Relations Between Cognitive Abilities, Drinking Characteristics, and Emotional Recognition in Alcohol Dependence: A Preliminary Exploration

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Background: Alcohol dependence is characterized by wide-ranging cognitive impairments, but also by emotional facial expressions (EFEs) recognition deficits. Although they play a crucial role both in the development and in the maintenance of the disease, cognitive and emotional disorders have up to now been mostly explored separately. As a result, not much is known regarding their interactions. This study thus aims at exploring the relations between cognition and emotion in alcohol dependence, and more specifically between cognitive performance, drinking characteristics, and EFE recognition.

Methods: About 26 recently detoxified alcohol-dependent individuals and 26 matched controls were tested for cognitive abilities (by means of a standardized neuropsychological battery) and for EFE recognition.

Results: Alcohol-dependent individuals simultaneously presented altered performances for executive abilities and EFE recognition (particularly for disgust recognition). Moreover, a regression analysis showed that EFE performance was centrally related to episodic memory and cognitive flexibility.

Conclusions: These results clarify the relations between EFE recognition, cognitive abilities, and drinking characteristics in alcohol dependence and clearly suggest that cognitive factors should be taken into account in future studies exploring emotional processes in alcohol dependence. Specific cognitive programs should be developed to rehabilitate cognitive and emotional abilities simultaneously.

Key Words: Alcohol Dependence, Emotional Facial Expressions, Cognition.

ALCOHOL DEPENDENCE IS a chronic, recurring disorder characterized by massive impairments in physiological, social, and psychological domains, but also at the cognitive level. Numerous studies have indeed shown that alcohol dependence is associated with large-scale neuropsychological deficits, mostly in visual–spatial cognition (Beatty et al., 1997; Wegner and Fahle, 1999), visual-motor coordination (Urucu-Milcent, 2005), episodic memory (Duka et al., 2001; Ray et al., 2004), and executive abilities (Houston et al., 2014; Loeber et al., 2009; Zago-Gomes and Nakamura-Palacios, 2009). Beyond these cognitive impairments, specific difficulties have been described among alcohol-dependent individuals in the recognition of emotional facial expressions (EFE; Frigerio et al., 2002; Maurage et al., 2008a; Townshend and Duka, 2003) and in the evaluation of their intensity (Foisy et al., 2007; Kornreich et al., 2001; Maurage et al., 2009; Townshend and Duka, 2003). However, while both cognitive and emotional deficits have been widely established in alcohol dependence, they have always been explored separately, and very little is known about their interactions and mutual influences. Indeed, to our knowledge, only 1 very recent study (Trick et al., 2014) simultaneously considered cognitive and emotional abilities in recently detoxified alcohol-dependent individuals. Results have revealed that cognitive flexibility and fear recognition deficits might both be attributed to dysfunctions of the inferior frontal cortex. However, cognition–emotion interactions were not the primary focus of that study. Only 1 cognitive task (the intra-extradimensional set shift, measuring flexibility) and a very limited number of EFE trials were used, and their direct correlations were not reported.

Research in healthy population has repeatedly shown that emotional and cognitive processes constantly interact in everyday life and have common underlying brain regions (Pessoa, 2008, 2010). The study of emotion–cognition interactions is now a blooming field in psychology and neuroscience, but these links have not been explored in alcohol dependence yet. Specifically, in view of the massive cognitive deficits related to alcohol dependence, it can be hypothesized that emotional impairments might be at least partly related to global cognitive deficits rather than to impaired emotional processing per se. However, this proposal has not been explored experimentally, and most studies exploring EFE recognition have assumed that the reduced EFE recognition performance observed reflected genuine emotional

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impairment. Moreover, the influence of alcohol consumption characteristics on the emotional deficit remains little understood. Indeed, several studies have assessed EFE intensity recognition and have clearly shown that alcohol-dependent individuals overestimate the emotional intensity of happiness, anger, and disgust, but underestimate expressions of sadness and fear (Foisy et al., 2007; Kornreich et al., 2001; Townshend and Duka, 2003). Other studies dealing with EFE recognition have shown that alcohol-dependent individuals exhibit poorer recognition of sadness (Frigerio et al., 2002), as well as anger and disgust (Townshend and Duka, 2003). The impaired recognition of anger EFE was also identified in a multimodal (visual and auditory) situation (Maurage et al., 2008b), and these results on faces have been generalized to other emotional stimuli like voices and postures (Maurage et al., 2009). However, those previous studies obtained discordant results regarding the correlations between EFE recognition and drinking characteristics. It has been shown that EFE recognition deficits were correlated with drug-usage variables (quantity and duration) among abstinent multidrug users (Fernández-Serrano et al., 2010), but results for mono-addict alcohol-dependent individuals are more mixed, and the specific influence of each drinking characteristic remains unclear.

In view of these limits, the aim of this study was to offer the first insights concerning the relations between cognitive abilities (e.g., memory, executive functions, and visual–spatial abilities), drinking characteristics (e.g., quantity, duration, and age at alcohol dependence onset), and EFE recognition deficits in recently detoxified alcohol-dependent individuals. A strict participant selection was conducted to reduce the variability in personal characteristics (age, socioeconomic level, IQ, anxiety and depression level, abstinence duration), and an exhaustive battery of standardized cognitive tests as used to encompass a large range of cognitive functions like visual–spatial (visual encoding, copy, and retrieval), memory (encoding, storage, recall and cued recognition), and executive (cognitive flexibility, categorization, strategy maintenance, inhibition, processing speed, and mental flexibility) abilities. As emotional processing and high-level cognitive functions (particularly executive functions) share common cerebral bases, notably in prefrontal regions, we hypothesized that executive abilities deficit would be the crucial predictor of emotional performance.

MATERIALS AND METHODS

Participants

Twenty-six recently detoxified alcohol-dependent participants (ADP; 7 women) diagnosed by a clinician according to the DSM-IV criteria were included (American Psychiatric Association, 1994). Patients participated on a voluntary basis while undergoing a 4-week alcohol detoxification program at the Center for Alcohol-Dependence Studies (Amiens, France). All patients (age range: 30 to 63 years old) were tested at the beginning of their third week of treatment and had been abstinent for exactly 15 days. None were taking any psychotropic medication. ADP were interviewed to determine alcohol dependence characteristics (alcohol consumption duration and intensity, age at alcohol dependence onset) before treatment using Ewing's CAGE questionnaire (Ewing, 1984). Twenty-six control participants (CP; 5 women) were matched with ADP on age and education level. All CP consumed less than 21 (for men) and 14 (for women) alcohol units per week, in line with the criteria for alcohol abuse or dependence of the World Health Organization (2010). As shown in Table 1, both groups were also tested for intelligence quotient index (IQ; using Raven's Standard Progressive Matrices; Raven, 1980), depression (Beck Depression Inventory [BDI-II]; Beck et al., 1996), and anxiety (Beck Anxiety Inventory; Beck et al., 1988).

Exclusion criteria for both groups were other addictive behaviors (excluding tobacco), previous major medical, neurological (epilepsy or head injury), or psychiatric disorders, and uncorrected visual impairment. An interview was conducted by a clinician to obtain anamnestic, medical, and personal information. All participants could read, write, and understand French correctly and were fully informed about the aim of the study and procedure details. They signed an informed consent form, which assured them that their answers would remain confidential and anonymous. The study was carried out according to the principles of the Declaration of Helsinki.

Procedure

After filling in the questionnaires, each participant was assessed for cognitive and emotional abilities by a qualified neuropsychologist in 2 individual sessions (45 minutes each). The neuropsychological battery explored the following abilities: (i) visuo-spatial abilities, using the Rey's figure recall test (Rey, 1959) to explore the ability to

Table 1. Demographic, Psychopathological, and Drinking Variables for Alcohol-Dependent (ADP) and Control Participants (CP) [Mean (SD)], with Student's t-test Comparison (t) and p-Value

	ADP (N = 26)	CP (N = 26)	t	p-Value
Gender: No. Female/No. Male	7/19	5/21	/	/
Age	44 (8.89)	47 (7.46)	−1.08	0.28
Educational level	11.23 (1.7)	11.92 (1.7)	−1.47	0.15
IQ (SPM)	102.2 (10)	110.1 (8.16)	−3.07	0.04*
Number of drinks per day	29.50 (13.29)	0.77 (0.86)	7.74	<0.001*
CAGE scores	3.44 (0.82)	/	/	/
AD duration	21 (9.26)	/	/	/
Age at AD onset	21 (8.89)	/	/	/
Beck Depression Inventory-II	6.63 (5.2) [0 to 19]	2.46 (2.16) [0 to 9]	3.75	<0.001*
Beck Anxiety Inventory	5.13 (5.81) [0 to 26]	4.46 (5.22) [2 to 16]	0.42	0.67

AD, alcohol dependence; SPM, Standard Progressive Matrices.
*Significant differences between alcohol-dependent and control participants ($p < 0.05$).

copy (FreyCO) and memorize (FreyRE) visual information; (ii) episodic memory, using the 16 items test (R16) by Gröber and Buschke (1987) which measures the scores for the 3 free recall learning sessions (R16fr1, R16fr2, R16fr3), the delayed free recall after 20 minutes (R16dfr), and the cued recognition (R16re); (iii) working memory and updating, using the Wechsler (1981) auditory–verbal and visual–spatial Digit Span Forward tests (DSFav and DSFvs) and auditory–verbal and visual–spatial Digit Span Backward tests (DSBav and DSBvs); (iv) set-shifting abilities, using the Modified Card Sorting Test (MCST) (Nelson, 1976), with scores for total completion time (MCSTtm), number of card used (MCSTcard), number of errors (MCSTer), and number of perseverations (MCSTpe) as dependent measures; (v) flexibility and task switching, using the Trail Making Test Parts A and B (TMT; Lezak, 1976) which measures completion time (TMTAtm, TMTBtm) and number of errors (TMTAer,TMTBer).

Emotional abilities were measured by an EFE recognition task on 24 photographs from the *Montreal Set of Facial Displays of Emotion* (Beaupré et al., 2000). The photographs were printed in black and white on 20 cm × 10 cm laminated cards. Twenty cards showing 4 Caucasian individuals (2 women) displaying 5 emotions (happiness, anger, fear, disgust, sadness) were presented in semi-random order. In addition, a card of each of the 4 individuals displaying a neutral expression remained on the table during the entire task. The experimenter showed the 20 cards one by one and asked the participant to identify the EFE, with the following instructions: *In your opinion, what emotion was being felt by this person when the picture was taken?* Maximum score is 4 for each of the 5 emotions (EFEfear, EFEang, EFEhapp, EFEsad, EFEdisg) and 20 for the total EFE recognition (EFEtot).

Data Preparation and Analytic Plan

Power Analysis. An a priori power analysis was conducted to determine the appropriate total sample size for testing hypotheses with the primary outcome variable. Based on previous studies on EFE recognition in alcohol dependence (Frigerio et al., 2002; Kornreich et al., 2001; Maurage et al., 2009; Philippot et al., 1999), we expected a medium–large effect size of Cohen's $d = 0.80$ (Cohen, 1988). Setting α at 0.05, and power (1-β) at 0.80, the power analysis (G*Power 3.1.3; Faul et al., 2007) indicated that a total sample size of 21 individuals per group would yield adequate power to detect medium effect size.

Data Analytic Plan. Data collection and processing were performed using SPSS® version 20 for Windows (IBM France, Bois-Colombes cedex, France). Group comparisons were performed using Student's 2-sample *t*-tests for demographic and clinical data, and multivariate analyses of variance (with groups as between factor and cognitive-emotional scores as within factor) for experimental data. Pearson's correlations were used to explore the relationship between cognitive and emotional factors, and simple linear regression analysis was used to explore which cognitive and drinking factors predicted EFE recognition scores in the alcohol-dependent group. Given the number of tests, we take a more restrictive threshold ($p < 0.01$) to minimize the type I error. A Bonferroni's correction was applied to each regression analysis to correct for multiple comparisons.

RESULTS

Demographics and Clinical Questionnaires

As described in Table 1, ADP showed significantly higher scores than CP for alcohol consumption and depression (while all participants scored below the cut off score for clinical depression in BDI-II), and the reverse pattern was found for IQ (while group did not differ on education level). Depression and IQ scores were thus included as covariates in the following analyses to control for their influence on experimental results.

Neuropsychological Assessment

As shown in Table 2, ADP presented significantly reduced performance compared to CP for the MCST measures. Moreover, ADP presented reduced performance for the total EFE recognition score and for the disgust recognition subscale.

Correlation and Regression Analysis

Correlations between drinking characteristics, and cognitive and emotional variables are presented in Table 3 for the whole sample and for the 2 groups. There were no significant differences in the correlations observed for each variable among ADP and CP.

The regression analysis focused on all cognitive scores and drinking characteristics to determine the most significant predicting factors of EFE recognition in the ADP. As shown in Table 4, after Bonferroni's correction for multiple comparisons, total EFE recognition score was significantly predicted by the second, third, and delayed free recall memory test (R16fr2, R16fr3, R16dfr) and by the completion time of the Trail Making Test Part B (TMTB time).

DISCUSSION

The recognition of other people's emotional state is a crucial ability for adapted social interactions (Chiller-Glaus et al., 2011), as errors in EFE recognition can cause misunderstandings about others' intentions and inappropriate reactions likely to lead to social conflict. EFE recognition impairments have been repeatedly reported in alcohol dependence over the last decade, but their interactions with cognitive dysfunctions had not been specifically explored yet. The main aim of the present study was thus to explore the links between emotional impairments, cognitive deficits, and drinking characteristics in alcohol dependence. Our results first confirmed that ADP present wide-ranging cognitive and emotional deficits. Impaired executive abilities were found for strategy maintenance (number of errors and card used on MCST), inhibition of irrelevant responses (number of perseverations on MCST), and processing speed (completion time on MCST). These results are totally in line with previous ones exploring cognitive performance in alcohol dependence (Houston et al., 2014; Loeber et al., 2009; Wegner and Fahle, 1999). Conversely, no significant deficit was found for episodic memory, updating, visuo-spatial processing, and flexibility, which might be related to insufficient sensitivity of the neuropsychological tests selected, designed to explore severe impairments in neurological populations. Concerning

Table 2. Cognitive and Emotional Results for Alcohol-Dependent (ADP) and Control Participants (CP) [Mean *(SD)*], and Group Comparison in the MANCOVA (R^2 Adjusted, *F*, *p*-Value) with Depression and IQ Scores as Covariates

	ADP	CP	R^2 adjusted	*F*	*p*-Value
R16fr1	8.17 *(2.06)*	8.08 *(1.83)*	−0.004	0.95	0.33
R16fr2	9.25 *(2.12)*	9.85 *(2.62)*	−0.052	0.24	0.62
R16fr3	10 *(2.23)*	10.69 *(2.4)*	−0.030	0.59	0.44
R16dfr	11 *(2.64)*	10.5 *(2.14)*	−0.047	0.53	0.47
R16re	15.46 *(0.98)*	15.15 *(1.08)*	0.058	3.82	0.06
DSFav	6.08 *(1.5)*	6.38 *(1.55)*	0.002	0.05	0.83
DSBav	5.08 *(1.64)*	5.19 *(2.08)*	0.093	0.16	0.69
DSFvs	6.50 *(1.45)*	7.81 *(1.42)*	0.273	1.99	0.16
DSBvs	6.17 *(1.27)*	7.04 *(1.28)*	0.196	0.85	0.36
FReyCO	32 *(4.16)*	34.31 *(0.93)*	0.134	2.74	0.11
FReyRE	14.67 *(5.42)*	15.73 *(5.24)*	−0.008	0.001	0.99
MCSTtm	5.96 *(2.31)*	3.73 *(1.37)*	0.216	13.83	0.001*
MCSTcard	43.21 *(5.19)*	38.27 *(3.39)*	0.53	15.81	<0.001*
MCSTer	5.92 *(5.83)*	1.92 *(3.07)*	0.122	6.48	0.01*
MCSTpe	1.46 *(1.91)*	0.12 *(0.33)*	0.189	12.67	0.001*
TMTAtm	54.38 *(28.77)*	35.62 *(12.91)*	0.035	3.58	0.06
TMTAer	0.13 *(0.33)*	0	0.371	4.65	0.04
TMTBtm	118.42 *(53.68)*	75.08 *(24.31)*	0.135	4.59	0.04
TMTBer	0.83 *(1.13)*	0.08 *(0.27)*	−0.032	5.91	0.019
EFEfear	1.21 *(1.22)*	1.38 *(1.29)*	0.032	0.09	0.76
EFEang	1.38 *(1.06)*	2.15 *(1.49)*	0.059	2.02	0.16
EFEhapp	3.63 *(0.82)*	4 *(0)*	0.134	1.38	0.25
EFEsad	2.75 *(1.29)*	3.31 *(0.68)*	0.035	2.87	0.09
EFEdisg	0.96 *(1.49)*	2.58 *(1.45)*	0.206	6.69	0.01*
EFEtot	9.92 *(2.83)*	13.42 *(2.5)*	0.324	8.7	0.005*

*Significant differences between alcohol-dependent and control participants ($p < 0.01$).

R16fr1, R16fr2, and R16fr3: free recall 1, 2, and 3; R16dfr: delayed free recall; R16re: recognition for the free and cued recall test (Gröber and Buschke, 1987). DSFav: auditory–verbal digit span forward; DSBav: auditory–verbal digit span backward; DSFvs: visual–spatial digit span forward; DSBvs: visual–spatial digit span backward (Wechsler, 1981). FReyCO: copying Rey's figure; FReyRE: recalling Rey's figure (Rey, 1959). MCSTtm: completion time; MCSTcard: number of cards used; MCSTer: number of errors; MCSTpe: number of perseverations on the Modified Card Sorting Test (Nelson, 1976). TMTAtm: time on Part A; TMTAer: number of errors on Part A; TMTBtm: time on Part B; TMTBer: number of errors on Part B on the Trail Making Test (Lezak, 1976). EFEfear: fear EFE recognition; EFEsad: sadness EFE recognition; EFEdisg: disgust EFE recognition; EFEhapp: happiness EFE recognition; EFEang: anger EFE recognition; EFEtot: total emotional facial expressions recognition.

emotional abilities, impaired EFE recognition was observed for the total EFE recognition score, as well as for the disgust subscale. Our results are in line with numerous earlier ones showing EFE recognition impairments in this population (Foisy et al., 2007; Frigerio et al., 2002; Kornreich et al., 2001; Townshend and Duka, 2003).

The main aim of our study concerned the exploration of the links between cognitive, drinking, and emotional variables. Regarding alcohol-related factors, the age at alcohol dependence onset was the only factor significantly correlated with EFE recognition. It is well established that alcohol neurotoxicity is increased when the brain is immature (Dayan et al., 2010; Witt, 2010; Yurgelun-Todd, 2007), and the higher EFE recognition impairments observed here might thus be related to the larger brain damages observed in alcohol-dependent individuals who was exposed to excessive alcohol consumption during adolescence or early adulthood. Concerning cognitive measures, EFE recognition deficit in ADP was centrally correlated with episodic memory, working memory, and flexibility, suggesting that these executive functions might be related to emotional decoding abilities. However, these correlations between emotional and cognitive abilities did not significantly differ between groups, which suggest that the involvement of memory and flexibility in EFE recognition is not specifically found in alcohol dependence but is rather a general pattern also present in healthy controls. Finally, the regression analysis performed showed that the free recalls at the R16 memory test, as well as the time needed to complete TMT part B, are the most reliable predictors of EFE recognition in ADP. Regarding the R16 test, this result is in line with the repeatedly reported links between episodic memory and emotional processing among healthy (D'Argembeau and Van der Linden, 2011; Liu et al., 2014) or psychopathological (Mano and Brown, 2013; Mitchell et al., 2014) populations and further supports the proposal that memory abilities are essential for efficient EFE recognition. Regarding the TMT test, as it centrally measures cognitive flexibility, this result reinforces the proposal that the ability to rapidly and efficiently switch between different cognitive tasks is related to EFE recognition. Such suggestion is in line with earlier results showing that these deficits are both related to inferior frontal cortex dysfunction (Trick et al., 2014). Moreover, TMT is also based on visuospatial exploration, and EFE recognition deficits in alcohol dependence might thus also be partly underlain by visual impairment. This suggestion is coherent with the recent proposal (D'Hondt et al., 2014) that early visuo-emotional interactions might be disrupted in alcohol dependence,

Table 3. Pearson's Correlational Results (p-Value) Between Total EFE Recognition Score and Cognitive Abilities/Drinking Characteristics in the Whole Sample, in Alcohol-Dependent Participants (ADP) and in Control Participants (CP), and Comparison Between Groups' Correlations (Fisher's z and p-Value)

	Whole sample	ADP	CP	Fisher's z	p-Value
R16fr1	0.30 (0.02)*	0.33 (0.06)	0.42 (0.02)*	0.04	0.72
R16fr2	0.41 (0.01)*	0.62 (<0.001)*	0.22 (0.14)	1.70	0.09
R16fr3	0.50 (<0.001)*	0.57 (0.01)*	0.44 (0.01)*	0.59	0.55
R16dfr	0.33 (0.01)*	0.65 (<0.001)*	0.24 (0.12)	1.80	0.07
R16re	0.12 (0.21)	0.44 (0.02)*	0.06 (0.38)	1.40	0.16
DSFav	0.37 (0.01)*	0.47 (0.01)*	0.30 (0.07)	0.68	0.49
DSBav	0.27 (0.03)*	0.34 (0.05)*	0.28 (0.09)	0.23	0.82
DSFvs	0.25 (0.04)*	0.10 (0.33)	−0.07 (0.37)	0.58	0.56
DSBvs	0.50 (<0.001)*	0.51 (0.01)*	0.28 (0.08)	0.93	0.35
FReyCO	0.31 (0.01)*	0.10 (0.31)	0.41 (0.02)*	1.14	0.25
FReyRE	0.23 (0.06)	0.28 (0.09)	0.13 (0.27)	0.53	0.6
MCSTtm	−0.39 (0.01)*	−0.05 (0.40)	−0.32 (0.06)	0.17	0.34
MCSTcard	−0.44 (0.01)*	−0.11 (0.31)	−0.40 (0.02)*	1.06	0.29
MCSTer	−0.41 (0.01)*	−0.14 (0.26)	−0.45 (0.01)*	1.17	0.24
MCSTpe	−0.28 (0.02)*	−0.07 (0.37)	0.13 (0.26)	0.68	0.5
TMTAtm	−0.49 (<0.001)*	−0.34 (0.05)*	−0.44 (0.01)*	0.40	0.69
TMTAer	–	−0.03 (0.44)	–	–	–
TMTBtm	−0.68 (<0.001)*	−0.63 (0.01)*	−0.37 (0.03)*	1.20	0.23
TMTBer	−0.29 (0.02)*	−0.11 (0.30)	0.13 (0.27)	0.82	0.41
No. drinks/d	−0.11 (0.29)	−0.16 (0.22)	−0.18 (0.20)	0.07	0.94
AD duration	–	−0.21 (0.16)	–	–	–
Age at AD onset	–	0.41 (0.03)*	–	–	–

*Significant correlations ($p > 0.05$).

R16fr1, R16fr2, and R16fr3: free recall 1, 2, and 3; R16dfr: delayed free recall; R16re: recognition for the free and cued recall test (Gröber and Buschke, 1987). DSFav: auditory–verbal digit span forward; DSBav: auditory–verbal digit span backward; DSFvs: visual–spatial digit span forward; DSBvs: visual–spatial digit span backward (Wechsler, 1981). FReyCO: copying Rey's figure; FReyRE: recalling Rey's figure (Rey, 1959). MCSTtm: completion time; MCSTcard: number of card used; MCSTer: number of errors; MCSTpe: number of perseverations on the Modified Card Sorting Test (Nelson, 1976). TMTAtm: time on Part A; TMTAer: number of errors on Part A; TMTBtm: time on Part B; TMTBer: number of errors on Part B on the Trail Making Test (Lezak, 1976).

AD, Alcohol dependence.

Table 4. Simple Linear Regression Analysis for Cognitive Performances and Alcohol Drinking Factors Predicting Total EFE Recognition Score for Alcohol-Dependent Participants

Predictor variables	R^2	R^2 change	F change (df)	*Sig. F* change	Standardized coefficients			Bonferroni corrected
					Beta	t	Sig.beta	
R16fr1	0.07	0.11	2.69 (2.78)	0.12	0.32	1.64	0.12	NS
R16fr2	0.37	0.39	14.83 (2.29)	0.001	0.63	3.85	0.001	0.02*
R16fr3	0.34	0.37	13.22 (2.34)	0.001	0.6	3.64	0.001	0.02*
R16dfr	0.42	0.45	18.56 (2.19)	0.001	0.67	4.31	0.001	0.02*
R16re	0.06	0.1	2.6 (2.79)	0.12	0.32	1.61	0.12	NS
DSFav	0.18	0.21	6.45 (2.56)	0.02	0.46	2.54	0.02	NS
DSBav	0.11	0.14	3.92 (2.67)	0.06	0.38	1.98	0.06	NS
DSFvs	−0.03	0.01	0.32 (2.86)	0.58	0.11	0.56	0.58	NS
DSBvs	0.28	0.31	10.65 (2.4)	0.003	0.55	3.26	0.003	NS
FReyCO	0.01	0.05	1.37 (2.8)	0.25	0.23	1.17	0.25	NS
FReyRE	0.07	0.11	2.82 (2.73)	0.11	0.32	1.68	0.11	NS
MCSTtm	−0.04	0.004	0.08 (2.83)	0.78	−0.06	−0.29	0.78	NS
MCSTcard	−0.03	−0.01	0.33 (2.81)	0.57	−0.12	−0.58	0.57	NS
MCSTer	−0.02	0.02	0.46 (2.81)	0.51	−0.14	−0.68	0.51	NS
MCSTpe	−0.04	0.001	0.03 (2.88)	0.86	−0.04	−0.18	0.86	NS
TMTAtm	0.15	0.18	5.14 (2.66)	0.03	−0.43	−2.27	0.03	NS
TMTAer	−0.04	<0.001	0.003 (2.94)	0.95	−0.01	−0.06	0.95	NS
TMTBtm	0.34	0.36	13.11 (2.35)	0.001	−0.6	−3.62	0.001	0.02*
TMTBer	−0.03	0.01	0.32 (2.92)	0.58	−0.12	−0.57	0.58	NS
No. drinks/d	−0.03	0.009	0.21 (2.87)	0.65	−0.09	−0.46	0.65	NS
AD duration	0.005	0.05	1.13 (2.82)	0.3	0.21	1.06	0.3	NS
Age at AD onset	−0.03	0.01	0.3 (2.86)	0.59	−0.11	−0.55	0.59	NS

*Significant regressions after Bonferroni's correction. Abbreviations as in Table 3.

thereby hampering the fast processing of emotional stimuli (relying on the magnocellular dorsal stream) leading to impaired performance in EFE recognition tasks.

The present study thus offers the first direct observation of the links between cognitive and emotional disturbances in alcohol dependence, centrally showing that both episodic memory and executive functioning (particularly information processing speed and cognitive flexibility) are strongly related to EFE recognition deficits. While earlier studies showing EFE recognition disturbances in alcohol dependence have univocally interpreted these deficits as indexing genuine impairment of emotional functions, our results suggest that more global cognitive abilities might significantly interact with EFE recognition performance. It should, however, be underlined that the present study exclusively used static EFE, and future studies should thus confirm the present results with more ecological stimuli, closer from real-life interactions (e.g., emotional videotapes). Moreover, as no global evaluation of basic perceptive or attentional abilities has been conducted, it cannot be totally excluded that the results observed for cognitive tasks might be partly explained by widely established perceptive or attentional impairments (Maurage et al., 2014; Wegner and Fahle, 1999) rather than by executive dysfunctions per se. Finally, the present results have been obtained on a specific subgroup of alcohol-dependent individuals, notably presenting quite low depression and anxiety scores, and they should thus be extended toward larger populations presenting stronger comorbidities or multidrug addiction. Despite these limitations, the present results already bare several crucial implications: at the experimental level, they should lead future studies on EFE recognition to systematically assess cognitive functions to determine their involvement in the emotional deficit observed. At the clinical level, while most current therapeutic programs are focused on the separate improvement of cognitive or emotional abilities, our results call for the development of joint rehabilitation programs simultaneously improving cognitive and emotional abilities and exploring their interactions, as they are intimately related and should no more be considered as independent. Future studies should thus go beyond this first correlational exploration and focus on the direct exploration of emotion–cognition interactions (by means of tasks simultaneously soliciting emotional and cognitive functions) to clarify the specific links between each cognitive ability and each emotional deficit in alcohol dependence, leading to an integrated model of cognitive-emotional deficits in this pathology.

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