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Neurocognitive correlates of Food and Alcohol Disturbances: An integrated neuropsychological investigation

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A B S T R A C T

Food and Alcohol Disturbance (FAD) represents a functional relationship between alcohol use and eating behaviors, in which individuals engage in disordered eating to enhance alcohol intoxication and/or compensate for alcohol-related caloric intake. FAD is highly prevalent among young adults, particularly University students. While the biopsychosocial correlates of FAD are documented, its specific neurocognitive correlates remain unexplored, despite extensive literature describing the distinct neurocognitive correlates of alcohol consumption and eating disorders. We therefore investigated whether FAD is associated with neurocognitive correlates in university students and examined whether different FAD sub-dimensions relate to distinct cognitive profiles. We assessed FAD in 130 French university students using the CEBRACS scale and administered an extensive neuropsychological battery measuring visuospatial abilities, episodic memory, and executive functions. We compared cognitive performance between individuals who do and do not engage in FAD and then conducted exploratory multivariate regression analyses to identify variations in cognitive profiles across the CEBRACS subscales. The general comparison between individuals who do and do not engage in FAD did not reveal significant differences. Conversely, analyses of the CEBRACS subscales identified specific patterns: (1) dietary restraint was associated with poorer visuospatial abilities and verbal episodic memory; (2) purging behaviors were associated with lower executive functioning but improved 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 encompassing various cognitive profiles according to the distinct eating behaviors involved and highlight the importance of considering the subcomponents of FAD when exploring its neurocognitive correlates.

1. Introduction

Food and Alcohol Disturbance (FAD) refers to the engagement in compensatory behaviors before, during, and/or after alcohol consumption to enhance its effect (e.g., restricting eating to boost intoxication) and/or to compensate for alcohol caloric intake (e.g., exercising, dietary restraint, and/or purging) (Choquette et al., 2018b; Shepherd et al., 2021). The relationship between alcohol use and eating disorders (ED) is well documented in young adults (Benjamin and Wulfert, 2005; Ferriter and Ray, 2011; Laghi et al., 2015) and university students (Pedersen et al., 2025; Rush et al., 2016). The prevalence of FAD is associated with both (1) excessive alcohol consumption (Shepherd et al., 2021), including binge drinking (Burke et al., 2010; Peralta et al., 2019; Rahal et al., 2012), and (2) eating disorders (ED; Hunt and Forbush, 2016; Pietrabissa et al., 2018; Pompili and Laghi, 2018; Ritz et al., 2023). Importantly, FAD is not conceptualized as the comorbidity between excessive alcohol use and clinical ED, and FAD can occur in the absence of excessive alcohol use and/or ED. It rather refers to a functional relationship between alcohol use and disordered eating behaviors (Berry et al., 2024), with intertwined motivations and deliberate mechanisms

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in which one condition promotes the other (Choquette et al., 2018).

FAD is not a unitary phenomenon, as it varies both in terms of behaviors (e.g., caloric restriction, dieting, dysfunctional exercise, purging, self-induced vomiting) and motivations (e.g., caloric compensation, alcohol enhancement motives). These FAD subtypes are associated with distinct prevalence rates, biopsychosocial correlates, and consequences (Berry et al., 2024). Scientific exploration of FAD has expanded recently, generating crucial insights regarding its epidemiology, predictors, conceptualization, and measurement (for a review, see Berry et al., 2024; Shepherd et al., 2021). Reported prevalence rates vary widely, ranging from 4.7 % to 79.8 % and 5.6 %–88.7 % for both alcohol enhancement and caloric compensation motives respectively. Among university students, the prevalence of alcohol enhancement motives ranges from 23.7 % to 35.8 %, while the prevalence of caloric compensation motive ranges from 37.6 % to 49.3 % (Berry et al., 2024). Alcohol use and disordered eating correlates are mainly associated with both motives, whereas appearance-related concerns and social peer pressure appear to be uniquely associated with caloric compensation motives. Regarding consequences, alcohol-related problems were associated with FAD for both motives. However, the specific neurocognitive correlates of FAD remain unexplored, as only one study has suggested increased memory loss and blackouts among students who engage in FAD, due to higher alcohol intoxication (Giles et al., 2009). Recent work has begun to examine cognitive expectancies associated with FAD (Berry and Looby, 2024), providing insight into beliefs and anticipated outcomes that may influence FAD-related behaviors; however, this study does not address neurocognitive functioning per se. This absence of data on the cognitive profiles of students who engage in FAD is surprising in view of the large literature describing the distinct neurocognitive and psychological consequences of excessive alcohol consumption (e.g., binge drinking Carbia et al., 2018; Lang et al., 2016) and ED (e.g., Prince et al., 2022; Rylander et al., 2020), which show widespread impairments in visuospatial abilities (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), attention, 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). Only one study, conducted using questionnaires in adolescents, has shown that FAD is associated with dysfunctional metacognitive processes, specifically in terms of cognitive rigidity and reduced inhibitory control (Laghi et al., 2020).

It remains unclear whether some cognitive deficits are premorbid traits or the direct (or indirect) consequences of FAD. In ED, there is a shift in how the cognitive profiles of individuals are considered, and neuropsychological impairments might be seen as predisposing factors for ED rather than as consequences of the disorder (Jáuregui-Lobera, 2013; Lena et al., 2004). Given that ED are chronic disorders with periods of exacerbation and remission, it has been suggested that neuropsychological deficits may exist before the onset of the disorder and contribute to the etiology of ED development (Lena et al., 2004). Similarly, in binge drinking, despite improvements in executive functioning, visuospatial abilities, and working memory after one week (Winward et al., 2014b), four weeks (Winward et al., 2014a), or two years of abstinence (Mota et al., 2013), performance remained lower compared to individuals who do not engage in binge drinking (Winward et al., 2014b), and verbal memory and cognitive flexibility were still impaired (Winward et al., 2014). These findings suggest that some cognitive deficits may exist prior to the onset of binge drinking.

As both binge drinking and ED are associated with neuropsychological deficits, the cognitive correlates of FAD might be widespread, combining the respective impacts of alcohol use/ED, while also potentially generating specific effects (e.g., greater brain damage through increased alcohol intoxication; Szynal 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 young adults. We thus aimed to provide a deeper understanding of FAD by investigating cognitive abilities in this population with two objectives: (1) determining whether FAD is associated with lower cognitive functioning in university students using a cross-sectional design to compare individuals who do and do not engage in FAD; and (2) examining whether the different sub-dimensions of FAD - i.e., in terms of motives (alcohol enhancement) and behaviors related to caloric compensation (dietary restraint and purging) - are associated with distinct cognitive profiles, through the identification of specific relationships between FAD sub-dimensions and cognitive performance.

2. Material and methods

2.1. Participants

We included 130 first-year volunteer students at the University of Caen Normandy (France). We recruited them on a voluntary basis and individually invited them to take part in the experiment in a laboratory room. The inclusion criteria were being a first-year university student aged 18–22 years, being a native French speaker, and being an alcohol consumer (i.e., having consumed alcohol at least once in the past year). The exclusion criteria concerned any self-reported neurological or psychiatric (major depressive disorder, bipolar disorder, psychotic disorders, or a diagnosis of alcohol use disorder and/or eating disorders), as well as endocrine or infectious disease likely to affect cognitive functioning. Participants were interviewed by a research assistant about their alcohol consumption and were asked about their weekly alcohol intake (in standard drinks, with one standard drink corresponding to 10 g of pure ethanol) and their frequency of drinking during a typical week (from 1 to 7 days). Descriptive statistics are presented in Table 1.

2.2. Ethics

This study is part of a broader research program exploring substance use 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 University of Caen, n°2025011616552700000220000433) prior to inclusion and provided written informed consent. We adhered to 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 using the French version of the Compensatory Eating and Behaviors in Response to Alcohol Consumption Scale (CEBRACS; Ritz et al., 2023), a 21-item questionnaire assessing 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 (α = 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 and 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; α = 0.97), assessing alcohol

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

Variables	*Descriptive statistics*	Individuals who do not engage in FAD (N = 60)	Individuals who engage in FAD (N = 70)
Age	18.4 ± 0.68	18.3 ± 0.67	18.4 ± 0.69
Range	18–22	18–22	18–21
Gender (Men/Women)	31/99	16/44	15/55
CEBRACS total score	27.00 ± 10.40	21.00 ± 0.00	32.2 ± 12.00
Range	21–68	21–21	22–68
CEBRACS "enhancement of alcohol effects" factor	10.1 ± 5.55	7.00 ± 0.00	12.70 ± 6.51
Range	7–29	7–7	7–29
CEBRACS "dietary restraint and exercise" factor	9.55 ± 5.21	7.00 ± 0.00	11.70 ± 6.35
Range	7–35	7–7	7–35
CEBRACS "purging behaviors" factor	5.06 ± 0.48	5.00 ± 0.00	5.11 ± 0.65
Range	5–10	5–5	5–10
CEBRACS "extreme fasting and self-induced vomiting" factor	2.37 ± 1.18	2.00 ± 0.00	2.69 ± 1.55
Range	2–9	2–2	2–9
AUDIT	9.88 ± 6.27	6.83 ± 4.50	12.5 ± 6.43
Range	0–32	0–19	1–32
Age of onset	15.01 ± 1.53	15.01 ± 1.53	15.40 ± 1.27
Range	10–18	12–18	10–18
Number of standard drinks per week	3.78 ± 4.15	2.75 ± 2.64	4.61 ± 4.92
Range	0–21	0–10	0–21
Number of days per week of alcohol consumption	1.60 ± 1.06	1.47 ± 0.72	1.71 ± 1.26
Range	1–7	1–4	1–7
SCOFF	1.37 ± 1.36	0.75 ± 0.91	1.90 ± 1.46
Range	0–5	0–3	0–5

Data are presented as mean ± standard deviation.
CEBRACS: Compensatory Eating and Behaviors in Response to Alcohol Consumption Scale; AUDIT: Alcohol Use Disorders Identification Test.

enhancement motives; and three subscales related to caloric compensation motives: "dietary restraint/exercising" (7–35; α = 0.93), "purging" (5–25 points; α = 0.92) and "extreme fasting/vomiting" (2–10 points; α = 0.79).

Given documented cultural differences between the U.S. and France in FAD behaviors (Choquette et al., 2018), we considered the French version of the CEBRACS more appropriate for use in our sample than the original measure (Rahal et al., 2012). We therefore used the validated French version of the CEBRACS, which has shown good psychometric properties, including internal consistency and concurrent validity, in a large sample of university students (Ritz et al., 2023).

2.3.2. Alcohol and eating disorder measures

Participants were interviewed using the French version of the Alcohol Use Disorders Identification Test (AUDIT; Gache et al., 2005; French validation: Demartini and Carey, 2012) ton assess alcohol-related problems. They were also assessed with the SCOFF questionnaire, designed to screen for the risk of developing ED (Garcia et al., 2010, 2011), which comprises five dichotomous questions ("yes"/"no", total score 0–5).

2.3.3. Cognitive testing

We administered an extensive neuropsychological battery assessing (1) ***verbal episodic memory*** using the French adaptation of the California Verbal Learning Test (CVLT; Delis et al., 1988); (2) ***visuospatial abilities*** and ***visual episodic memory*** using the Rey-Osterrieth Complex Figure (ROCF; Osterrieth, 1944); and (3) ***executive functions*** using 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 2.

The neuropsychological battery was selected to cover the main cognitive abilities typically assessed in neurological/psychopathological disorders, as well as to focus on the cognitive domains frequently reported as altered in AUD/ED, which are relevant to the behavioral control processes implicated in FAD. All tests are standardized cognitive instruments with strong construct validity and sensitivity to neuropsychological dysfunction (Lezak et al., 2012; Strauss et al., 2007).

2.4. Procedure

Participants were recruited through institutional mailing lists and flyers distributed across the University. Interested students first contacted the research team by email to verify eligibility criteria and received the information letter, allowing sufficient time for consideration before participation. Those who agreed then attended an inclusion visit, during which the inclusion and exclusion criteria were confirmed, the study was presented in detail, and written informed consent was obtained.

Participants then completed two testing sessions, each lasting approximately 90 min, scheduled within a maximum interval of 15 days to accommodate their academic schedules. Participants were required to abstain from alcohol for the 12 h preceding the experiment (as confirmed by a breathalyzer test). Other short-term factors (e.g. fasting, recent sleep quality/quantity, time of day, tobacco use, or recent physical activity) were not controlled, as previous studies indicate that the cognitive tasks are robust to such short-term fluctuations (Gijselaers et al., 2016; Pasetes et al., 2020). All cognitive tasks and questionnaires were administered in a fixed order to ensure standardization. Sessions took place in a dedicated testing room under the supervision of a trained research engineer (CM, co-author of this paper).

Participants were instructed to answer all questions as honestly as possible and were reminded that there were no correct or incorrect answers.

Table 2
Retained scores from the cognitive battery.

Cognitive domains	Cognitive tests	Retained scores
Verbal episodic memory	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)
Visual episodic memory	ROCF	Delayed free recall (+30 min: copy accuracy/36 points)
Visuospatial abilities	ROCF	Copy accuracy (/36 points)
Executive functions	Stroop TMT RFFT WCST	Interference-Naming: time Interference-Naming: errors TMT Part B - Part A: time TMT Part B- Part A: errors Total strategy designs Total strategies 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.

2.5. Statistical analyses

To determine whether FAD is associated with specific cognitive performances, participants with a CEBRACS total score greater than 21 were categorized as engaging in FAD (N = 70; 54 %), while participants with a CEBRACS total score of 21 were categorized as not engaging in FAD (N = 60; 46 %). The non-FAD group included individuals who did not report engaging in any of the behaviors on the CEBRACS scale, indicating an absence of engagement in compensatory behaviors on any subscale. We compared cognitive battery scores (presented in Table 2) between students who do and do not engage in FAD using ANOVAs. AUDIT/SCOFF scores were subsequently entered as covariates in ANCOVAs to estimate the specific impact of FAD on cognition, beyond the respective contributions of alcohol use and ED. Levene's test was used to examine the homogeneity of variances, and a Bonferroni correction was applied to prevent type I-error ($p \leq 0.003$ for 14 comparisons).

To examine whether the distinct motive (alcohol enhancement) and behaviors related to caloric compensation (dietary restraint, purging, and extreme fasting/vomiting) 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), used as the comparison group for all subscales); (2) Negative CEBRACS for the subscale (FAD-), i.e., individuals who engage in FAD but report never engaging in behaviors related to the subscale; (3) Positive CEBRACS for the subscale (FAD+), i.e., individuals who engage in FAD and report engaging in behaviors related to the subscale, scoring at least one item ≥2; Pinna et al. (2024). The three behavioral subscales (dietary restraint, purging, and extreme fasting/vomiting) were analyzed separately rather than combined into a single caloric compensation score, as they reflect distinct processes in the ED literature and do not constitute a unified factor in the validated structure of the CEBRACS.

The CEBRACS subscales were categorized because they are ordinal measures and are not normally distributed (all skewness and kurtosis parameters>|2|). We then conducted a multivariate regression analysis including all participants, with cognitive measures as the dependent variables and the categorized 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 errors and to account for the interrelationships between dependent variables, we conducted multivariate regression analyses rather than separate univariate regression analyses for each cognitive measure. Tukey tests were used as post-hoc. Due to the relatively small sample size, we applied a bootstrapping with 1000 replicates and a 95 % CI. Statistical analyses were conducted using SPSS software.

No missing data were recorded, as all participants completed the questionnaires and cognitive assessments in the laboratory under direct supervision.

As no previous data are available regarding cognitive functioning in FAD, the expected effect size was derived from meta-analytic findings in related clinical populations (AUD: (Crowe et al., 2020; Stavro et al., 2013); ED: (Keegan et al., 2021; Stedal et al., 2022). An a priori power analysis (G*Power), assuming a medium effect size ($f = 0.25$; $\alpha = 0.05$; power = 0.80) for an ANOVA comparing two groups (students who do and do not engage in FAD), indicated that a sample of 128 participants would be required. The present sample (N = 130) therefore provided sufficient power to detect medium-sized effects.

3. Results

Students who do and do not engage in FAD did not significantly differ in age (FAD: 18.39 ± 0.69; non-FAD: 18.32 ± 0.68; $t_{(128)} = 0.57$; $p = 0.57$) or sex ratio (FAD 15/55 men/women; non-FAD 16-44 men/women; $Chi^2 = 0.49$; $p = 0.48$). As expected, however, students who engage in FAD and those who do not were not matched on AUDIT ($t_{(128)} = 5.72$; $p \leq 0.001$) and SCOFF scores ($t_{(128)} = 5.29$; $p \leq 0.001$), with students who engage in FAD having higher scores than those who do not (Table 1; Ritz et al., 2024; Roosen and Mills, 2015).

3.1. Comparison of cognitive performance between students who do and do not engage in FAD

Statistical comparisons between participants who do and do not engage in FAD using ANOVAs on cognitive measures did not yield significant results, with/without Bonferroni correction ($p > 0.003$ and $p > 0.05$ respectively) (Table 3), and effect sizes were very small (partial η2 inferior to equal to 0.02). Within the FAD group, coefficients of variation for each cognitive measure were large, ranging from 5 % (for a single

Table 3
Comparisons of students who engage in FAD and students who do not on the comprehensive cognitive assessment.

Cognitive scores	Individuals who do not engage in FAD (N = 60)	Individuals who engage in FAD (N = 70)	Statistics F; p value; effect size[1]
Verbal episodic memory			
CVLT Learning (sum of correct responses across 5 trials)	64.42 ± 8.42	63.94 ± 7.97	$F_{(1,128)} =$ 0.10; 0.74; 0.001
CVLT Learning (sum of errors across 5 trials)	3.57 ± 3.29	3.13 ± 2.72	$F_{(1,128)} =$ 0.69; 0.41; 0.005
CVLT Delayed free recall (number of correct responses)	14.32 ± 2.15	14.07 ± 1.74	$F_{(1,128)} =$ 0.51; 0.47; 0.004
CVLT Delayed free recall (number of errors)	0.28 ± 0.58	0.30 ± 0.57	$F_{(1,128)} =$ 0.03; 0.87; 0.00
Visual episodic memory			
ROCF Delayed free recall	25.06 ± 4.26	25.67 ± 5.12	$F_{(1,128)} =$ 0.52; 0.47; 0.004
Visuospatial abilities			
ROCF Copy accuracy (/36 points)	37.71 ± 1.59	34.66 ± 1.88	$F_{(1,128)} =$ 0.02; 0.89; 0.00
Executive functions			
Stroop Interference-Naming: time	38.05 ± 17.07	44.71 ± 29.88	$F_{(1,128)} =$ 2.33; 0.13; 0.02
Stroop Interference-Naming: errors	0.50 ± 1.10	0.34 ± 0.74	$F_{(1,128)} =$ 0.36; 0.55; 0.003
TMT Part B - Part A: time	36.92 ± 21.05	34.11 ± 17.92	$F_{(1,128)} =$ 0.67; 0.41; 0.005
TMT Part B - Part A: errors	0.15 ± 1.09	0.23 ± 0.78	$F_{(1,128)} =$ 0.23; 0.63; 0.002
RFFT Total strategy designs	83.78 ± 31.60	87.16 ± 26.91	$F_{(1,128)} =$ 0.43; 0.35; 0.007
RFFT total strategies	47.32 ± 31.53	40.01 ± 26.90	$F_{(1,128)} =$ 2.032; 0.16; 0.02
WCST Number of perseverative errors	9.85 ± 7.11	10.24 ± 7.50	$F_{(1,128)} =$ 0.09; 0.76; 0.00
WCST maintenance of categories	66.22 ± 8.71	64.66 ± 10.11	$F_{(1,128)} =$ 0.87; 0.35; 0.007

Data are presented as mean ± standard deviation.
Analyses were conducted using ANOVAs. For all analyses, Levene's test was not significant, indicating homogeneity of variance.
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.
[1] partial eta square; 0.01: small effect size; 0.06: moderate; 0.14: large.

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measure: ROCF copy accuracy) to 508 %, suggesting substantial heterogeneity in cognitive performance.

When including AUDIT and SCOFF scores as covariates, the 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 students who do and do not engage in FAD on ROCF copy accuracy, where students who engage in FAD showed reduced performance. AUDIT and SCOFF scores therefore had no overall effect on cognitive performance in students who engage in FAD, and these variables were not included in subsequent analyses.

In an exploratory analysis, we examined whether the number of FAD behaviors endorsed (CEBRACS total score) was associated with cognitive performance within the group of students who engage in FAD. Results showed no significant associations (all p values > 0.004; see Table S1).

3.2. *Distinct cognitive profiles across FAD subdimensions in students who do and do not engage in FAD (Table 4 and Fig. 1)*

Among students who engage in FAD (N = 70), 76 % (N = 53) did so for alcohol-related motives, and 74 % (N = 52) for at least one caloric compensation motive. Specifically, 71 % (N = 50) engaged in dietary restraint/exercising behaviors for caloric compensation, 4 % (N = 3) in purging behaviors, and 24 % (N = 17) in extreme fasting/vomiting behaviors. In addition, 50 % (N = 35) of students who engage in FAD reported engaging in FAD for both alcohol enhancement and caloric compensation motives. Exploratory analyses comparing students who engage in FAD for only one motive with those who engage in FAD for both motives revealed no significant cognitive differences (all p values > 0.05; see Table S2 in the Supplementary Materials).

Multivariate regression analyses examining associations between CEBRACS subscales and neurocognitive performance are presented in Table 4 and Fig. 1. The ***CEBRACS "alcohol enhancement"*** categorized subscale was never a significant predictor of cognitive performance (all $p > 0.05$). The ***CEBRACS "dietary restraint/exercising"*** categorized subscale significantly predicted ROCF copy accuracy (small effect size), as well as the number of learning errors and delayed free recall errors on the CVLT (small effect sizes). Post-hoc comparisons revealed that students who engage in FAD but never engage in behaviors related to this subscale (FAD−) performed better than students who engage in FAD and exhibit behaviors related to this subscale (FAD+), showing higher ROCF copy accuracy and fewer CVLT errors, as well as better performance than students with globally negative CEBRACS scores (C−; total score = 21), with fewer errors on delayed CVLT recall (Fig. 1A). The ***CEBRACS "purging"*** categorized subscale significantly predicted ROCF delayed recall and total strategy designs on the RFFT (small effect sizes). Post-hoc comparisons showed that FAD + students performed better than C- students (greater ROCF copy accuracy) but worse than FAD-students (fewer strategy designs on the RFFT) (Fig. 1B). The ***CEBRACS "extreme fasting and vomiting"*** subscale significantly predicted ROCF delayed recall, the number of errors on the Stroop, and maintenance of categories on the WCST (small effect sizes). Post-hoc comparisons showed that FAD + students performed worse than FAD-students on visual memory (lower ROCF recall) but better than FAD-students (fewer Stroop errors and greater card sorting on the WCST) and C- students (fewer Stroop errors) on executive functions (Fig. 1C).

4. Discussion

We explored the previously unexamined neuropsychological correlates of FAD in French University students. We went beyond a simple comparison between students who do and do not engage in FAD to consider FAD as a multi-dimensional construct, in which distinct subcomponents - one motivational (alcohol enhancement) and three behavioral components related to caloric compensation (dietary restraint/exercising, purging, and extreme fasting/vomiting) - may be

Table 4
Results of the multivariate regression analyses examining relationships between distinct Food and Alcohol Disturbance motives and neurocognitive performance.

Cognitive scores	FAD predictors	Statistics1 (F; p value; partial η2)	Post-hoc comparisons
Verbal episodic memory			
CVLT Learning: correct responses	CEBRACS "OH"	$F_{(1,124)} = 0.88$; 0.35; 0.01	
	CEBRACS "dietary"	$F_{(1,124)} = 0.32$; 0.57; 0.00	
	CEBRACS "purging"	$F_{(1,124)} = 0.30$; 0.86; 0.00	
	CEBRACS "extreme"	$F_{(1,124)} = 0.01$; 0.92; 0.00	
CVLT Learning: errors	CEBRACS "OH"	$F_{(1,124)} = 0.29$; 0.59; 0.00	FAD- < (FAD+ = C-)
	CEBRACS "dietary"	**$F_{(1,124)} = 4.45$; 0.04*; 0.03**	
	CEBRACS "purging"	$F_{(1,124)} = 1.84$; 0.18; 0.01	
	CEBRACS "extreme"	$F_{(1,124)} = 2.92$; 0.09: 0.02	
CVLT Delayed free recall: number of correct responses	CEBRACS "OH"	$F_{(1,124)} = 0.45$; 0.50; 0.00	
	CEBRACS "dietary"	$F_{(1,124)} = 1.52$; 0.22: 0.01	
	CEBRACS "purging"	$F_{(1,124)} = 0.01$; 0.93; 0.00	
	CEBRACS "extreme"	$F_{(1,124)} = 2.96$; 0.09: 0.02	
CVLT Delayed free recall: number of errors	CEBRACS "OH"	$F_{(1,124)} = 0.11$; 0.74; 0.00	FAD- < FAD+
	CEBRACS "dietary"	**$F_{(1,124)} = 3.92$; 0.05*; 0.03**	
	CEBRACS "purging"	$F_{(1,124)} = 0.86$; 0.36; 0.01	
	CEBRACS "extreme"	F(1,124) = 0.07; 0.79; 0.00	
Visual episodic memory			
Delayed recall of the ROCF	CEBRACS "OH"	$F_{(1,124)} = 0.42$; 0.43; 0.00	FAD+ > C- FAD- > FAD+
	CEBRACS "dietary"	$F_{(1,124)} = 0.63$; 0.08; 0.02	
	CEBRACS "purging"	$F_{(1,124)} = 4.17$; 0.04*; 0.03	
	CEBRACS "extreme"	F(1,124) = **4.59; 0.03*; 0.04**	
Visuospatial abilities			
Copy accuracy of the ROCF	CEBRACS "OH"	$F_{(1,124)} = 0.01$; 0.97; 0.00	FAD- > FAD+
	CEBRACS "dietary"	**$F_{(1,124)} = 3.92$; 0.05*; 0.02**	
	CEBRACS "purging"	$F_{(1,124)} = 2.83$; 0.09; 0.02	
	CEBRACS "extreme"	$F_{(1,124)} = 1.61$; 0.21; 0.01	
Executive functions			
Stroop Interference-Naming: time	CEBRACS "OH"	$F_{(1,124)} = 0.35$; 0.85; 0.00	
	CEBRACS "dietary"	$F_{(1,124)} = 0.46$; 0.50; 0.00	
	CEBRACS "purging"	$F_{(1,124)} = 0.03$; 0.87; 0.00	
	CEBRACS "extreme"	$F_{(1,124)} = 0.10$; 0.75; 0.00	
Stroop Interference-Naming: errors	CEBRACS "OH"	$F_{(1,124)} = 0.47$; 0.49; 0.00	FAD+ < (C- = FAD-)
	CEBRACS "dietary"	$F_{(1,124)} = 1.66$; 0.20; 0.01	
	CEBRACS "purging"	$F_{(1,124)} = 0.05$; 0.81; 0.00	
	CEBRACS "extreme"	**$F_{(1,124)} = 3.93$; 0.05*; 0.03**	
TMT Part B - Part A: time	CEBRACS "OH"	$F_{(1,124)} = 1.25$; 0.27; 0.10	
	CEBRACS "dietary"	$F_{(1,124)} = 0.01$; 0.99; 0.00	

(continued on next page)

Table 4 (*continued*)

Cognitive scores	FAD predictors	Statistics1 (F; p value; partial η2)	Post-hoc comparisons
	CEBRACS "purging"	$F_{(1,124)} = 0.02$; 0.88; 0.00	
	CEBRACS "extreme"	$F_{(1,124)} = 2.16$; 0.75: 0.00	
TMT Part B - Part A: errors	CEBRACS "OH"	$F_{(1,124)} = 1.23$; 0.27; 0.10	
	CEBRACS "dietary"	$F_{(1,124)} = 0.67$; 0.41; 0.00	
	CEBRACS "purging"	$F_{(1,124)} = 0.09$; 0.76: 0.00	
	CEBRACS "extreme"	$F_{(1,124)} = 0.29$; 0.59; 0.00	
RFFT Total strategy designs	CEBRACS "OH"	$F_{(1,124)} = 0.01$; 0.99; 0.00	FAD- > FAD+
	CEBRACS "dietary"	$F_{(1,124)} = 0.01$; 0.83; 0.00	
	CEBRACS "purging"	**$F_{(1,124)} = 3.92$; 0.50*; 0.03**	
	CEBRACS "extreme"	$F_{(1,124)} = 0.80$; 0.36; 0.01	
RFFT total strategies	CEBRACS "OH"	$F_{(1,124)} = 1.39$; 0.24; 0.01	
	CEBRACS "dietary"	$F_{(1,124)} = 1.21$; 0.27; 0.01	
	CEBRACS "purging"	$F_{(1,124)} = 2.39$; 0.12; 0.20	
	CEBRACS "extreme"	$F_{(1,124)} = 0.60$; 0.44: 0.00	
WCST Number of perseverative errors	CEBRACS "OH"	$F_{(1,124)} = 1.81$; 0.18; 0.01	
	CEBRACS "dietary"	$F_{(1,124)} = 0.01$; 0.92; 0.00	
	CEBRACS "purging"	$F_{(1,124)} = 0.95$; 0.33; 0.01	
	CEBRACS "extreme"	$F_{(1,124)} = 2.13$; 0.15: 0.02	
WCST maintenance of categories	CEBRACS "OH"	$F_{(1,124)} = 0.70$; 0.40; 0.01	FAD+ > FAD-
	CEBRACS "dietary"	$F_{(1,124)} = 0.01$; 0.96; 0.00	
	CEBRACS "purging"	$F_{(1,124)} = 0.30$; 0.59; 0.00	
	CEBRACS "extreme"	**$F_{(1,124)} = 4.58$; 0.03*; 0.04**	

1 CEBRACS dimensions were entered as three-level categorical predictors. Accordingly, results are reported using F statistics and partial eta squared (η^2p) to reflect overall factor effects, rather than standardized beta coefficients, which are not uniquely defined for multi-level categorical predictors.
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 $p \le 0.05$; significant results are in bold.
Partial η2: = 0.01 small effect size; = 0.06 medium effect size; = 0.14 large effect size.
C-: negative CEBRACS for the total score = 21 (students who do not engage in FAD behaviors).
FAD-: negative CEBRACS for this subscale (students who engage in FAD but report never engaging in behaviors related to the subscale).
FAD+: positive CEBRACS for this subscale (students who engage in FAD and report engaging in behaviors related to the subscale).

associated with dissociable cognitive correlates.

4.1. FAD: an umbrella term without differentiated cognitive profiles

We did not find significant differences in cognitive abilities between students who do and do not engage in FAD, suggesting that FAD behaviors are not globally associated with neurocognitive deficits (Szynal et al., 2022), even after controlling for alcohol consumption and ED. However, these results - consistent with findings in binge drinking - may reflect the fact that the students who engage in FAD in our sample, being young university students, have a high cognitive reserve, potentially allowing them to compensate for the cognitive and brain effects of alcohol use and ED during early engagement (as proposed in the compensation hypothesis for binge drinking, e.g., Campanella et al., 2013; Crego et al., 2012), which makes it difficult to detect subtle cognitive inefficiencies. As cognitive functioning was assessed at only a single time point, it is impossible to determine whether these cognitive correlates are a cause or a consequence of FAD behaviors.

Findings also reveal considerable heterogeneity in cognitive performance within the FAD group. FAD encompasses different clinical realities, characterized by distinct motives and behaviors as well as different psychological vulnerabilities (Ritz et al., 2024), each of which may be associated with a specific cognitive profile. Thus, FAD may constitute an umbrella term, and the CEBRACS total score may obscure considerable cognitive heterogeneity across the various motives and behaviors found in students who engage in FAD.

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

Findings reveal heterogeneity in the relationship between the distinct FAD motives/behaviors and cognitive performance among university students. The differences observed in cognitive profiles suggest that FAD behaviors and motives are not uniformly associated with cognitive functioning but are instead related to various cognitive domains, with some abilities enhanced and others reduced compared with students who do not engage in FAD.

Surprisingly, the FAD motive to enhance alcohol intoxication is not related to cognitive functioning in university students, contrary to what might be expected from the literature on binge drinking (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). Unlike AUD, FAD involves a planned behaviour of restricting eating in anticipation of alcohol consumption to maximise intoxicating effects, which may explain why students who engage in FAD for alcohol motives do not show poorer cognitive functioning than students who do not engage in FAD. Indeed, executive abilities are essential both for managing alcohol use (Bates et al., 2002), and for planning and maintaining anticipatory behaviours such as dietary restraint. Therefore, engaging in FAD for the alcohol enhancement motive may require intact executive abilities.

Conversely, the behavioral components related to the caloric compensation motive - dietary restraint, self-induced vomiting, and purging behaviors-observed in FAD students appear to be associated with lower visuospatial abilities, episodic memory, and executive strategies, as reported in individuals with ED (Jáuregui-Lobera, 2013; Nandrino et al., 2006; Sherman et al., 2006; Stedal et al., 2012; Weider et al., 2015). Visuospatial deficits have been primarily reported in individuals with ED (Jones et al., 1991; Kingston et al., 1996), including difficulties in shifting from local to global processing, resulting in a focus on details rather than the overall information, consistent with the central coherence deficit reported in the literature (Eichen et al., 2017; Lang et al., 2016; Lopez et al., 2008a; Lopez et al., 2008b; Roberts et al., 2013; Stedal et al., 2012). This poor global integration (i.e. weak coherence) leads to a focus on details related to disordered eating, such as shape and weight, rather than overall health (Roberts et al., 2016), thereby contributing to disease progression (Kingston et al., 1996). Similarly, in individuals with ED, recurrent images 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 the retrieval of adaptive memories - was also observed in our sample. Our results may also reflect a loss of control in FAD students, who do not implement effective strategies to anticipate alcohol use. They may

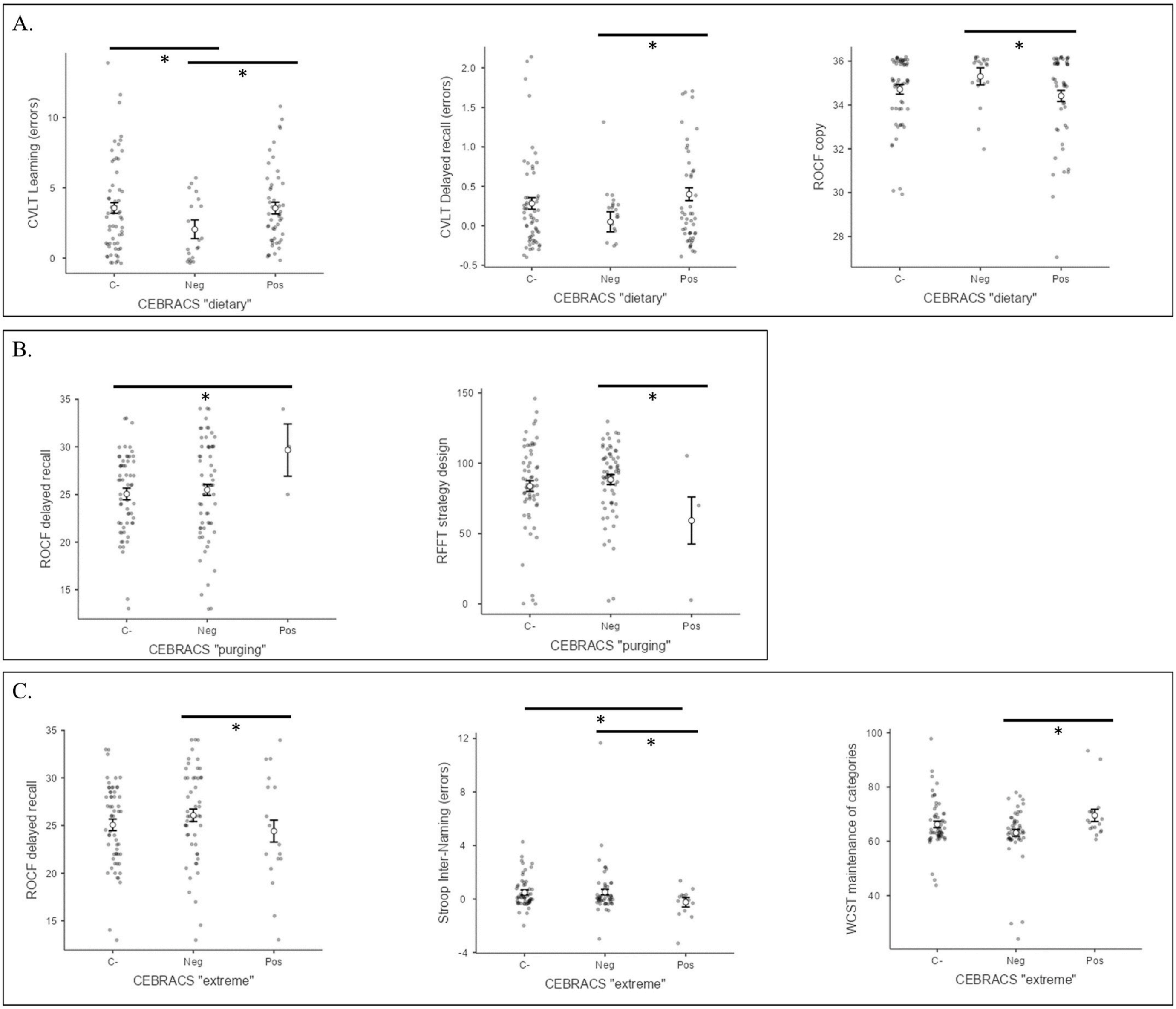

Fig. 1. Comparisons of cognitive performance between students who do not engage in FAD and students who engage in FAD, according to the distinct motives identified by the CEBRACS subscales

A: Students who engage in FAD on the "dietary restraint and exercising" CEBRACS subscale; B: Students who engage in FAD on the "purging" CEBRACS subscale; C: Students who engage in FAD on the "extreme fasting and vomiting" CEBRACS subscale

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

Neg: scale negative (students who engage in FAD but report never engaging in behaviors on the subscale under consideration); Pos: scale positive (students who engage in FAD and report engaging in behaviors on least one item of the subscale under consideration); C-: CEBRACS negative for a total CEBRACS score = 21 (i.e., students who do not engage in FAD).

exhibit cognitive rigidity that leads them to consistently engage in purging behaviors during and/or after drinking, thereby stabilizing FAD-related habits. Indeed, inhibition deficits, reported in individuals with bulimia nervosa, have been shown 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, which aligns with the greater lack of premeditation reported in a previous study involving students who engage in FAD with purging behaviors (Ritz et al., 2024).

Conversely, students who engage in FAD with 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 in order to refrain from eating, plan alternative 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 in order to compensate for alcohol calories. Students who engage in FAD and who have efficient visual episodic memory may be better able to remember 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 to global information (Eichen et al., 2017; Lang et al., 2016; Lopez et al., 2008; Lopez et al., 2008; Roberts et al., 2013; Stedal et al., 2012), better visual episodic memory may lead students who engage in FAD to primarily remember the calorie intake of alcoholic beverages, resulting in the use of laxatives/diuretics as a compensatory behavior despite the purging-related health damages.

This study highlights that FAD should not be considered a homogeneous phenomenon and that it is essential to examine its different motives and behaviors related to caloric compensation, as these are differentially associated with the cognitive profile of students who engage in FAD. These findings support the need for research that examines the correlates of FAD at both the motivational and behavioral levels (Berry et al., 2024). Additionally, it is important to further explore the cognitive profiles associated with the different motives and behaviors related to FAD by adopting an approach that considers both better and poorer cognitive functioning. This approach allows for a more nuanced understanding of how different cognitive abilities may influence the expression of distinct FAD behaviors and motives. From a clinical perspective, therapeutic approaches for students who engage in FAD 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. Limitations and perspectives

Our cross-sectional design limits our understanding of the causal relationship between cognitive functioning and FAD, and does not address whether cognitive vulnerability is a premorbid trait or a consequence of FAD. In addition, the regression analyses examining associations between CEBRACS subscales and neurocognitive performance were exploratory in nature, as no a priori hypotheses were formulated regarding specific cognitive profiles. A longitudinal follow-up including students before the development of FAD is necessary to address this issue. Moreover, the small effect sizes observed in the relationship between FAD and cognition suggest that FAD is a complex behavior that may be related not only to cognitive correlates but also to social, psychological, and emotional processes. This encourages the use of a comprehensive approach with individuals who engage in FAD, in order to better tailor therapeutic and preventive strategies. In this line, although the neuropsychological battery provided a comprehensive overview of key executive, memory, and visuospatial processes, offering the first description of the neurocognitive correlates of FAD, it did not cover all cognitive domains that might be involved in FAD behaviors. Other domains, such as social cognition or emotional processing, would be relevant to examine in future studies. It should also be noted that some uncontrolled factors (e.g., recent fasting/exercising, stress, sleep) might have influenced the neuropsychological results. Moreover, FAD was assessed over a three-month period, as defined by the validated CEBRACS instrument (Rahal et al., 2012; Ritz et al., 2023). This time frame, consistent with all existing versions of the scale, ensures comparability across studies but limits conclusions regarding longer-term engagement in FAD behaviors. In addition, the SCOFF questionnaire was included to screen for the risk of ED as a control variable, rather than to assess ED symptomatology for diagnostic purposes, which might explain why this measure did not emerge as a significant correlate in our analyses. Finally, as the present study focused on first-year university students in France, future research should be conducted in other age groups, educational levels, and cultural contexts to determine the generalizability of these findings.

4.4. Conclusion

The present study is the first to examine the neurocognitive profile of students who engage in FAD, paving the way for a better understanding of the neuropsychological correlates of FAD behaviors. When considering FAD as a single entity, screened using the CEBRACS total score, the cognitive profile of students who engage in FAD does not differ from that of students who do not. However, FAD constitutes an umbrella term encompassing various motivations, behaviors, and clinical manifestations that may lead to different 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 also by differentially enhanced or impaired cognitive functions. Caloric compensation-related behaviors, such as dietary restraint and exercising, are associated with poorer visuospatial abilities and verbal episodic memory. In addition, students who engage in FAD with purging behaviors show 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 limits the exploration of causal links between cognitive functioning and FAD, our results have several clinical implications. They encourage clinicians to consider the different motives and behaviors associated with FAD, as these have distinct relationships with cognitive functioning, and to tailor prevention strategies to specific cognitive vulnerabilities, which could otherwise lead to a decline in academic performance. Therapeutic strategies should focus on reducing alcohol consumption in students who engage in FAD 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 students who engage in FAD, helping them manage negative states and thereby reduce unhealthy eating habits.

CRediT authorship contribution statement

Ludivine Ritz: Writing – original draft. **Nicolas Mauny:** Writing – review & editing, Methodology. **Charlotte Montcharmont:** Methodology. **Hélène Beaunieux:** Conceptualization. **Pierre Maurage:** Writing – review & editing, Supervision.

Declaration of competing interest

The authors declare that they have no conflicts of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jpsychires.2026.01.020.

Data availability

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