverse life experiences play a central role in triggering self-induced vomiting (Hinrichsen et al., 2007), such impaired visual episodic memory (potentially interfering with adapted memories recollection) being also found in our sample. Our results may also reflect loss of control in FAD students, who do not implement effective strategies to anticipate alcohol use. They may exhibit cognitive rigidity that leads them to consistently engage in purging behaviors during and/or after drinking, stabilizing FAD-related habits. Indeed, inhibition deficits, reported in patients with bulimia nervosa, have been reported to contribute to the maintenance of disordered eating behaviors (Weider et al., 2015). Individuals with poor executive functioning may be more likely to engage in compensatory behaviors after drinking, in relation to the higher lack of premeditation reported in a previous study in FAD students with purging behaviors (Ritz et al., 2024).

Conversely, FAD students engaged in the extreme fasting and vomiting behaviors have better inhibition and plan maintenance. These cognitive functions are directly in line with these FAD behaviors, in which students restrict their food intake over several meals or even several days after drinking, deliberately avoiding food. Starving oneself requires efficient executive functioning, to refrain from eating, plan other activities at mealtimes and maintain food privation over time. Purging behaviors are also associated with better visual episodic memory. One possible explanation is that purging behaviors observed in FAD (laxative/diuretic uses) occur mainly during or after drinking to compensate for alcohol calories. FAD students with efficient visual episodic memory would be better able to remember the drinking occasions and to visualize their alcohol consumption, prompting them to engage in purging behaviors to mitigate the perceived negative impact of alcohol calories on weight gain. In association with superior attention to details rather than global information (Eichen et al., 2017; Lang et al., 2016; Lopez, Tchanturia, Stahl, Booth, et al., 2008; Lopez, Tchanturia, Stahl, & Treasure,

2008; Roberts et al., 2013; Stedal et al., 2012), better visual episodic memory may lead FAD students to mainly remember the calorie intake of alcoholic beverages, resulting in the use of laxatives/diuretics as a counterbalanced behavior, despite the purging-related health damages.

This study highlights that FAD should not be considered as a homogeneous phenomenon and that it is essential to examine its different motives and behaviors, as they are differentially associated with the cognitive profile in FAD students. These findings support the need for research that examines the correlates of FAD separately by motives (Berry et al., 2024). Additionally, it is important to further explore the cognitive profiles associated with the different motives/behaviors of FAD, by adopting an approach that considers both a better versus a less cognitive functioning, rather than focusing solely on cognitive deficits. This approach allows for a more nuanced understanding of how different cognitive abilities may influence the expression of distinct FAD behaviors/motives. From a clinical perspective, therapeutic approaches for FAD students should harness their efficient cognitive functioning, such as memory and executive functions, to help them focus on and remember other aspects of their drinking days, and less on alcohol-related calories. These strategies should also promote the planning and adoption of healthier eating behaviors, especially on drinking days, to prevent the negative consequences of disordered eating.

4.3. Conclusion

The present study is the first to examine the cognitive profile of FAD students, paving the way for a better understanding of the neuropsychological correlates of FAD behaviors. When considering FAD as a unique entity screened using the CEBRACS total score, the cognitive profile of FAD students does not differ from that of non-FAD students. However, FAD constitutes an umbrella term encompassing various motivations, behaviors and clinical

manifestations potentially leading to various cognitive profiles. Indeed, when the various subcomponents of FAD are considered separately, the findings reveal distinct cognitive outcomes, not only characterized by deficits (as usually found in clinical AUD and ED) but rather by differentially improved/impaired cognitive functions. Dietary restraint and exercising are associated with poorer visuospatial abilities and verbal episodic memory. In addition, purging behaviors are associated with poorer executive functioning but better visual episodic memory. In contrast, extreme fasting and self-induced vomiting are related to better executive functioning but lower visual episodic memory. While our cross-sectional design hampers to explore the causal links between cognitive functioning and FAD, our results have several clinical implications. They encourage clinicians to consider the different motives associated with FAD as they have distinct relationships with cognitive functioning, and to tailor prevention strategies to the specific cognitive vulnerabilities, which could lead to a decline in academic performance. Therapeutic strategies should focus on reducing alcohol consumption in FAD students to prevent the onset of alcohol-related cognitive deficits, and on promoting the adoption of healthier eating behaviors to avoid the negative consequences of food deprivation and self-induced vomiting. Cognitive behavioral therapy may be an effective therapeutic approach to improve emotional regulation in FAD students, to manage negative states and thus reduce unhealthy eating habits.

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6. Tables

Table 1: Sample characteristics of the participants (N=130)

<i>Variables</i>	<i>Descriptive statistics</i>	Non-FAD individuals (N=60)	FAD individuals (N=70)
Age	18.4 ± 0.68	18.3 ± 0.67	18.4 ± 0.69
<i>Range</i>	18-22	18-22	18-21
Gender (Men/Women)	31/99		
CEBRACS total score	27.00 ± 10.40	21.00 ± 0.00	32.2 ± 12.00
<i>Range</i>	21-68	21-21	22-68
CEBRACS “enhance the alcohol effects” factor	10.1 ± 5.55	7.00 ± 0.00	12.70 ± 6.51
<i>Range</i>	7-29	7-7	7-29
CEBRACS “dietary restraint and exercising” factor	9.55 ± 5.21	7.00 ± 0.00	11.70 ± 6.35
<i>Range</i>	7-35	7-7	7-35
CEBRACS “purging” factor	5.06 ± 0.48	5.00 ± 0.00	5.11 ± 0.65
<i>Range</i>	5-10	5-5	5-10
CEBRACS “extreme fasting and vomiting” factor	2.37 ± 1.18	2.00 ± 0.00	2.69 ± 1.55
<i>Range</i>	2-9	2-2	2-9
AUDIT	9.88 ± 6.27	6.83 ± 4.50	12.5 ± 6.43
<i>Range</i>	0-32	0-19	1-32
Age of onset	15.01 ± 1.53	15.01 ± 1.53	15.40 ± 1.27
<i>Range</i>	10-18	12-18	10-18
Number of standard drinks per week	3.78 ± 4.15	2.75 ± 2.64	4.61 ± 4.92
<i>Range</i>	0-21	0-10	0-21
Number of day per week of alcohol consumption	1.60 ± 1.06	1.47 ± 0.72	1.71 ± 1.26
<i>Range</i>	1-7	1-4	1-7
SCOFF	1.37 ± 1.36	0.75 ± 0.91	1.90 ± 1.46
<i>Range</i>	0-5	0-3	0-5

Data are shown as mean ± standard deviation

CEBRACS: Compensatory Eating and Behaviors in Response to Alcohol Consumption Scale; AUDIT: Alcohol Use Disorders Identification Test

Table 1: Retained scores of the cognitive battery

Cognitive domains	Cognitive tests	Retained scores
<i>Verbal episodic memory</i>	CVLT	Learning (sum of correct responses across 5 trials)
		Learning (sum of errors across 5 trials)
		Delayed free recall (number of correct responses)
		Delayed free recall (number of errors)
<i>Visual episodic memory</i>	ROCF	Delayed free recall (+30 minutes: copy accuracy /36 points)
<i>Visuospatial abilities</i>	ROCF	Copy accuracy (/36 points)
<i>Executive functions</i>	Stroop	Interference-Naming: time
		Interference-Naming errors
	TMT	TMT Part B - Part A time
		TMT Part B- Part A errors
	RFFT	Total strategy design
		Total strategies
	WCST	Number of perseverative errors
		Maintenance of categories (number of cards)

CVLT: California Verbal Learning Test; ROCF : Rey Osterrieth Complex Figure; TMT: Trail Making Test; TMT B-A : Trail Making Test Part A minus Part B; RFFT : Ruff Figural Fluency Test; WCST: Wisconsin Card Sorting Test

Table 3: Comparisons of FAD and non-FAD students on the cognitive extensive examination

Cognitive scores	Non-FAD individuals (N=60)	FAD individuals (N=70)	Statistics p value; effect size ¹
<i>Verbal episodic memory</i>			
CVLT Learning (sum of correct responses across 5 trials)	64.42 ± 8.42	63.94 ± 7.97	0.74; 0.001
CVLT Learning (sum of errors across 5 trials)	3.57 ± 3.29	3.13 ± 2.72	0.41; 0.005
CVLT Delayed free recall (number of correct responses)	14.32 ± 2.15	14.07 ± 1.74	0.47; 0.004
CVLT Delayed free recall (number of errors)	0.28 ± 0.58	0.30 ± 0.57	0.87; 0.00
<i>Visual episodic memory</i>			
ROCF Delayed free recall	25.06 ± 4.26	25.67 ± 5.12	0.47; 0.004
<i>Visuospatial abilities</i>			
ROCF Copy accuracy (/36 points)	37.71 ± 1.59	34.66 ± 1.88	0.89; 0.00
<i>Executive functions</i>			
Stroop Interference-Naming (time)	38.05 ± 17.07	44.71 ± 29.88	0.13; 0.02
Stroop Interference-Naming (errors)	0.50 ± 1.10	0.34 ± 0.74	0.55; 0.003
TMT Part B - Part A (time)	36.92 ± 21.05	34.11 ± 17.92	0.41; 0.005
TMT Part B - Part A (errors)	0.15 ± 1.09	0.23 ± 0.78	0.63; 0.002
RFFT Total strategy design	83.78 ± 31.60	87.16 ± 26.91	0.35; 0.007
RFFT total strategies	47.32 ± 31.53	40.01 ± 26.90	0.16; 0.02
WCST Number of perseverative errors	9.85 ± 7.11	10.24 ± 7.50	0.76; 0.00
WCST maintenance of categories	66.22 ± 8.71	64.66 ± 10.11	0.35; 0.007

Data are shown as mean ± standard deviation

Analyses were conducted with ANOVAs. For all analyses, Levene's test was not significant, indicating homogeneity of variances.

¹ partial eta square; 0.01: small effect size; 0.06: moderate; 0.14: large

FAD: Food and Alcohol Disturbance

CVLT: California Verbal Learning Test; ROCF : Rey Osterrieth Complex Figure; TMT: Trail Making Test; TMT B-A : Trail Making Test Part A minus Part B; RFFT : Ruff Figural Fluency Test; WCST: Wisconsin Card Sorting Test

Table 4: Relationships between distinct motives for Food and Alcohol Disturbance and cognitive performance

Cognitive scores	FAD predictors	Statistics (p value; partial η^2)	Post-hoc comparisons
<i>Verbal episodic memory</i>			
CVLT Learning correct responses	CEBRACS “OH” CEBRACS “dietary” CEBRACS “purging” CEBRACS “extreme”	0.35; 0.01 0.57; 0.00 0.86; 0.00 0.92; 0.00	
CVLT Learning errors	CEBRACS “OH” CEBRACS “dietary” CEBRACS “purging” CEBRACS “extreme”	0.59; 0.00 0.04*; 0.03 0.18; 0.01 0.09; 0.02	FAD- < (FAD+ = C-)
CVLT Delayed free recall (number of correct responses)	CEBRACS “OH” CEBRACS “dietary” CEBRACS “purging” CEBRACS “extreme”	0.50; 0.00 0.22; 0.01 0.93; 0.00 0.09; 0.02	
CVLT Delayed free recall (number of errors)	CEBRACS “OH” CEBRACS “dietary” CEBRACS “purging” CEBRACS “extreme”	0.74; 0.00 0.05*; 0.03 0.36; 0.01 0.79; 0.00	FAD- < FAD+
<i>Visual episodic memory</i>			
Delayed recall of the ROCF	CEBRACS “OH” CEBRACS “dietary” CEBRACS “purging” CEBRACS “extreme”	0.43; 0.00 0.08; 0.02 0.04*; 0.03 0.03*; 0.04	FAD+ > C- FAD- > FAD+
<i>Visuospatial abilities</i>			
Copy accuracy of the ROCF	CEBRACS “OH” CEBRACS “dietary” CEBRACS “purging” CEBRACS “extreme”	0.97; 0.00 0.05*; 0.02 0.09; 0.02 0.21; 0.01	FAD- > FAD+
<i>Executive functions</i>			
Stroop Interference-Naming (time)	CEBRACS “OH” CEBRACS “dietary” CEBRACS “purging” CEBRACS “extreme”	0.85; 0.00 0.50; 0.00 0.87; 0.00 0.75; 0.00	
Stroop Interference-Naming (errors)	CEBRACS “OH” CEBRACS “dietary”	0.49; 0.00 0.20; 0.01	

	CEBRACS “purging” CEBRACS “extreme”	0.81; 0.00 0.05*; 0.03	FAD+ < (C- = FAD-)
TMT Part B - Part A (time)	CEBRACS “OH” CEBRACS “dietary” CEBRACS “purging” CEBRACS “extreme”	0.27; 0.10 0.99; 0.00 0.88; 0.00 0.75; 0.00	
TMT Part B - Part A (errors)	CEBRACS “OH” CEBRACS “dietary” CEBRACS “purging” CEBRACS “extreme”	0.27; 0.10 0.41; 0.00 0.76; 0.00 0.59; 0.00	
RFFT Total strategy design	CEBRACS “OH” CEBRACS “dietary” CEBRACS “purging” CEBRACS “extreme”	0.99; 0.00 0.83; 0.00 0.50*; 0.03 0.36; 0.01	FAD- > FAD+
RFFT total strategies	CEBRACS “OH” CEBRACS “dietary” CEBRACS “purging” CEBRACS “extreme”	0.24; 0.01 0.27; 0.01 0.12; 0.20 0.44; 0.00	
WCST Number of perseverative errors	CEBRACS “OH” CEBRACS “dietary” CEBRACS “purging” CEBRACS “extreme”	0.18; 0.01 0.92; 0.00 0.33; 0.01 0.15; 0.02	
WCST maintenance of categories	CEBRACS “OH” CEBRACS “dietary” CEBRACS “purging” CEBRACS “extreme”	0.40; 0.01 0.96; 0.00 0.59; 0.00 0.03*; 0.04	FAD+ > FAD-

CVLT: California Verbal Learning Test; ROCF : Rey Osterrieth Complex Figure; TMT: Trail Making Test; TMT B-A : Trail Making Test Part A minus Part B; RFFT : Ruff Figural Fluency Test; WCST: Wisconsin Card Sorting Test

CEBRACS “OH”: “alcohol enhancement” subscale of the CEBRACS; CEBRACS “dietary”: “dietary restraint and exercising” subscale; CEBRACS “extreme”: “extreme fasting and vomiting” subscale

* significant at $p \leq 0.05$; significant results are in bold

Partial η^2 : =0.01 small effect size; =0.06 medium effect size; =0.14 large effect size

C-: negative CEBRACS for total score = 21 (no engagement in FAD behaviors)

FAD-: negative CEBRACS for this subscale (FAD individuals who declare never engaging in behaviors related to the subscale)

FAD+: positive CEBRACS for this subscale (FAD individuals who declare engaging in behaviors related to the subscale)

7. Figures

Figure 1: Comparisons of cognitive performance between non-FAD individuals and FAD

individuals according to the distinct motives identified by the CEBRACS subscales

A: FAD individuals on the “dietary restraint and exercising” CEBRACS subscale; B: FAD individuals on the “purging” CEBRACS subscale; C: FAD individuals on the “extreme fasting and vomiting” CEBRACS subscale

* Significant difference at $p \leq 0.05$ (Tukey post-hoc)

Neg: scale negative (FAD individuals who declare they never engage in FAD behaviors on the subscale under consideration); Pos scale positive (FAD individuals who declare they engage in FAD behaviors at least on one item on the subscale under consideration); C-: CEBRACS negative for a CEBRACS total score = 21 (i.e. individuals not engaged in FAD)