Emotion Regulation in Alcohol Dependence

Géraldine Petit, Olivier Luminet, François Maurage, Juan Tecco, Stéphane Lechantre, Marc Ferauge, James J. Gross, and Philippe de Timary

Background: The main aim of this study was to investigate, in alcohol-dependent (AD) patients, the use of the 5 emotion regulation strategies specified in Gross's (1998, Rev Gen Psychol, 2, 271) process model of emotion regulation with the use of a semi-structured interview allowing a detailed and high-quality assessment of emotion regulation strategies. A secondary aim was to examine the possible influence of protracted abstinence and detoxification on emotion dysregulation. Finally, the association between the level of craving and the types of regulation strategies was investigated.

Methods: Forty-four treatment-seeking AD patients with varying time spent in rehabilitation, and 26 healthy controls were interviewed using a version of the Emotion Regulation Interview (Werner et al., 2011, J Psychopathol Behav Assess, 33, 346) adapted to alcohol dependence.

Results: Compared to controls, AD patients reported significantly greater use of response modulation and attentional deployment, but lesser use of cognitive change. Among patients, (1) rehabilitation duration was positively correlated with the use of cognitive change and (2) the use of response modulation was positively associated with the level of craving.

Conclusions: These findings clarify the specific pattern of emotion dysregulation associated with alcohol dependence. They also suggest that (1) abstinence is associated with a shift toward more adaptive emotion regulation patterns and that (2) inefficient regulation strategies may lead to craving and the maintenance of alcohol use. If these findings are confirmed through longitudinal and mediation designs, they will have important clinical implications.

Key Words: Alcohol Dependence, Emotion Regulation, Abstinence, Craving.

EMOTIONAL DISTURBANCES ARE a central characteristic of many mental disorders, including alcohol dependence. In particular, alcohol dependence has been associated with difficulties with identifying emotions in self (one central characteristic of alexithymia) (e.g., de Timary et al., 2008), humor comprehension (e.g., Uekermann et al., 2007), theory of mind (e.g., Maurage et al., 2011), emotional empathy (Martinotti et al., 2009), emotional intelligence (e.g., Cordovil de Susa Uva et al., 2010b), and categorizing emotions expressed by faces (e.g., Foisy et al., 2007), voices (e.g., Uekermann et al., 2005), and music (Kornreich et al., 2013). It has been proposed that these emotional impairments could explain alcoholic individuals' difficulties in interpersonal relationships (e.g., Philippot et al., 2003), which in turn trigger further drinking behavior and relapse (Marlatt, 1996). While these emotional impairments have received much consideration in the field of alcohol dependence, another crucial emotional component, that is, *emotion regulation*, has been less well characterized, despite the fact that (1) the lack of emotion regulation skills are thought to be a core feature of alcohol dependence and the primary reason for alcohol use (for reviews, see Kober and Bolling, 2014; Sher and Grekin, 2007), and (2) effective emotion regulation is frequently seen as a necessary condition for optimal social functioning (e.g., Gross and Muñoz, 1995) linked, for its part, to successful alcohol dependence treatment outcomes (e.g., Moos and Moos, 2006).

Emotion regulation refers to the processes engaged in order to influence the type of emotions people have, the moment they have them, and the way these emotions are experienced or expressed (Gross, 2004; Gross and Thompson, 2007). Gross (1998) proposed a process model of emotion regulation which provides a framework for defining different categories of emotion regulation strategies. The model delineates 5 types of emotion regulation strategies according to the point at which they have their primary impact in the emotion-generative process. *Situation selection* shapes the emotion trajectory from the earliest possible point. It involves choosing whether to avoid or approach some situations as a function of their expected emotional impact. *Situation modification* entails modifying the situation

From the Laboratory of Psychological Medicine and Addictology (GP), ULB Neuroscience Institute (UNI), Université Libre de Bruxelles (ULB), Brussels, Belgium; Department of Psychology (OL), Belgian National Fund for Scientific Research, Louvain-la-Neuve, Belgium; Department of Adult Psychiatry (PdT), Institute of Neuroscience, Université Catholique de Louvain (UCL), Louvain-la-Neuve, Belgium; Hopital Psychiatrique du Chêne aux Haies (FM, JT, SL), Mons, Belgium; Clinique Psychiatrique du Beauvallon (MF), Saint-Servais, Belgium; and Department of Psychology (JJG), Stanford University, Stanford, California.

Received for publication May 26, 2015; accepted September 21, 2015.

Reprint requests: Philippe de Timary, Unité Intégrée d'Hépathologie, Department of Adult Psychiatry, UCL2160, Avenue Hippocrate 10, B-1200, Brussels, Belgium. Tel.: +32 27642038; Fax: +32 27648921; E-mail: Philippe.detimary@uclouvain.be

DOI: 10.1111/acer.12914

to alter its emotional impact. *Attentional deployment* refers to directing one's attention to a specific feature of the situation with the goal of changing how one feels. *Cognitive change* encompasses the active reappraisal of the meaning or importance of the situation, to manipulate emotional responding. *Response modulation* occurs at the end of the emotion-generative process and refers to increasing or decreasing its expression using strategies targeting the bodily manifestations (e.g., suppression of facial expression).

The strategy we use to regulate our emotions impacts the way we experience them and influences our well-being and our interpersonal relationships. Gross (1998) has suggested that some strategies may have more positive outcomes than others. In particular, the use of cognitive change, which alters the emotional trajectory early on, has been linked to higher levels of well-being, better social functioning and quality of life, and enhanced expression of positive emotion (e.g., John and Gross, 2004). In contrast, although response modulation may reduce the outward expression of emotion, this strategy, which intervenes later, and thus has to combat a higher intensity emotional response, has been associated with worse social functioning, poorer social support, reduced relationship closeness, greater expression of negative emotion, and decreased well-being over the long term (Gross, 1998; Gross and John, 2003).

Consistent with these findings, clinical populations use more response modulation and less cognitive change than nonclinical populations (e.g., anxiety and mood disorders: Joormann and Gotlib, 2010; Werner et al., 2011; schizophrenia: Kimhy et al., 2012). However, few studies have investigated emotion regulation in individuals with alcohol dependence (Berking and Wupperman, 2012; Fox et al., 2008), and no study has made use of a theoretically derived framework to investigate multiple emotion regulation strategies within one research paradigm. Little is thus known regarding specific emotion regulation habits of people with alcohol dependence. Investigation is needed to determine whether in comparison with their healthy counterparts, individuals with alcohol dependence overuse response modulation and implement cognitive regulation with less frequency. The primary goal of this study therefore was to provide precise insight into emotion dysregulation in alcohol-dependent (AD) patients.

The study of emotion regulation has so far mainly been based on self-reported questionnaires typically focusing only on 1 or 2 emotion regulation strategies at a time (e.g., the Emotion Regulation Questionnaire [ERQ]: Gross and John, 2003; the Difficulties in Emotion Regulation Scale: Gratz and Roemer, 2004). This type of assessment clearly is advantageous in terms of ease and speed of administration. However, the use of a semi-structured interview, the Emotion Regulation Interview (ERI), that investigates the 5 emotion regulation strategies specified in Gross's process model of emotion regulation, has proven to present many other advantages (Werner et al., 2011). It allows the quantification of frequency of the 5 distinct emotion regulation strategies and thus furnishes a more refined assessment and classification of emotion regulation strategies. It also implies a recall exercise of specific instances of emotion regulation experiences and therefore provides information concerning real-life situations. The interview format further makes possible to clarify concepts and offer examples (and additional ones if needed in some cases) of each category of regulation strategies to better help participants to determine which of them they actually use. These advantages led us to opt for the interview format to assess emotion regulation in our study.

In the context of alcoholism, mid- and long-term abstinence has been widely associated with improvement in different areas of functioning (e.g., Cordovil de Sousa Uva et al., 2010a; Mann, 1999), including the emotional domain. Abstinence is linked to lower depression and anxiety symptoms (de Timary et al., 2008; Schuckit, 1994), normalization of emotional intensity evaluation (Kornreich et al., 2001), decreases in negative affect (Cordovil de Susa Uva et al., 2010b) and alexithymia (e.g., de Timary et al., 2008; Loas et al., 1997a,b), and improvement of awareness and clarity of emotional experience (Fox et al., 2008). Focusing on different stages of abstinence following detoxification period was therefore of interest in this study of emotion regulation strategies in AD patients.

Finally, the literature suggests that emotional dysregulation could contribute to the emergence and the maintenance of alcohol use disorders through an increase in alcohol craving. Imaging studies in alcoholics have demonstrated that the mechanisms underlying the regulation of craving involve the same neural circuits that are known to be associated with regulating other emotions (Kober et al., 2010; Seo et al., 2013). Craving was therefore assessed in terms of specific emotion regulation abilities. Given that response modulation has been linked to the type of negative affect (Gross, 1998; Gross and John, 2003) often associated with craving (Tiffany, 2010), it could be speculated that this particular type of emotion regulation strategy might be important in increasing craving and maintaining alcohol use disorders.

We hypothesized that compared to healthy controls, individuals with alcohol dependence would endorse greater frequency of use of response modulation, but lesser use of cognitive change. Because several previous studies have shown that recovery of emotional functioning may occur with protracted withdrawal and detoxification, we hypothesized that the use of the most adaptative emotion regulation strategy, that is, cognitive change, would be positively associated with time spent in rehabilitation. Finally, we hypothesized that a high level of craving, would be linked to the use of the less adaptative emotion regulation strategy, that is, response modulation.

MATERIALS AND METHODS

Participants

Forty-four treatment-seeking AD individuals were recruited from 3 different rehabilitation centers: The Clinique Psychiatrique

du Beauvallon in Saint-Servais, Belgium for a large part, and to a lesser extent, from The CHU Ambroise Paré and The Chêne aux Haies in Mons, Belgium. Patients with dependence or abuse of drugs other than alcohol or nicotine were excluded. The length of stay in the rehabilitation center for these patients ranged from 1 to 730 days with a mean of 104.23 ± 179.36 days. The control population consisted of 26 subjects who were recruited by word of mouth from the community. Their habits concerning drug and alcohol use were screened before being enrolled in the study with a brief prescreening questionnaire. We excluded participants reporting current or past diagnoses of any substance dependence other than nicotine or consumption of more than 21 standard drinks/wk (14 for women) or 3 drinks/d (2 for women) because their consumption pattern placed them "at risk" for alcohol-related problems according to World Health Organization (2013) guidelines. All participants were excluded if they met current DSM-IV criteria for other Axis I and Axis II disorders, required psychiatric medications, or were not in good health. The study was approved by the ethical committees of the 3 above-described hospitals, and the patients signed an informed consent form.

Assessments of Emotion Regulation and Craving

Emotion Regulation. Emotion regulation was assessed with the ERI. The ERI is a semi-structured clinical interview designed by Werner and colleagues (2011) and based on Gross's (1998) process model of emotion regulation. It involves interviewing participants regarding the 5 theoretically derived emotion regulation strategies. It was in the first place used by Werner and colleagues (2011) to study emotion regulation in a socially anxious population. In the Werner and colleagues (2011) study, the convergent validity was established by the authors by correlating the ERI subscales with questionnaires assessing the same variables. Specifically, Werner and colleagues (2011) demonstrated that the ERI situation selection frequency was correlated with the avoidance subscale of the Liebowitz Social Anxiety Scale (Fresco et al., 2001; Rytwinski et al., 2009) ($r = 0.55$, $p < 0.001$), the ERI attention deployment frequency was correlated with the distraction subscale of the Response Styles Questionnaire (Nolen-Hoeksema and Morrow, 1991) ($r = 0.25$, $p = 0.014$), the ERI response modulation frequency was correlated with the suppression subscale of the ERQ (Gross and John, 2003) ($r = 0.21$, $p = 0.046$), and the cognitive change frequency was correlated with the cognitive reappraisal scale of the ERQ ($r = 0.27$, $p = 0.009$). The test–retest reliability of the interview was demonstrated by examining correlations between the ERI responses of participants collected at baseline and those assessed 4 months later. In our study, we adapted the ERI for alcohol dependence. Our version did not involve setting up an anxiety inducing situation; we only maintained the recall of 2 idiographic situations but also extended it to all the emotions and not exclusively to anxiety. Participants were thus asked to report at least 2 emotion-evoking situations from their own lives which occurred very recently (within days preceding the interview). The recall of 2 different situations allowed us to identify the most consistent scenarios and commonly used regulation strategies. Next, the interviewer explained the 5 regulation strategies and gave examples of each of them to make sure each strategy was well understood. Participants were then asked about the frequency of use (0%: never/not at all to 100%: always) of the 5 emotion regulation strategies in these situations. The specific verbal probes were "What percent of the time do you _____ to reduce your emotion?" (1) situation selection: avoid situations (2) situation modification: modify the situation (3) attentional deployment: distract yourself (4) cognitive change: think about the situation differently (5) response modulation: hide the visible signs of your emotion. The ERI was conducted by a clinical psychologist.

Craving. For AD subjects, craving was assessed with the Obsessive Compulsive Drinking Scale (OCDS; Anton et al., 1995), translated and validated in French (Ansseau et al., 2000). The OCDS is a self-report craving questionnaire that investigates obsessive and compulsive dimensions of craving over the last 7 days at the time of filling out the measure. It is usually comprised of 14 items: 6 items are related to obsessive dimension (e.g., How much of your time when you are not drinking is occupied by ideas, thoughts, impulses, or images related to drinking?), and 8 items refer to compulsive aspects (e.g., How much of an effort do you make to resist consumption of alcoholic beverages?). However, 4 of these latter (items 7, 8, 9, and 10 of Anton's [1995] questionnaire) inquire about current alcohol consumption (e.g., How many drinks do you drink each day?). Given that alcohol consumption is forbidden during hospitalization, these 4 items were inappropriate for AD within the context of this study and were thus eliminated. A modified 4-item compulsive subscore and a modified 10-item total score were then computed for AD. All items are rated along 5-point Likert scale (0 = least, 4 = most) referring to 5 statements which express the degree of the severity of craving.

Procedure

After describing the study and obtaining informed consent, participants were assessed with demographic and craving questionnaires (for AD patients only) followed by the semi-structured interview.

Statistical Analyses

Group differences for demographic continuous variables were compared using independent *t*-tests. Group differences for demographic categorical variables were evaluated using the chi-square statistic. A *p*-value of <0.05 (2-tailed) was considered as statistically significant. As regards to regulation strategies, we first compared the variables between the 2 groups and then proceeded to additional analyses controlling for demographic variables that differed between groups. Specifically, group differences in frequency of use of each regulation strategy were first assessed using *t*-tests, followed by univariate analyses of covariance (ANCOVAs) controlling for marital status, family history of alcoholism (FHA), and tobacco smoking. In patients, Pearson's correlations were computed between the frequency of use of each emotion regulation strategies and (1) the length of stay in rehabilitation and (2) the scores of craving. Finally, hierarchical multiple regression analysis was used to examine the possible prediction potential of the variables that came out as significant in the correlation analysis. All analyses were conducted with SPSS 17.02 (SPSS, Chicago, IL), with the level of significance at 0.05.

RESULTS

Demographics

Not surprisingly (as the majority of the inpatients came from The Beauvallon center, which, for historical reasons, only has women), participants of the AD group contained mostly women. Their ages ranged from 23 to 77 years. The participants of the control group, whose ages ranged from 25 to 70 years, matched the patients of the AD group for gender ($\chi^2 = 0.74$, $p = 0.390$), age, $t(50.997) = 0.978$, $p = 0.332$, and educational level ($\chi^2 = 5.812$, $p = 0.055$). Controls differed from patients in their marital status ($\chi^2 = 18.874$, $p < 0.001$), for FHA (i.e., having at least 1 relative of their generation or

the previous one with alcohol-related issues) ($\chi^2 = 37.708$, $p < 0.001$), and for tobacco smoking ($\chi^2 = 7.541$, $p = 0.006$). Detailed demographics for both groups can be found in Table 1.

Craving

Patients had a score of 8.02 ± 5.9 on the compulsive scale and a score of 6.65 ± 6.1 on the obsessive scale. Scores of craving in patients are summarized in Table 1.

Emotion Regulation Strategies

To test our first hypothesis, that is, that AD patients and controls would differ in their use of regulation strategies, frequency of use (in %) for each strategy was compared using independent *t*-tests. Analyses revealed that groups differed on 3 regulation strategies: attentional deployment, $t(64.462) = 4.050$, $p < 0.001$, cognitive change, $t(55.618) = -2.397$, $p = 0.020$, and response modulation, $t(39.607) = 5.001$, $p < 0.001$. Patients reported using attentional deployment ($M = 53\%$ vs. 24%) and response modulation ($M = 76\%$ vs. 37%) strategies more often than controls. They also indicated using cognitive change less often than controls ($M = 30\%$ vs. 48%). There were no group differences for situation selection ($p = 0.3214$) or situation modification ($p = 0.883$) (see Fig. 1). To control for a possible influence of demographic variables that differed between groups (i.e., marital status, FHA and tobacco smoking) on the group differences in emotion regulation, we secondly computed univariate ANCOVAs for each emotion regulation strategy that came out to be significantly different between groups with independent *t*-tests. Analyses showed that these variables did not affect the results as the group difference remained significant for each emotion regulation strategies [Attentional deployment: $F(1) = 7.379$, $p = 004$, $\eta^2 = 0.102$, observed Power = 0.763; Cognitive change: $F(1) = 8.942$, $p = 004$, $\eta^2 = 0.121$, observed Power = 0.838; Response modulation: $F(1) = 11.452$, $p = 001$, $\eta^2 = 0.150$, observed Power = 0.915].

Table 1. Demographic Characteristics of Patients and Controls

	Patients ($n = 44$)	Controls ($n = 26$)	*p*-Value
Females	33	17	0.390
Age (years)	47 (10)	44 (11)	0.332
Smoking (% with nicotine dependence)	86	11	*0.006*
Family history of alcoholism (FHA) (% positive[a])	57	23	*<0.001*
Craving[b]			
Obsessions	6.65 (6.1)		
Compulsions	8.02 (5.9)		
Education level (% accomplished)			
Primary school degree	52	23	0.055
Secondary school degree	14	19	
University degree	34	58	
Marital status (%)			
Single	64	15	*<0.001*
Stable couple	27	81	
Occasional couple	9	4	

[a]Presence of at least 1 first- (father and/or mother) and/or second-degree (grandfather and/or grandmother) relative with alcohol dependence.
[b]Assessed with a modified version of the Obsessive Compulsive Drinking Scale (Anton et al., 1995).
In italics: *p*-values that are equal to or smaller than the significance level (α).

Correlation Between Emotion Regulation Strategies and Length of Stay in Rehabilitation

To test our second hypothesis, that is, that emotion regulation strategies evolve with time and protracted abstinence, we performed Pearson's correlations between frequencies of use of each of the 5 emotion regulation strategies in patients and the number of days spent in treatment centers. Results showed that 1 strategy, that is, cognitive change, was associated with the length of stay in rehabilitation ($r = 0.335$, $p = 0.026$), which means that the longer time the patients had spent in treatment centers, the more they made use of cognitive change. No other strategies were found to be related to the number of days spent in rehabilitation ($p > 0.245$).

Correlation Between Emotion Regulation Strategies and Craving

To test our last hypothesis, that is, that increased level of craving would be associated with maladaptative emotion regulation, we performed Pearson's correlations between frequencies of use of each of the 5 emotion regulation strategies in patients and scores of craving. Analyses showed that 1 strategy, the level of response modulation, was positively correlated with all craving scores. The higher the use of response modulation in emotion elicited situations, the higher the level of compulsions ($r = 0.356$, $p = 0.018$) and the higher the level of obsessions for alcohol ($r = 0.344$,

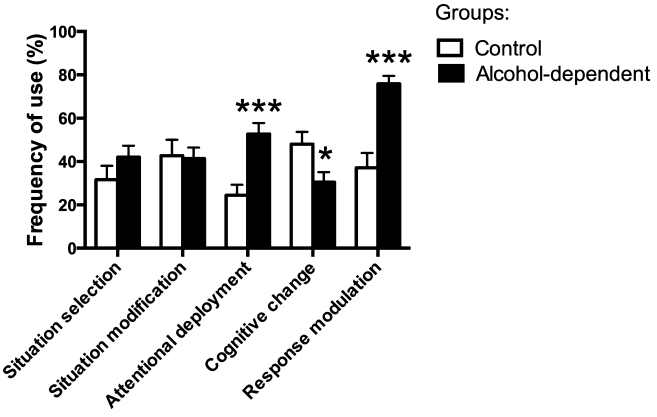

Fig. 1. Frequency of use (in %) of the 5 emotion regulation strategies in control and alcohol-dependent groups. *Statistically significant difference between groups at $p < 0.05$; ***statistically significant difference between groups at $p < 0.001$.

$p = 0.022$) reported by the patients (total score of craving: $r = 0.359$, $p = 0.017$).

The Ability of Length of Stay in Rehabilitation in Predicting the Recourse to Cognitive Change

To examine, in patients, whether the time spent in rehabilitation accounted for the variance in the use of cognitive change strategy while controlling for the effect of potential confounding variables as demographic variables (age and gender), a hierarchical multiple regression analysis was conducted with cognitive change strategy entered as the dependent variable. A dummy variable was created for gender. The demographic variables were entered as independent variables in the first step (block 1), and the time spent in rehabilitation was entered in a second block. This analyze revealed that at step 1, the control variables (age and gender) accounted for 5.5% of the variance in cognitive change strategy, but this was not a significant contribution (significance for F change: $p = 0.311$). When adding the time spent in rehabilitation in the second block, the model as a whole then explained 15.3% of the variability in cognitive change. This thus means that after having controlled for the effects of control variables, the time spent in rehabilitation explained an additional 9.8% of the variance in cognitive change and this was a statistically significant contribution (significance for F change: $p = 0.038$). The model as a whole (including all 3 variables) was however not able to significantly predict the recourse to cognitive change, $F(3, 43) = 2.414$, $p = 0.081$. The only variable that made a unique statistically significant contribution to the variation in the use of cognitive change was the time spent in rehabilitation ($\beta = 0.338$, $p = 0.038$). Table 2 depicts these regression results.

The Ability of the Use of Response Modulation in Predicting the Level of Craving

To examine, in patients, whether the use of response modulation could explain a part of variance in the level of craving while controlling for the effect of potential confounding variables including tobacco smoking, marital status, and age of onset of alcohol dependence, hierarchical multiple regression analysis was conducted with the total craving score entered as the dependent variable. Dummy variables were created for marital status (single vs. stable couple vs. occasional couple) and tobacco smoking (yes vs. no). The hierarchical multiple regression revealed that at step 1, the variables (tobacco smoking, marital status, age of onset of alcohol dependence) accounted for 10% of the variance in the level of craving, and this was not a significant contribution (significance for F change: $p = 0.403$). When adding the recourse to response modulation strategy in the second block, the model as a whole then explained about 26% of the variability in craving. This thus means that after having controlled for the effects of possible confounding variables, the percentage of use of response modulation explained an additional 16% of the variance in response modulation, and this was a statistically significant contribution (significance for F change: $p = 0.008$). The model as a whole (including all 4 variables) was able to significantly predict the level of craving $F(5, 41) = 2.535$, $p = 0.046$. The analysis of the coefficients further showed that only 2 variables made a unique statistically significant contribution to the variation in the craving score, that is, the age of onset of alcohol dependence ($p = 0.022$) and the use of response modulation ($p = 0.008$), with this latter variable making the largest contribution to the model ($\beta = 0.436$). Table 3 depicts these regression results.

Table 2. Multiple Hierarchical Regression Analysis Examining Predictors of the Use of Cognitive Change in Patients

Step and variable	β	t	R^2	ΔR^2
Step 1				
Age	−0.021	−0.131	0.055	0.055
Gender	0.201	1.370		
Step 2				
Age	−0.021	−0.131	0.153	0.098
Gender	0.201	1.370		
Time spent in rehabilitation (in days)	0.338	2.152*		

β = slope of the regression line; t = regression coefficient; R^2 = coefficient of determination = the amount of variation in the response-dependent variable explained by the independent variable; Δ (delta) R^2 = change in R^2 values from one model to the other; $N = 44$.

*$p < 0.05$.

Table 3. Multiple Hierarchical Regression Analysis Examining Predictors of the Level of Craving

Step and variable	β	t	R^2	ΔR^2
Step 1				
Age of onset of alcohol dependence	−0.301	−1.886	0.100	0.100
Occasional couple	0.131	0.818		
Stable couple	−0.051	−0.308		
Tobacco smoking	−0.053	−0.320		
Step 2				
Age of onset of alcohol dependence	−0.354	−2.399*	0.260	0.160**
Occasional couple	0.158	1.069		
Stable couple	0.119	0.722		
Tobacco smoking	−0.066	−0.434		
Response modulation	0.436	2.790**		

β = slope of the regression line; t = regression coefficient; R^2 = coefficient of determination = the amount of variation in the response-dependent variable explained by the independent variable; Δ (delta) R^2 = change in R^2 values from one model to the other; $N = 44$.

*$p < 0.05$, **$p < 0.01$.

Craving score = Total Obsessive Compulsive Drinking Scale (OCDS) craving score assessed with a modified version of the OCDS (Anton et al., 1995).

DISCUSSION

Alcohol dependence has long been thought to be associated with emotion dysregulation. However, the precise nature of the emotion dysregulation in AD subjects has not been well characterized. In the present study, we used the

conceptual framework developed by Gross (1998), and the related ERI, to explore in more detail processes by which the emotional experience is typically manipulated in AD patients.

Results showed that individuals with alcohol dependence display differential use of emotion regulation strategies compared to controls. In particular, and in line with our expectations, emotion regulation strategies in AD patients are characterized by a significantly higher use of response modulation and lower use of cognitive change. Given that the habitual use of cognitive change has been found to be linked to higher positive affect, better interpersonal functioning, and greater well-being, and that the use of response modulation has been correlated with lower emotional functioning (Gross and John, 2003; Mauss et al., 2007), the profile of regulation strategies in AD patients may largely be described as maladaptive. The recourse to response modulation and therefore to treating emotions at a late stage of the emotion-generative process could be due to cognitive impairments induced by prolonged excessive alcohol drinking (Cordovil de Sousa Uva et al., 2010a; Pitel et al., 2009). This would be in keeping with the model of Kober and Bolling (2014) that proposes that chronic drug use (through its deleterious effects on prefrontal cortex, key neural region of emotion regulation) decreases capacities to deal with negative emotions which further leads to enhanced drug use. Interestingly, as far as we did not have any a priori hypothesis about this specific strategy, AD patients also showed more use of attentional deployment than controls. According to the process model of emotion regulation (Gross and Thompson, 2007), this technique, although not the most beneficial, consists of interjecting regulation relatively early on in the emotion-generative process and should thus be relatively efficient in altering the course of the emotional response. Gross's team further showed that attentional deployment may be especially beneficial in situations involving high emotional intensity stimuli (Thiruchselvam et al., 2010). It would be interesting to further explore whether this strategy has positive consequences in AD patients when exposed to situations of high emotion intensity.

It is besides worth mentioning that FHA did not affect the group differences observed in the use of the emotion regulation strategies. These differences are thus not ascribable to the greater propensity of AD individuals to have close relatives with alcohol-related issues, and thus probably not to hereditary or educational/environmental factors.

Although AD patients showed less use of cognitive change compared to controls, the length of stay in rehabilitation was linked to an increased use of this strategy. Regression analysis further demonstrated that the time spent in treatment was predictive of the frequency of use of cognitive change while regulating emotions. These observations are in accordance with our predictions and fit with earlier longitudinal work showing that some emotional abilities and in particular mood, affect, and alexithymia recover along with abstinence in alcohol dependence (e.g., de Timary et al., 2008; Loas et al., 1997a), while others, such as emotional intelligence (Cordovil de Susa Uva et al., 2010b), recognition of emotional facial expression (Kornreich et al., 2001), or self-consciousness (de Timary et al., 2013), do not. It is also in accordance with Fox and colleagues (2007), who demonstrated that in cocaine-dependent subjects, difficulties in emotion regulation decreased with abstinence. It is however not known whether the improvements in cognitive change can be ascribed to the effect of abstinence or to therapeutic interventions and/or resocialization. It would however in both cases be interesting to further explore whether these changes are linked to rehabilitation of the neural mechanisms underlying emotion regulation.

Finally and as expected, our results showed that, in patients, the use of response modulation was associated with, and could predict, higher rates of craving. Given the fact that response modulation leads to negative affects (Gross, 1998; Gross and John, 2003), the higher rates of craving could be explained by the fact that these undesirable emotions would provoke intense need for alcohol (craving) with the specific aim of alleviating negative emotional states. Alcohol would then act as a pharmacological agent to control the physiological response elicited by emotions not successfully managed and leading to an intense distress and physiological reactions (Mauss et al., 2007). This idea is consistent with the "self-medication hypothesis" of Khantzian (1985) and acute alcohol intoxication could in this case be considered as a secondary means of emotion regulation, as has been proposed by Kober and Bolling (2014). It is important to note that even though we considered the link between craving and response modulation in this one directional way, it may also be viewed the other way around. It could be that high expression of craving would hinder AD individuals to set up early and efficient regulation strategies. Social psychological theories indeed suggest that alcohol/drug wanting or craving during abstinence may lead to "goal conflict" which may impinge upon ability to regulate affect successfully (Tice et al., 2001). We could furthermore hypothesize a vicious circle to be involved; maladaptative emotion regulation and its consequent intense distress may lead to enhanced level of craving, which in turn, could prevent subjects from adequately dealing with emotions and so forth. Nevertheless, the observation of a link between response modulation and craving is not trivial given the acknowledged role of craving in alcohol consumption and relapse (Bottlender and Soyka, 2004). This does stress the importance of the detection, by clinicians, of this type of regulation strategy in patients and the doubtless necessity to focus on enhancing emotion regulation skills and especially modifying deleterious regulation schemes in these patients.

The opportunities for guided recall and clarification afforded by the use of the ERI constitute assets for the ERI approach in assessing emotion regulation strategies compared to the completion of questionnaires (Werner et al., 2011). We fully realized that the exercise of generating retrospective memories associated with emotions, guided by the

therapist, offered a rich opportunity for patients to report their regulation strategies. However, our version of the ERI did not include any evaluation of the effect of emotion regulation strategies usage on participants' well-being and social functioning. Future versions of this adapted ERI should therefore add self-efficacy measures for emotion regulation strategies, as has been already done for response modulation and cognitive change in anxious patients (Werner et al., 2011). It is also worth mentioning that even though the convergent validity of the ERI has been tested in the previous study by Werner and colleagues (2011) and that the associations between the strategies of the ERI and related measures were statistically significant, the coefficients of correlation were rather weak, especially as far as attentional deployment, response modulation, and cognitive change were concerned. Werner and colleagues (2011) suggested that these modest correlations could be explained by the fact that unlike the questionnaire, which asks for the frequency of use of strategies in a general perspective, the ERI queries about specific situations. Nevertheless, future work will have to explore the associations of the strategies with other similar but more connected measures.

Our study has several other limitations that should be mentioned. The first one is linked to the self-reported nature of the data (Werner et al., 2011). Although the ERI facilitates the recall of regulation strategies, the task of adequately assessing regulatory strategies remains a difficult one, and certainly especially in AD patients given their known difficulties in emotion awareness (e.g., Carton et al., 2010). In addition, the explicit nature of emotion regulation strategies, that is, the extent to which individuals can actually self-report them, has also recently been questioned. Many authors have emphasized the possible automatic and unconscious nature of emotion regulation (e.g., Gyurak et al., 2011) that would limit the reach of self-report measures. The use of observational methods instead of self-reported ones would be of interest in further investigations.

Another limitation lies in the use of a cross-sectional design that did not allow us to draw a firm conclusion on the effect of abstinence on regulation strategies. Therefore, an alternative hypothesis, that is, that actually neither the effect of abstinence, nor of therapeutic interventions is responsible for the observed correlation cannot be ruled out. Instead, the variables' association could simply be due to prior better regulation abilities in some patients, those patients being then more likely to remain longer in treatment (i.e., less likely to drop out). Replication of the present findings in a longitudinal and mediation study will be necessary to shed light on the exact explanation to give to the results.

A third limitation is linked to some characteristics of the sample that are likely to dampen its representativeness. First, the number of subjects is small. Adding more subjects in future works is necessary to add more power to the results and increase their potential for generalization to the whole AD population. Second, a large proportion of our sample was female. Yet, there are more men than women in the AD population (e.g., Hasin et al., 2007). Moreover, women respond differently on self-report emotional scales than men (e.g., Derntl et al., 2010). Particular care will thus have to be taken in further research for the selection of participants (concerning both gender and sample size) in order to guarantee a more efficient representativeness of the AD population and to determine whether our conclusions are valid in males and females. Despite these limitations, our present findings have important clinical implications. It has been shown that emotion dysregulation is associated with relational difficulties (Gross, 1998; Gross and John, 2003). It is also well known that interpersonal problems in alcohol dependence constitute a considerable source of relapse (Marlatt, 1996). Given our results, emotion regulation training should arguably be part of the alcohol dependence clinical setting, helping to improve interpersonal skills and therefore decrease relapse. Part of our intervention is already dedicated to improving the patient's abilities to deal with emotions. The use of the ERI could help clinicians to go further in this approach. As a screening tool, it could be used to investigate individual emotion regulation profiles in each patient. It would first help clinicians to identify those patients that show difficulties and detect those who do not evolve with time and abstinence. It would secondly help them to orient patients to the use of specific therapeutic techniques accordingly to the highlighted dysfunctional strategies at an individual level. For example, mindfulness could be useful for those inflexibly favoring attentional deployment, acceptance may help to decrease over-recourse to response modulation (Werner et al., 2011).

In conclusion, the present study suggests that alcohol dependence is associated with emotion dysregulation which itself is linked to higher rates of craving, and that abstinence is associated with a shift toward more adaptive emotion regulation habits. The ERI is a promising tool to study emotion regulation strategies in clinical contexts and could also be useful as a guide for practitioners in their treatments.

ACKNOWLEDGMENTS

We wish to thank all patients that participated in the study for time taken to answer to the interviews and questionnaires, the teams of Clinique Psychiatrique du Beauvallon and Hôpital Psychiatrique du Chêne aux Haies for helping us to collect the data, and Dr. Sophie Leclercq for helping us in graphic details. This research was supported by the Belgian National Fund for Scientific Research (FNRS-FRS; grant 3.4585.07) and by Fonds spéciaux de recherche of clinique du Chêne aux Haies, Mons Belgium. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript. The authors declare no conflicts on interest.

REFERENCES

Ansseau M, Besson J, Lejoyeux M, Pinto E, Landry U, Cornes MEEA, Deckers F, Potgieter A, Ades J (2000) A French translation of the

Obsessive-Compulsive Drinking Scale for craving in alcohol-dependent patients: a validation study in Belgium, France, and Switzerland. Eur Addict Res 6:51–56.

Anton RF, Moak DH, Latham P (1995) The Obsessive Compulsive Drinking Scale: a self-rated instrument for the quantification of thoughts about alcohol and drinking behavior. Alcohol Clin Exp Res 19:92–99.

Berking M, Wupperman P (2012) Emotion regulation and mental health: recent findings, current challenges, and future directions. Curr Opin Psychiatry 25:128–134.

Bottlender M, Soyka M (2004) Impact of craving on alcohol relapse during, and 12 months following, outpatient treatment. Alcohol Alcohol 39:357–361.

Carton S, Bayard S, Paget V, Jouanne C, Varescon I, Edel Y, Detilleux M (2010) Emotional awareness in substance-dependent patients. J Clin Psychol 66:599–610.

Cordovil de Susa Uva M, de Timary P, Cortesi M, Mikolajczak M, Du Roy de Blicquy P, Luminet O (2010b) Moderating effect of emotional intelligence on the role of negative affect in the motivation to drink in alcohol-dependent subjects. Pers Individ Dif 48:16–21.

Cordovil de Sousa Uva M, Luminet O, Cortesi M, Constant E, Derely M, de Timary P (2010a) Distinct effects of protracted withdrawal on affect, craving, selective attention and executive functions among alcohol-dependent patients. Alcohol Alcohol 45:241–246.

Derntl B, Finkelmeyer A, Eickhoff S, Kellermann T, Falkenberg D, Schneider F, Habel U (2010) Multidimensional assessment of empathic abilities: neural correlates and gender differences. Psychoneuroendocrinology 35:67–82.

de Timary P, de Sousa Uva MC, Denoël C, Hebborn L, Derely M, Desseilles M, Luminet O (2013) The associations between self consciousness, depressive state and craving to drink among alcohol dependent patients undergoing protracted withdrawal. PLoS ONE 8:e71560.

de Timary P, Luts A, Hers D, Luminet O (2008) Absolute and relative stability of alexithymia in alcoholic inpatients undergoing alcohol withdrawal: relationship to depression and anxiety. Psychiatry Res 157: 105–113.

Foisy ML, Kornreich C, Fobe A, D'Hondt L, Pelc I, Hanak C, Verbanck P, Philippot P (2007) Impaired emotional facial expression recognition in alcohol dependence: do these deficits persist with midterm abstinence? Alcohol Clin Exp Res 31:404–410.

Fox HC, Axelrod SR, Paliwal P, Sleeper J, Sinha R (2007) Difficulties in emotion regulation and impulse control during cocaine abstinence. Drug Alcohol Depend 89:298–301.

Fox HC, Hong KA, Sinha R (2008) Difficulties in emotion regulation and impulse control in recently abstinent alcoholics compared with social drinkers. Addict Behav 33:388–394.

Fresco DM, Coles ME, Heimberg RG, Liebowitz MR, Hami S, Stein MB, Goetz D (2001) The Liebowitz Social Anxiety Scale: a comparison of the psychometric properties of self-report and clinician-administered formats. Psychol Med 31:1025–1035.

Gratz KL, Roemer L (2004) Multidimensional assessment of emotion regulation and dysregulation: development, factor structure, and initial validation of the difficulties in emotion regulation scale. J Psychopathol Behav Assess 26:41–54.

Gross JJ (1998) The emerging field of emotion regulation: an integrative review. Rev Gen Psychol 2:271–299.

Gross JJ, John OP (2003) Individual differences in two emotion regulation processes: implications for affect, relationships, and well-being. J Pers Soc Psychol 85:348–362.

Gross JJ, Muñoz RF (1995) Emotion regulation and mental health. Clin Psychol Sci Pract 2:151–164.

Gross JJ, Thompson RA (2007) Emotion regulation: conceptual foundations, in Handbook of Emotion Regulation (Gross JJ ed), pp 3–24. Guilford Press, New York, NY.

Gross TF (2004) The perception of four basic emotions in human and nonhuman faces by children with autism and other developmental disabilities. J Abnorm Psychol 32:469–480.

Gyurak A, Gross JJ, Etkin A (2011) Explicit and implicit emotion regulation: a dual-process framework. Cogn Emot 25:400–412.

Hasin DS, Stinson FS, Ogburn E, Grant BF (2007) Prevalence, correlates, disability, and comorbidity of DSM-IV alcohol abuse and dependence in the United States: results from the National Epidemiologic Survey on Alcohol and Related Conditions. Arch Gen Psychiatry 64:830–842.

John OP, Gross JJ (2004) Healthy and unhealthy emotion regulation: personality processes, individual differences, and life span development. J Pers 72:1301–1334.

Joormann J, Gotlib IH (2010) Emotion regulation in depression: relation to cognitive inhibition. Cogn Emot 24:281–298.

Khantzian EJ (1985) The self-medication hypothesis of addictive disorders: focus on heroin and cocaine dependence. Am J Psychiatry 142:1259–1264.

Kimhy D, Vakhrusheva J, Jobson-Ahmed L, Tarrier N, Malaspina D, Gross JJ (2012) Emotion awareness and regulation in individuals with schizophrenia: implications for social functioning. Psychiatry Res 200:193–201.

Kober H, Bolling D (2014) Emotion regulation in substance use disorders, In *Handbook of Emotion Regulation*, 2nd ed., (Gross J ed.) pp. 428–446. Guilford, New York, NY.

Kober H, Mende-Siedlecki P, Kross EF, Weber J, Mischel W, Hart CL, Ochsner KN (2010) Prefrontal–striatal pathway underlies cognitive regulation of craving. Proc Natl Acad Sci USA 107:14811–14816.

Kornreich C, Blairy S, Philippot P, Dan B, Foisy M, Hess U, Le Bon O, Pelc I, Verbanck P (2001) Impaired emotional facial expression recognition in alcoholism compared with obsessive–compulsive disorder and normal controls. Psychiatry Res 102:235–248.

Kornreich C, Brevers D, Canivet D, Ermer E, Naranjo C, Constant E, Verbanck P, Campanella S, Noël X (2013) Impaired processing of emotion in music, faces and voices supports a generalized emotional decoding deficit in alcoholism. Addiction 108:80–88.

Loas G, Fremaux D, Otmani O, Lecercle C, Delahousse J (1997a) Is alexithymia a negative factor for maintaining abstinence? A follow-up study. Compr Psychiatry 38:296–299.

Loas G, Parker JD, Otmani O, Verrier A, Fremaux D (1997b) Confirmatory factor analysis of the French translation of the 20-item Toronto Alexithymia Scale. Percept Mot Skills 85:1018.

Mann S (1999) Emotion at work: to what extent are we expressing, suppressing, or faking it? Eur J Work Organ Psychol 8:347–369.

Marlatt GA (1996) Taxonomy of high-risk situations for alcohol relapse: evolution and development of a cognitive–behavioral model. Addiction 91:37–50.

Martinotti G, Di Nicola M, Tedeschi D, Cundari S, Janiri L (2009) Empathy ability is impaired in alcohol-dependent patients. Am J Addict 18:157–161.

Maurage P, Grynberg D, Noel X, Joassin F, Hanak C, Verbanck P, Luminet O, de Timary P, Campanella S, Philippot P (2011) The "Reading the Mind in the Eyes" test as a new way to explore complex emotions decoding in alcoholism. Psychiatry Res 190:375–378.

Mauss IB, Cook CL, Cheng JYJ, Gross JJ (2007) Individual differences in cognitive reappraisal: experiential and physiological responses to an anger provocation. Int J Psychophysiol 66:116–124.

Moos RH, Moos BS (2006) Rates and predictors of relapse after natural and treated remission from alcohol use disorders. Addiction 101:212–222.

Nolen-Hoeksema S, Morrow J (1991) A prospective study of depression and posttraumatic stress symptoms after a natural disaster: the 1989 Loma Prieta earthquake. J Pers Soc Psychol 61:115–121.

Philippot P, Kornreich C, Blairy S (2003) Nonverbal deficits and interpersonal regulation in alcoholics, in *Nonverbal Behavior in Clinical Settings* (Philippot P, Feldman RS, Coats EJ eds), pp 209–231. Oxford University Press, Oxford, UK.

Pitel AL, Rivier J, Beaunieux H, Vabret F, Desgranges B, Eustache F (2009) Changes in the episodic memory and executive functions of abstinent and relapsed alcoholics over a 6 month period. Alcohol Clin Exp Res 33:490–498.

Rytwinski NK, Fresco DM, Heimberg RG, Coles ME, Liebowtitz MR, Cissell S, Stein MD, Hofmann SG (2009) Screening for social anxiety disorder with the self-report version of the Liebowitz Social Anxiety Scale. Depress Anxiety 26:34–38.

Schuckit MA (1994) Alcohol and depression – a clinical perspective. Acta Psychiatr Scand 89:28–32.

Seo D, Lacadie CM, Tuit K, Hong KI, Constable RT, Sinha R (2013) Disrupted ventromedial prefrontal function, alcohol craving, and subsequent relapse risk. JAMA Psychiatry 70:727–739.

Sher KJ, Grekin ER (2007) Alcohol and affect regulation, in *Handbook of Emotion Regulation* (Gross JJ ed), pp 560–580. Guilford Press, New York, NY.

Thiruchselvam R, Blechert J, Sheppes G, Rydstrom A, Gross JJ (2010) The temporal dynamics of emotion regulation: an EEG study of distraction and reappraisal. Biol Psychol 87:84–92.

Tice DM, Bratslavsky E, Baumeister RF (2001) Emotional distress regulation takes precedence over impulse control: if you feel bad, do it!. J Pers Soc Psychol 80:53–67.

Tiffany ST (2010) Drug craving and affect, in *Substance Abuse and Emotion*, pp 83–108. American Psychological Association, Washington, DC.

Uekermann J, Channon S, Winkel K, Schlebusch P, Daum I (2007) Theory of mind, humour processing and executive functioning in alcoholism. Addiction 102:232–240.

Uekermann J, Daum I, Schlebusch P, Trenckmann U (2005) Processing of affective stimuli in alcoholism. Cortex 41:189–194.

Werner KH, Goldin PR, Ball TM, Heimberg RG, Gross JJ (2011) Assessing emotion regulation in social anxiety disorder: the emotion regulation interview. J Psychopathol Behav Assess 33:346–354.

World Heath Organization (WHO) (2013) Status Report on Alcohol and Health in 35 European Countries. Available at: http://www.euro.who.int/fr/publications/abstracts/status-report-on-alcohol-andhealth-in-35-european-countries-2013. Accessed November 12, 2015.