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Impaired Emotional Facial Expression Decoding in Alcoholism is Also Present for Emotional Prosody and Body Postures

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Abstract — Aims: Emotional facial expression (EFE) decoding impairment has been repeatedly reported in alcoholism (e.g. Philippot *et al*., 1999). Nevertheless, several questions are still under debate concerning this alteration, notably its generalization to other emotional stimuli and its variation according to the emotional valence of stimuli. **Methods:** Eighteen recently detoxified alcoholic subjects and 18 matched controls performed a decoding test consisting in emotional intensity ratings on various stimuli (faces, voices, body postures and written scenarios) depicting different emotions (anger, fear, happiness, neutral, sadness). Perceived threat and difficulty were also assessed for each stimulus. **Results:** Alcoholic individuals had a preserved decoding performance for happiness stimuli, but alcoholism was associated with an underestimation of sadness and fear, and with a general overestimation of anger. More importantly, these decoding impairments were observed for faces, voices and postures but not for written scenarios. **Conclusions:** We observed for the first time a generalized emotional decoding impairment in alcoholism, as this impairment is present not only for faces but also for other visual (i.e. body postures) and auditory stimuli. Moreover, we report that this alteration (1) is mainly indexed by an overestimation of anger and (2) cannot be explained by an 'affect labelling' impairment, as the semantic comprehension of written emotional scenarios is preserved. Fundamental and clinical implications are discussed.

INTRODUCTION

The non-verbal expression of emotions and their correct perception are crucial for social interactions (Oatley and Johnson-Laird, 1987) in order to develop and maintain adapted interpersonal relationships (Feldman *et al*., 1991; Carton *et al*., 1999). A variety of communication channels are involved in the transmission of affective states in humans, but faces are without doubt the most predominant one. Emotional facial expressions (EFE) decoding has thus been extensively explored in normal (e.g. Camras *et al*., 1993) as well as psychiatric populations (Power and Dalgleish, 1997), and seems particularly impaired in alcoholism (see Balconi, 2008 for a recent review).

Indeed, it has been classically observed that alcoholic subjects have an impaired interpretation of the emotional valence depicted in EFE, overestimate the intensity of these EFE and are not conscious of their impairments (Kornreich *et al*., 2001, 2002). While some contradictory results have been described (Uekermann *et al*., 2005), this EFE decoding impairment now appears strongly established (Oscar-Berman *et al*., 1990; Philippot *et al*., 1999; Townshend and Duka, 2003). This alteration is of high clinical relevance as it is correlated with the intensity of interpersonal problems (Kornreich *et al*., 2002). It could thus hamper social interactions and eventually reinforce social isolation in alcoholism. This may in turn increase alcohol consumption, used as a coping strategy to face with this isolation, *de facto* leading to a vicious circle (Kornreich *et al*., 2001, 2002). Nevertheless, several aspects of this impairment are still under debate.

A first question very little explored up to now is whether the impairment is specific for EFE or could be applied generally to various emotional stimuli. Studies exploring emotional perception in alcoholism mainly focused on EFE, but several other ways are used by humans to communicate emotions. For example, emotions expressed in the voice (namely *affective prosody*) have become a major field of interest during the last decade (see Ethofer *et al*., 2006, for a review). Nevertheless, only four studies explored affective auditory decoding in alcoholism, showing either an impaired (Monnot *et al*., 2001, 2002; Uekermann *et al*., 2005) or preserved performance (Oscar-Berman *et al*., 1990). These contradictory results, and the fact that these studies did not explore the differential impairment across emotions, restrains any firm conclusion concerning emotional prosody decoding in alcoholism and its comparison with the EFE decoding alteration. Moreover, the perception of emotion signals through *body postures* also recently led to a growing interest (e.g. Meeren *et al*., 2005; de Gelder, 2006), showing the crucial role of this medium in the emotional communication, but the processing of these stimuli in alcoholism has not been studied yet.

A second aspect still to be clarified is the variation of the impairment across emotions. While some emotions seem accurately evaluated (mainly happiness and disgust), alcoholism is associated with an overestimation of anger (Marlatt, 1979; Philippot *et al*., 1999). As previous studies led to heterogeneous results concerning the differential impairment across emotions, it appears important to clarify this question, and notably to confirm the overestimation of anger in alcoholism.

Finally, this impaired emotional decoding in alcoholism is usually considered as reflecting an alteration in emotion perception, but an alternative explanation cannot be ruled out on the basis of existing results. Indeed, while emotion recognition is usually considered as automatic (e.g. Smith *et al*., 2005), emotional perception is not decoded independently of language, and the accessibility of emotion words influences normal participants' speed and accuracy in perceiving EFE (Lindquist *et al*., 2006). In this 'language-as-context' view (Barrett *et al*., 2007), EFE decoding impairment could be at least partly explained by

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an ‘affect labelling’ impairment. The deficient EFE decoding would then be due to a biased emotion labelling rather than to an impaired emotional perception *per se*. This hypothesis has to be explored (via tasks exploring the identification of emotions depicted in semantic stimuli) as it could lead to a global reinterpretation of earlier results.

This study, based on an emotion-detection paradigm allowing direct comparison between different emotions and stimuli types, aimed at clarifying the EFE decoding impairment observed in alcoholism, by testing three main hypotheses:

(1) This impairment is not specific for EFE but rather general for emotional stimuli, in visual (i.e. body postures) as well as auditory (i.e. emotional prosody) modalities.
(2) This impairment varies across emotions, with a preserved decoding for some emotions (e.g. happiness) and an impaired one for others (e.g. an overestimation of anger).
(3) This impairment could be due to an ‘affect labelling’ impairment: alcoholism could be associated with a ‘semantic’ alteration, leading to a misidentification of the emotion expressed in linguistic stimuli (namely written emotional scenarios, namely scripts).

MATERIALS AND METHODS

Participants

Eighteen patients (four women), diagnosed with alcohol dependence according to DSM-IV criteria, were recruited during the third week of their treatment in a detoxification centre (Integrated Hepatology Unit, St Luc Hospital, Catholic University of Louvain, Brussels, Belgium). These patients were selected on the basis of a first screening phase, including 76 patients and leading to the inclusion of the patients fulfilling several criteria: they had all abstained from alcohol for at least 2 weeks (mean: 14.53 days; SD 1.94), were free of any other psychiatric diagnosis (including depression and clinical anxiety as assessed by an exhaustive psychiatric examination based on a structured interview), were not given any medication and were all right handed. The mean duration of alcohol dependence was 115.7 months (SD 86.4), the mean alcohol consumption among patients just before detoxification was 26.7 standard drinks per day (SD 3.4) and the mean number of previous detoxification treatments was 2.71 (SD 1.62). Patients were matched for age, gender and education with a control group composed of 18 volunteers who were free of any personal or familial history of psychiatric disorder or drug/substance abuse, as assessed by an exhaustive psychiatric examination. The mean alcohol consumption in the control group was 4.5 standard drinks per week (SD 2.51), and control subjects abstained from any alcohol consumption at least 3 days before testing. Exclusion criteria for both groups included major medical problems, central nervous system disease (including epilepsy), visual or auditory impairment and polysubstance abuse (including tobacco). Each participant had a normal-to-corrected vision and a normal audition. The education level was assessed according to the number of years of education completed since starting primary school. Moreover, patients and control subjects were assessed for several psychological tests, in order to evaluate the presence of subclinical comorbid psychopathologies and impairments, which are known to influence emotional processing. The following variables were evaluated using validated self-completion questionnaires (mentioned within parentheses): State and trait anxiety (State and Trait Anxiety Inventory, forms A and B, Spielberger *et al.*, 1983), depression (Beck Depression Inventory, short version, Beck and Steer, 1987), interpersonal problems (Inventory of Interpersonal Problems, Horowitz *et al.*, 1988) and alexithymia (20-item Toronto Alexithymia Scale, Bagby *et al.*, 1994). Participants were provided with full details regarding the aims of the study and the procedure to be followed. After receiving this information, all participants gave their informed consent. The study was approved by the ethical committee of the medical school.

Table 1. Categorization of emotional voices by 70 pilot-study participants (see Maurage *et al.*, 2007b)

	Emotion (mean % of participant responses)						
Stimulus	Anger	Disgust	Fear	Happiness	Neutral	Sadness	Other
AW1	95	2	2	0	0	0	1
AW2	96	3	1	0	0	0	0
AM1	90	6	1	0	0	1	2
AM2	92	5	2	0	0	1	0
FW1	1	3	90	0	0	6	0
FW2	0	1	92	0	0	6	1
FM1	0	3	91	0	0	4	2
FM2	1	2	94	0	0	3	0
HW1	0	0	0	100	0	0	0
HW2	0	0	0	97	0	2	1
HM1	0	0	1	98	0	1	0
HM2	0	0	3	94	0	2	1
NW1	0	0	0	0	96	3	1
NW2	0	0	0	0	98	2	0
NM1	2	0	1	0	97	0	0
NM2	1	0	2	0	94	3	0
SW1	3	0	0	0	1	94	2
SW2	0	2	0	0	1	97	0
SM1	0	2	4	0	0	93	1
SM2	0	2	1	0	0	96	1

Participants had to decide whether randomly presented voices mainly displayed a prosody of anger, disgust, fear, happiness, neutral, sadness or of an other emotion. Mean percentages of responses are presented for each stimulus on each emotion used in this study. W = woman, M = man, A = anger, F = fear, H = happiness, N = neutral, S = sadness.

Pretest and stimuli selection

We used an emotion-detection task using four types of emotional stimuli, namely voices, faces, body postures and scripts.

The voices were auditory stimuli consisting in audiotapes enunciating of a semantically neutral word (namely ‘paper’) with an emotional prosody. These stimuli were selected from a standardized battery of 195 emotional auditory stimuli (Maurage *et al.*, 2007b) based on a pilot study (conducted on 70 participants, 43 females, mean age = 18.74, SD = 0.89) and lasted 700 ms. The four voices (two males) leading to the best percentages of correct identification for the five emotions (anger, happiness, fear, neutral, sadness) were selected. The categorization percentages for these 20 auditory stimuli (four voices and five audiotapes for each) are presented in Table 1.

The visual stimuli, namely faces, postures and scripts, were elaborated specifically for this experiment, and a pretest was thus performed to confirm that the emotion depicted in the stimuli was correctly perceived by control subjects. First, 40 stimuli were constructed for each visual stimulus type, namely eight 'persons' (four males) depicting five emotions each (anger, happiness, fear, neutral, sadness): 40 faces [using the software Face-Gen Modeller 3.1. (Singular inversions, 2006), which allows to construct and modulate realistic emotional facial expressions on the basis of the FACS system (Ekman and Friesen, 1976)], 40 body postures [using the software Poser 6.0 (E-Frontier, 2006) and on the basis of earlier studies (e.g. Coulson, 2004; Meeren *et al.*, 2005)] and 40 scripts. These scripts consisted in short texts (about 30 words) describing a situation appearing in a person's life and associated with a specific emotion (e.g. Anger: 'While she has been waiting for several hours to obtain concert tickets, Sandra is pushed out of the way by a man who jumps the queue and buys the last two tickets'; Happiness: 'While John is walking down the street he bumps into his best friend from high school who he has been trying to find for the past few years without success', see Scherer, 1986 for other examples). All visual stimuli were then standardized using Photoshop 6.0: they were placed on a grey background, resized to a 15 × 7.5 cm format (stimuli subtended a visual angle of 8 × 4°).

Second, these 120 stimuli were presented in a pretest phase to 55 participants (37 females, mean age = 18.24 years, SD = 1.23) who had a normal-to-corrected vision, were free of any personal or familial history of psychiatric disease, neurological disorder or drug/substance abuse (including binge drinking habits). Their personal alcohol consumption during the last 6 months was below six standard drinks per week. Participants had to report which emotion(s) were displayed in each stimulus, with 8-point Lickert scales (from 0 'Absolutely not' to 7 'Totally') that had to be completed on the basis of the following general question: 'Is this emotion expressed in this stimulus?'. Ten scales were proposed, reflecting emotions actually displayed in several stimuli (anger, fear, sadness, happiness) or other emotions (shame, boredom, surprise, contempt, annoyance, disgust) chosen for their proximity with the emotions actually expressed. A stimulus was considered as accurately identified (i.e. really depicting the expected emotion) if the scale associated with this emotion led to higher intensity rating than every other scale. Concerning the neutral emotion, a stimulus was considered as neutral if the intensity rating score was <2 on each emotion scale. On the basis of the results obtained among the 55 participants, global mean percentages of correct identification were computed for each stimulus. For each visual stimulus type and each emotion, the four stimuli leading to the highest identification percentages were then selected for the experiment. These stimuli appeared to be emotion specific as they led to a mean correct identification >92%. These mean identification percentages for each visual stimulus category (i.e. each combination between stimulus type and emotion) are summarized in Table 2. Faces and postures are illustrated in Fig. 1. This study thus comprised 80 stimuli, namely 4 'persons' (two males) × 4 stimulus types (faces, voices, postures, scripts) × 5 emotion types (anger, happiness, fear, neutral, sadness). Each combination between stimulus and emotion type was associated with four different stimuli.

Table 2. Mean percentages of correct identification for each combination between visual stimulus and emotion type at the pretest phase (55 independent judges)

Emotion stimulus	Anger	Happiness	Neutral	Fear	Sadness
Faces	96	99	97	97	96
Postures	94	97	95	92	94
Scripts	97	99	95	94	98

For anger, happiness, fear and sadness stimuli, the number represents the percentage of participants for whom the scale associated with the expected emotion led to higher intensity rating than every other scale.
For the neutral stimuli, the number represents the percentage of participants for whom ratings were lower than 2 (on 8-point Lickert scale) for every emotion scale.

Procedure

Participants had to judge the emotion(s) displayed in the stimuli by rating each of these stimuli on 7-point scales for four emotions: anger, happiness, fear and sadness. These four rating scales were presented in a random order on the computer screen, below the stimulus. The first scale appeared simultaneously with the stimulus, and the subject had to make his choice by clicking on a scale point using a computer mouse. This first scale was then immediately followed by the following one. After the four emotional scales, two complementary 7-point scales (from 'Not at all' to 'Very intensively') appeared in a fixed order: 'task difficulty' (i.e. How difficult was the decision concerning the emotion displayed in the stimulus?) and 'perceived threat' (i.e. How threatening did this stimulus appear to you?). The stimulus was maintained on the computer screen (or repeated as much as wanted by the subject for the auditory stimuli) until all scales had been completed. There was an intertrial interval of 3 s between each stimulus. The 80 stimuli were presented once each, in a random order. This study thus comprised four emotion scales (anger, happiness, fear, sadness) and two complementary scales ('task difficulty' and 'perceived threat'). The rating score (ranging from 1 to 7) obtained for each stimulus on each of the six scales was recorded. Please note the important distinction between the five emotion types (i.e. the emotion depicted in the stimulus) and the four emotion scales (i.e. the emotional label of the scale to be rated by the subjects).

Before starting the experiment, 16 practice trials (four for each stimulus type, using stimuli which were not used in the experiment) were presented to each participant in order to familiarize them with the procedure and the use of the computer. The whole decoding task was then conducted individually by each participant. After completion of the experiment, participants were asked to fill in depression, anxiety, interpersonal problems and alexithymia questionnaires.

RESULTS

Psychological measures

As shown in Table 3, alcoholic individuals and controls were similar in terms of age [$F(1,34) = 0.05$, N.S.], gender and education [$F(1,34) = 0.72$, N.S.]. Moreover, the two groups did not differ significantly on state anxiety [$F(1,34) = 0.29$, N.S.], trait anxiety [$F(1,34) = 0.23$, N.S.] and alexithymia [$F(1,34) = 0.34$, N.S.]. Nevertheless, the two groups significantly differed on depression [$F(1,34) = 8.83$, $P < 0.01$] and interpersonal problems [$F(1,34) = 6.08$, $P < 0.05$], alcoholic subjects presenting more depressed feelings and interpersonal problems than

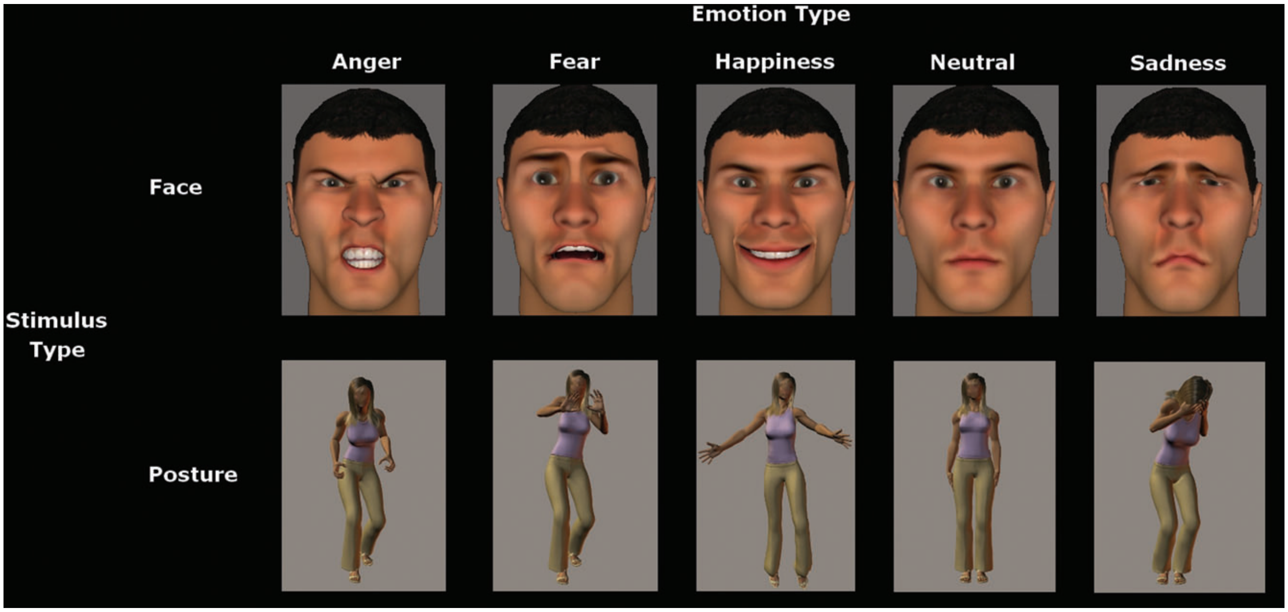

Fig. 1. Illustration of the faces and body postures used in this study, varying according to the emotion depicted (anger, fear, happiness, neutral, sadness).

Table 3. Characteristics of the alcoholic and control groups: mean (SD)

	Controls ($N = 18$)	Alcoholics ($N = 18$)
Gender (women/men)[NS]	4/14	4/14
Age (in years)[NS]	47.94 (11.91)	47.11 (10.3)
Education level (in years since starting primary school)[NS]	13.78 (2.04)	13.17 (2.26)
Number of standard drinks per day (before detoxification)***	0.64 (0.78)	26.7 (3.4)
Number of days since last drink	4.07 (1.53)	14.53 (1.94)
Number of anterior treatments	NA	2.71 (1.62)
Mean disease duration (in months)	NA	115.7 (86.4)
BDI[a,**]	2.83 (2.52)	6.73 (6.07)
STAI A[b,NS]	32.58 (9.47)	36.73 (12.97)
STAI B[b,NS]	38.33 (10.02)	35.92 (10.59)
IIP[c,*]	0.98 (0.45)	1.49 (0.53)
TAS-20[d,NS]	42.73 (14.83)	43.22 (17.69)

[NS] = non-significant; $^{*}P < 0.05$; $^{**}P < 0.01$; $^{***}P < 0.001$.
[a]BDI = Beck Depression Inventory, short version (Beck and Steer, 1987).
[b]STAI = State and Trait Anxiety Inventory (Spielberger *et al.*, 1983).
[c]IIP = Inventory of Interpersonal Problems (Horowitz *et al.*, 1988).
[d]TAS-20 = Twenty-item Toronto Alexithymia Scale—II (Bagby *et al.*, 1994).

controls. These interpersonal problems in alcoholism are mainly explained by the strongly significant group effect observed for the 'self-control problems' subscale [$F(1,34) = 30.88$, $P < 0.001$], showing important self-control difficulties among alcoholics.

Experimental results

As preliminary analyses did not show any significant influence of the stimulus gender, the four stimuli used for each stimulus type–emotion type combination (namely two males and two females) were collapsed in our statistical analyses.

All the results are presented in Table 4. This section will only describe the statistically significant ones and will be separated in two parts. First, the results related to each emotion type will be presented. Second, the results concerning non-emotional scales (namely 'Perceived threat' and 'task difficulty' scales) will be presented.

Emotional results. For each emotion type (anger, happiness, fear, neutral and sadness), a 4 × 4 × 2 ANOVA with stimulus type (face, voice, posture, script) and emotion scale (anger, happiness, fear, sadness), as within-factor and group (alcoholics, controls) as between-factor was carried out (a Greenhouse–Geisser correction was applied when appropriate). *Post hoc t*-tests and *post hoc* paired sample *t*-tests were also used to test general results and group differences, respectively. For each emotion type, we will first present the general results (i.e. not related to the central focus of this study, namely group differences) and then the significant group differences.

Anger stimuli. General results. Two main effects were observed: (1) Stimulus type [$F(3102) = 45.28$, $P < 0.001$, $\eta^2 = 0.57$]: scripts led to higher intensity ratings than faces [$t(35) = 9.03$, $P < 0.001$], voices [$t(35) = 9.32$, $P < 0.001$] and postures [$t(35) = 7.47$, $P < 0.001$]; (2) Emotion scale [$F(3102) = 526.56$, $P < 0.001$, $\eta^2 = 0.94$]: as expected, anger scale led to higher intensity ratings than happiness [$t(35) = 38.10$, $P < 0.001$], fear [$t(35) = 23.67$, $P < 0.001$] and sadness [$t(35) = 24.24$, $P < 0.001$]; and happiness scale led to lower intensity ratings than fear [$t(35) = 6.13$, $P < 0.001$] and sadness [$t(35) = 8.34$, $P < 0.001$] ones.

Group differences. A main effect of group was observed [$F(1,34) = 4.45$, $P < 0.05$, $\eta^2 = 0.13$]: the intensity ratings scores were globally higher among alcoholics. This effect is explained by a Group × Stimulus type × Emotion Scale interaction [$F(9306) = 3.58$, $P < 0.01$, $\eta^2 = 0.24$] showing that higher intensity ratings were found for alcoholics as compared to controls only in the anger scale for faces [$t(35) = 3.95$, $P < 0.01$], voices [$t(35) = 2.16$, $P < 0.05$] and postures [$t(35) = 3.08$, $P < 0.01$].

Table 4. Mean emotional rating [mean (SD)] among control and alcoholic subjects on each scale (anger, fear, happiness, sadness, perceived threat, difficulty) and each stimulus type (face, posture, script, voice) for each emotion type: Anger (1), Fear (2), Happiness (3), Neutral (4) and Sadness (5)

Emotional rating scale stimulus type		Anger	Fear	Happiness	Sadness	Threat	Difficulty
(1) Anger							
Face	Alcoholics	6.91 (0.24)	1.95 (1.04)	1.24 (0.41)	1.91 (1.15)	6.83 (0.23)	2.4 (1.39)
	Controls	6.26 (0.61)	2.09 (0.89)	1.11 (0.22)	1.49 (0.59)	5.47 (1.1)	2.39 (0.96)
	Group difference	$t(35) = 3.95^{**}$	N.S.	N.S.	N.S.	$t(35) = 5.14^{***}$	N.S.
Posture	Alcoholics	5.75 (0.95)	2.33 (0.93)	1.76 (0.56)	2.45 (1.11)	5.14 (1.12)	2.88 (1.35)
	Controls	4.68 (1.22)	2.08 (0.83)	1.86 (0.82)	1.88 (0.69)	4.12 (1.24)	2.63 (1.05)
	Group difference	$t(35) = 3.08^{**}$	N.S.	N.S.	N.S.	$t(35) = 2.58^{*}$	N.S.
Script	Alcoholics	6.63 (0.41)	2.38 (0.83)	1.18 (0.3)	4.34 (1.27)	3.63 (1.27)	2.22 (1.31)
	Controls	6.43 (0.56)	2.32 (0.97)	1.01 (0.03)	4.03 (1.32)	3.36 (1.02)	2.41 (1.15)
	Group difference	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Voice	Alcoholics	6.08 (0.9)	2 (1.22)	1.39 (0.47)	1.84 (1.19)	6.03 (0.86)	2.56 (1.39)
	Controls	5.13 (1.39)	1.84 (1.02)	1.26 (0.31)	1.49 (0.54)	4.45 (1.24)	2.47 (0.92)
	Group difference	$t(35) = 2.16^{*}$	N.S.	N.S.	N.S.	$t(35) = 4.46^{***}$	N.S.
(2) Fear							
Face	Alcoholics	2.94 (0.94)	5.34 (0.76)	1.31 (0.41)	4.39 (1.15)	2.89 (1.04)	2.4 (1.26)
	Controls	2.16 (1.04)	6.7 (0.36)	1.17 (0.25)	4.2 (1.28)	2.18 (1.11)	2.62 (0.91)
	Group difference	$t(35) = 2.23^{*}$	$t(35) = 8.65^{***}$	N.S.	N.S.	$t(35) = 2.24^{*}$	N.S.
Posture	Alcoholics	3.16 (0.98)	5.4 (1.08)	1.98 (0.69)	2.49 (1.16)	2.87 (1.08)	2.52 (1.45)
	Controls	2.02 (0.9)	6.26 (0.44)	1.47 (0.43)	2.11 (0.95)	1.76 (0.76)	2.57 (1.07)
	Group difference	$t(35) = 5.35^{***}$	$t(35) = 3.12^{**}$	N.S.	N.S.	$t(35) = 3.58^{**}$	N.S.
Script	Alcoholics	3.59 (1.34)	6.76 (0.37)	1.25 (0.41)	3.28 (1.44)	1.92 (0.91)	2.27 (1.54)
	Controls	2.54 (1.23)	6.61 (0.55)	1.06 (0.18)	3.02 (1.6)	2.27 (1.34)	1.92 (0.85)
	Group difference	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Voice	Alcoholics	3.02 (1.02)	3.41 (1.24)	1.83 (0.74)	3.82 (1.19)	2.79 (0.95)	2.63 (1.37)
	Controls	1.88 (0.84)	4.59 (1.27)	1.51 (0.5)	3.34 (0.93)	1.77 (1.01)	2.49 (0.99)
	Group difference	$t(35) = 3.97^{**}$	$t(35) = 2.54^{*}$	N.S.	N.S.	$t(35) = 3.15^{**}$	N.S.
(3) Happiness							
Face	Alcoholics	1.24 (0.53)	1.21 (0.35)	6.39 (0.7)	1.19 (0.33)	1.27 (0.62)	1.59 (1.32)
	Controls	1.08 (0.19)	1.17 (0.26)	6.09 (0.94)	1.14 (0.32)	1.19 (0.35)	1.54 (0.93)
	Group difference	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Posture	Alcoholics	1.56 (0.61)	1.55 (0.64)	5.56 (0.7)	1.62 (0.5)	1.29 (0.5)	2.04 (1.27)
	Controls	1.67 (0.66)	1.62 (0.62)	5.33 (0.72)	1.48 (0.58)	1.45 (0.61)	2.36 (1.14)
	Group difference	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Script	Alcoholics	1.39 (0.93)	1.89 (0.82)	6.59 (1.09)	1.41 (1.01)	1.45 (1.17)	1.49 (1.13)
	Controls	1.05 (0.14)	1.44 (0.39)	6.67 (0.41)	1.15 (0.28)	1.06 (0.14)	1.45 (0.94)
	Group difference	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Voice	Alcoholics	1.7 (0.89)	1.68 (0.84)	4.74 (1.18)	1.87 (1.08)	1.53 (0.76)	2.13 (1.34)
	Controls	1.39 (0.71)	1.53 (0.58)	4.83 (1.2)	1.37 (0.62)	1.41 (0.68)	1.92 (0.88)
	Group difference	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
(4) Neutral							
Face	Alcoholics	3.41 (0.98)	2.67 (0.96)	1.61 (0.58)	3.23 (1.17)	3.34 (0.91)	2.45 (1.38)
	Controls	2.25 (0.85)	2.34 (0.97)	1.55 (0.54)	2.67 (1.15)	2.31 (0.94)	2.62 (1.02)
	Group difference	$t(35) = 3.72^{**}$	N.S.	N.S.	N.S.	$t(35) = 3.31^{**}$	N.S.
Posture	Alcoholics	2.82 (0.95)	2.21 (0.85)	1.79 (0.81)	3.04 (1.11)	2.63 (0.75)	2.56 (1.27)
	Controls	1.81 (0.77)	2.19 (0.8)	1.59 (0.71)	2.5 (1.01)	2.04 (0.84)	2.63 (1.08)
	Group difference	$t(35) = 3.36^{**}$	N.S.	N.S.	N.S.	$t(35) = 2.2^{*}$	N.S.
Script	Alcoholics	1.48 (0.54)	1.59 (0.58)	3.16 (1.11)	1.48 (0.54)	1.36 (0.67)	1.86 (1.35)
	Controls	1.35 (0.34)	1.37 (0.37)	2.38 (0.96)	1.33 (0.32)	1.25 (0.35)	1.81 (0.86)
	Group difference	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Voice	Alcoholics	2.83 (0.93)	1.94 (1)	1.49 (0.52)	3.23 (1.37)	2.79 (1.1)	2.23 (1.22)
	Controls	1.58 (0.68)	1.79 (0.77)	1.48 (0.59)	2.66 (1.18)	1.4 (0.48)	2.36 (0.92)
	Group difference	$t(35) = 5.11^{***}$	N.S.	N.S.	N.S.	$t(35) = 4.93^{***}$	N.S.
(5) Sadness							
Face	Alcoholics	3.21 (1.37)	3.13 (1.39)	1.18 (0.32)	5.29 (1.21)	2.93 (1.11)	2.59 (1.57)
	Controls	2.57 (1.26)	2.39 (1.35)	1.06 (0.14)	6.73 (0.3)	2.29 (1.31)	2.4 (0.96)
	Group difference	$t(35) = 2.34^{*}$	N.S.	N.S.	$t(35) = 4.55^{*}$	N.S.	N.S.
Posture	Alcoholics	3.23 (1.05)	4.07 (1.16)	1.24 (0.41)	5.58 (1.02)	2.46 (0.69)	2.29 (1.43)
	Controls	1.93 (0.67)	3.18 (1.37)	1.18 (0.22)	6.16 (0.67)	1.4 (0.6)	2.26 (1.02)
	Group difference	$t(35) = 5.09^{***}$	N.S.	N.S.	$t(35) = 2.21^{*}$	$t(35) = 4.9^{***}$	N.S.
Script	Alcoholics	4.28 (1.06)	2.84 (1.11)	1.25 (0.5)	6.09 (0.76)	1.56 (0.67)	2.06 (1.25)
	Controls	3.79 (1.07)	2.55 (1.07)	1.12 (0.23)	6 (0.54)	1.48 (0.48)	2.12 (0.9)
	Group difference	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Voice	Alcoholics	2.59 (0.88)	3.07 (1.19)	1.43 (0.56)	3.52 (0.72)	2.54 (0.82)	2.31 (1.39)
	Controls	1.44 (0.7)	2.68 (0.95)	1.14 (0.24)	5.28 (0.98)	1.3 (0.35)	2.11 (0.92)
	Group difference	$t(35) = 6.31^{***}$	N.S.	N.S.	$t(35) = 6.31^{***}$	$t(35) = 5.89^{***}$	N.S.

The significant group differences are also presented ($^{*}P < 0.05$; $^{**}P < 0.01$; $^{***}P < 0.001$).

Fear stimuli. General results. Two main effects were found: (1) Stimulus type [$F(3102) = 24.47$, $P < 0.001$, $\eta^2 = 0.42$]: scripts and faces led to higher intensity ratings than voices [Script − Voices: $t(35) = 5.11$, $P < 0.001$; Faces − Voices: $t(35) = 6.48$, $P < 0.001$] and postures [Script − Postures: $t(35) = 4.72$, $P < 0.001$; Faces − Postures: $t(35) = 8.14$, $P < 0.001$]; (2) Emotion scale [$F(3102) = 333.62$, $P < 0.001$, $\eta^2 = 0.91$]: as expected, the fear scale led to higher intensity ratings than anger [$t(35) = 18.82$, $P < 0.001$], happiness [$t(35) = 39.28$, $P < 0.001$] and sadness [$t(35) = 14.12$, $P < 0.001$] ones. Moreover, lower intensity ratings were observed for happiness as compared to anger [$t(35) = 8.22$, $P < 0.001$] and sadness [$t(35) = 12.73$, $P < 0.001$], and for sadness as compared to anger [$t(35) = 5.87$, $P < 0.001$].

Group differences. A main effect of group was observed [$F(1,34) = 6.84$, $P < 0.05$, $\eta^2 = 0.17$]: the intensity scores were globally higher among alcoholics. This effect is explained by a Group × Stimulus type × Emotion Scale interaction [$F(9306) = 5.11$, $P < 0.001$, $\eta^2 = 0.13$] showing that higher intensity scores were found for alcoholics as compared to controls only in the anger scale for faces [$t(35) = 2.23$, $P < 0.05$], voices [$t(35) = 3.97$, $P < 0.01$] and postures [$t(35) = 5.35$, $P < 0.001$]. Moreover, alcoholic subjects presented lower intensity ratings than controls on the fear scale for faces [$t(35) = 8.65$, $P < 0.001$], voices [$t(35) = 2.54$, $P < 0.05$] and postures [$t(35) = 3.12$, $P < 0.01$].

Happiness stimuli. General results. Two main effects were observed: (1) Stimulus type [$F(3102) = 10.92$, $P < 0.001$, $\eta^2 = 0.24$]: scripts led to higher intensity ratings than faces [$t(35) = 5.34$, $P < 0.001$], voices [$t(35) = 5.13$, $P < 0.001$] and postures [$t(35) = 2.58$, $P < 0.05$]; (2) Emotion scale [$F(3102) = 726.29$, $P < 0.001$, $\eta^2 = 0.95$]: as expected, the happiness scale led to higher intensity ratings than anger [$t(35) = 27.45$, $P < 0.001$], fear [$t(35) = 29.02$, $P < 0.001$] and sadness [$t(35) = 27.87$, $P < 0.001$] ones.

Group differences. No main effect of group nor interaction implicating group differences were found.

Neutral stimuli. General results. Two main effects were observed: (1) Stimulus type [$F(3102) = 24.59$, $P < 0.001$, $\eta^2 = 0.42$]: scripts led to lower intensity ratings than faces [$t(35) = 8.45$, $P < 0.001$], voices [$t(35) = 3.62$, $P < 0.001$] and postures [$t(35) = 6.17$, $P < 0.001$]; (2) Emotion scale [$F(3102) = 23.37$, $P < 0.001$, $\eta^2 = 0.41$]: the anger scale led to higher intensity ratings than fear [$t(35) = 2.18$, $P < 0.05$], happiness [$t(35) = 3.27$, $P < 0.01$] and sadness [$t(35) = 3.45$, $P < 0.01$] ones.

Group differences. A main effect of group was observed [$F(1,34) = 4.64$, $P < 0.05$, $\eta^2 = 0.12$]: the intensity ratings scores were globally higher among alcoholics. This effect is explained by a Group × Stimulus type × Emotion Scale interaction [$F(9306) = 4.11$, $P < 0.001$, $\eta^2 = 0.11$] showing that higher intensity scores were found for alcoholics as compared to controls only in the anger scale for faces [$t(35) = 3.72$, $P < 0.01$], voices [$t(35) = 5.11$, $P < 0.001$] and postures [$t(35) = 3.36$, $P < 0.01$].

Sadness stimuli. General results. Two main effects were observed: (1) Stimulus type [$F(3102) = 44.07$, $P < 0.001$, $\eta^2 = 0.56$]: voices led to lower intensity ratings than faces [$t(35) = 5.97$, $P < 0.001$], scripts [$t(35) = 10.51$, $P < 0.001$] and postures [$t(35) = 6.37$, $P < 0.001$]; (2) Emotion scale [$F(3102) = 373.35$, $P < 0.001$, $\eta^2 = 0.92$]: as expected, the sadness scale led to higher intensity ratings than anger [$t(35) = 17.15$, $P < 0.001$], happiness [$t(35) = 41.25$, $P < 0.001$] and fear [$t(35) = 16.91$, $P < 0.001$] ones. Moreover, lower intensity ratings were observed for happiness as compared to anger [$t(35) = 11.81$, $P < 0.001$] and fear [$t(35) = 12.12$, $P < 0.001$].

Group differences. A main effect of group was observed [$F(1,34) = 7.02$, $P < 0.05$, $\eta^2 = 0.17$]: the intensity ratings were globally higher among alcoholics. This effect is explained by a Group × Stimulus type × Emotion Scale interaction [$F(9306) = 10.61$, $P < 0.001$, $\eta^2 = 0.24$] showing that higher intensity ratings were observed for alcoholics as compared to controls only in the anger scale for faces [$t(35) = 2.34$, $P < 0.05$], voices [$t(35) = 6.31$, $P < 0.001$] and postures [$t(35) = 5.09$, $P < 0.001$]. Moreover, alcoholic subjects presented lower intensity ratings than controls on the sadness scale for faces [$t(35) = 4.55$, $P < 0.05$], voices [$t(35) = 6.31$, $P < 0.001$] and postures [$t(35) = 2.21$, $P < 0.05$].

Non-emotional scales. 'Perceived threat' scale. A 4 × 5 × 2 ANOVA with stimulus type (face, voice, posture, script) and stimulus emotion (anger, happiness, fear, neutral, sadness) as within factor and group (alcoholics, controls) as between factor was carried out. Three main effects were observed: (1) Group [$F(1,34) = 11.16$, $P < 0.01$, $\eta^2 = 0.25$]: alcoholics globally perceived the stimuli as more threatening than controls; (2) Stimulus type [$F(3102) = 92.19$, $P < 0.001$, $\eta^2 = 0.73$]: scripts are perceived as less threatening than faces [$t(35) = 11.24$, $P < 0.001$], voices [$t(35) = 6.14$, $P < 0.001$] and postures [$t(35) = 6.78$, $P < 0.001$]; (3) Emotion type [$F(4136) = 320.9$, $P < 0.001$, $\eta^2 = 0.91$]: Anger stimuli are perceived as more threatening than happiness [$t(35) = 25.01$, $P < 0.001$], neutral [$t(35) = 22.76$, $P < 0.001$], fear [$t(35) = 14.89$, $P < 0.001$] and sadness [$t(35) = 22.14$, $P < 0.001$], and happiness stimuli are perceived as less threatening than neutral [$t(35) = 9.81$, $P < 0.001$], fear [$t(35) = 8.28$, $P < 0.001$] and sadness [$t(35) = 7.97$, $P < 0.001$].

These main effects were moderated by two interactions: (1) Group × Stimulus Type [$F(3102) = 17.63$, $P < 0.001$, $\eta^2 = 0.34$]: alcoholic subjects perceived more threat than controls in faces [$F(1,34) = 11.42$, $P < 0.01$], voices [$F(1,34) = 25.44$, $P < 0.001$] and postures [$F(1,34) = 11.25$, $P < 0.01$], but not in scripts [$F(1,34) = 0.23$, N.S.]; (2) Group Emotion Type [$F(4136) = 5.29$, $P < 0.01$, $\eta^2 = 0.14$]: alcoholic subjects perceived more threat than controls in anger [$F(1,34) = 17.19$, $P < 0.001$], neutral [$F(1,34) = 11.33$, $P < 0.01$], fear [$F(1,34) = 4.48$, $P < 0.05$] and sadness [$F(1,34) = 11.13$, $P < 0.01$] stimuli, but not in happiness [$F(1,34) = 0.32$, N.S.].

'Task difficulty' scale. A 4 × 5 × 2 ANOVA with stimulus type (face, voice, posture, script) and stimulus emotion (anger, happiness, fear, neutral, sadness) as within factor and group (alcoholics, controls) as between factor was carried out. No main effect of group was observed [$F(1,34) = 0.03$, N.S.], but main effects were observed for (1) Stimulus type [$F(3102) = 15.37$, $P < 0.001$, $\eta^2 = 0.29$]: scripts are perceived as less difficult to judge than faces [$t(35) = 5.32$, $P < 0.001$], voices [$t(35) = 5.08$, $P < 0.001$] and postures [$t(35) = 5.27$, $P < 0.001$]; (2) Emotion type [$F(4136) = 17.89$, $P < 0.001$, $\eta^2 = 0.31$]: happiness stimuli were perceived as less difficult to judge than anger [$t(35) = 5.53$, $P < 0.001$], neutral [$t(35) = 5.49$, $P < 0.001$], fear [$t(35) = 5.53$, $P < 0.001$] and sadness [$t(35) = 4.45$, $P < 0.001$].

Table 5. Pearson's correlations in the alcoholic group between interpersonal problems assessed by the Inventory of Interpersonal Problems (global score and self-control problems subscale) and the global rating scores for the anger and 'perceived threat' scales : P value (*P-value*)

Rating Scales Psychol. Measures	Mean rating for Anger scale	Mean rating for 'perceived threat' scale
IIP[a] global score	0.444 (0.129)	0.343 (0.252)
Self-control problems	**0.750 (0.003)**	**0.644 (0.017)**

Significant results are indicated in bold text.[a]IIP = Inventory of Interpersonal Problems (Horowitz *et al.*, 1988).

Complementary analyses

Finally, complementary analyses were computed in order to

(1) Test the potential effect of subject gender: this variable was included as a covariate in our ANOVA statistical analyses. We did not observe any significant influence of the gender on experimental results ($P > 0.05$ for every test).
(2) Test the potential influence of depression scores on experimental results: as even moderate scores on the BDI can indicate a clinically relevant depression (Furlanetto *et al.*, 2005), we can not definitely rule out the possibility that subclinical depression observed among several alcoholic subjects (six alcoholics had a BDI score >9) had an influence on our results. Nevertheless, the higher scores observed in alcoholism concerning depression are unlikely to have influenced the experimental results, as (a) no significant Pearson's correlations (calculated within each group and across group) were shown between depression scores and any experimental results (alcoholic group: $r \leq 0.469$, $P \geq 0.11$; control group: $r \leq 0.293$, $P \geq 0.33$; across groups: $r \leq 0.51$, $P \geq 0.075$) and (b) a complementary analysis was conducted, including the depression scores as covariate in all our ANOVA statistical analyses associated with group differences. No significant influence of depression scores was observed on any group differences ($P > 0.05$ for every covariate analysis).
(3) Test the potential influence of interpersonal problems on experimental results: Pearson's correlations were computed between the results of the interpersonal problems questionnaires (global and self-control subscale scores) and the results from our experimental data. No significant correlations were observed concerning the global interpersonal problems score ($P > 0.05$ for every correlation). Nevertheless, as illustrated in Table 5, significant correlations were found in the alcoholic group between self-control problems subscale and (a) the global mean rating score on anger scale and (b) the global mean rating score on 'perceived threat' scale. Moreover, these global ratings on anger and 'perceived threat' scales were highly correlated together ($P = 0.92$, $P < 0.001$).

DISCUSSION

The main purpose of this study was to specify the emotional decoding impairment repeatedly described in alcoholism, by addressing four points: (1) the confirmation of this alteration for EFE with a more simple and controlled paradigm; (2) the generalization of this alteration to other visual and auditory emotional stimuli; (3) the variability of this alteration across emotions; and (4) the examination of an alternative explanation of this alteration, based on the hypothesis of a semantic 'affect labelling' impairment among alcoholic subjects. These four aspects will now be successively discussed in the light of the results.

Confirmation of the EFE decoding impairment

First, our results globally confirmed the well-known EFE decoding impairment in alcoholism (e.g. Philippot *et al.*, 1999; Kornreich *et al.*, 2001, 2002). Indeed, alcoholic subjects presented an impaired performance for EFE perception (particularly for negative emotions) and were not conscious of this impairment, as suggested previously (e.g. Kornreich *et al.*, 2002). This confirmation of the EFE decoding impairment is fundamental as it was conducted with:

(1) *A more direct paradigm*. Studies exploring EFE decoding in alcoholism used complex methodology to detect this impairment: variations in the EFE intensity (Philippot *et al.*, 1999), use of morphed EFE simultaneously depicting two emotions (Townshend and Duka, 2003) or even variations in face orientation (Frigerio *et al.*, 2002). We thus reinforced earlier results, with a straighter paradigm based on full-blown emotions: alcoholism is associated with an EFE decoding alteration.
(2) *A stronger control of psychological measures*. Earlier studies did not propose a simultaneous control of depression, anxiety and alexithymia levels. As these frequent alcoholism comorbidities are associated with EFE processing impairments (e.g. Mendlewicz *et al.*, 2005; Rossignol *et al.*, 2005; Vermeulen *et al.*, 2008), they could at least partly explain the EFE decoding alteration in alcoholism, and thus invalidate the observed results. Moreover, several studies (Oscar-Berman *et al.*, 1990; Frigerio *et al.*, 2002), taking place during the early abstinence period, did not take the medication into account. As withdrawal symptoms in alcoholism are usually treated using benzodiazepines (e.g. McKeon *et al.*, 2007), which have a well-known sedative effect (e.g. Stewart, 2005), medication could bias EFE decoding. Our results ruled out these potential biasing influences of comorbidities and medication by showing that EFE decoding impairment in alcoholism was (a) present among alcoholics who were neither anxious, alexithymics nor medicated and (b) not influenced by the depression level. Our results thus strongly suggest that this impairment is a consequence of alcoholism *per se* and cannot be explained by comorbidities or medication.

Generalization of the EFE decoding impairment

If face is the most frequently used channel to communicate emotions, voices and body language also constitute very important emotional media. Nevertheless, very few studies investigated emotional prosody perception in alcoholism, and none focused on body postures, leaving it unclear if this impairment was specific for EFE or present for every emotional stimulus. Our results suggest that the alteration observed for faces is generalizable to other emotional stimuli, in the visual (i.e. postures) and auditory modalities (i.e. voices). Moreover, no significant differences were observed between the different stimulus types concerning the intensity and emotional specificity of this impairment, suggesting that the impairment is identical for faces, voices and postures.

This first observation of a general emotional impairment in alcoholism has several implications. First, at a theoretical level, this observation of an identical impairment across different stimuli in a psychiatric population supports earlier studies among normal subjects (e.g. Hadjikhani and de Gelder, 2003; Magnée *et al*., 2007) that suggested that the same cerebral areas (e.g. amygdala) may be implicated in every emotional processing independently of the stimulus type and modality. Second, at a clinical level, it is a call for considering emotional decoding impairment in alcoholism as a holistic problem (i.e. not only affecting EFE but also other visual and auditory stimuli), and thus developing integrative therapeutic programmes aiming at the global revalidation of emotional decoding.

Variation of the impairment across emotions

The results observed here clearly confirm that the intensity of the impairment in alcoholism varies across emotions. First, we observed a preserved processing of positive emotion (namely happiness), which is in line with earlier results (e.g. Frigerio *et al*., 2002; Townshend and Duka, 2003). Second, we described an underestimation of fear and sadness. This underestimation appears surprising as some earlier studies (e.g. Philippot *et al*., 1999) previously showed an overestimation of fear and sadness in alcoholism. Nevertheless, these earlier results can be explained by biasing comorbidities, as (a) fear overestimation among alcoholics disappears when state anxiety is controlled (Townshend and Duka, 2003) and (b) comorbid depressive state is associated with an overestimation of sadness (e.g. Bouhuys *et al*., 1999; Gotlib *et al*., 2004) and with an increased neural response to sadness stimuli (e.g. Surguladze *et al*., 2005). These results suggest that the overestimation of fear and sadness observed in certain earlier studies could be due to uncontrolled comorbidities influences. Our results show that, when comorbidities are taken into account, control subjects have a ceiling effect in the estimation of fear and sadness while alcoholics tend to underestimate the presence of these emotions, and to confuse them with anger (as shown below).

Our results also indicated an overestimation of anger. This constitutes a central result of this study as we showed that alcoholic subjects overestimated the intensity of anger depicted not only in anger stimuli but also in fear, sad and even neutral ones. The overestimation of anger depicted in anger (Townshend and Duka, 2003) and sad stimuli (Frigerio *et al*., 2002) had already been described, but our results further describe this bias by showing that this overestimation of anger is (a) present for every negative stimuli (i.e. not only anger, sadness but also fear); (b) present even for neutral stimuli, where no emotion is indeed depicted and (c) associated with an increased threat perception and with higher self-control problems.

This generalized overestimation of anger and its link with interpersonal problems is of high clinical relevance. Indeed, these results bring an experimental validation to clinical studies (Bartek *et al*., 1999; Karno and Longabaugh, 2004) that suggested a tendency of alcoholic subjects to overestimate the anger and threat expressed by others, even if no anger or threat is indeed expressed (e.g. in neutral stimuli) and a link between this overestimation and self-control problems. Moreover, these observations reinforce the hypothesis of a vicious circle in alcoholism. Indeed, the excessive perception of anger and threat associated with a lower self-control could lead to more frequent aggressive behaviours (Bushman and Cooper, 1990; Wall and Wekerle, 2002) and thus reinforce interpersonal problems and isolation. These increased social difficulties may lead to an enhanced alcohol consumption, used as a coping strategy, which may finally, because of alcohol neurotoxicity, further deteriorate emotional decoding (Philippot *et al*., 2003).

Alternative explanation of the impairment

EFE decoding alteration in alcoholism has up to now been interpreted straightforwardly as reflecting an impaired perception of the emotional content depicted in the stimuli. Nevertheless, decoding abilities have always been evaluated using emotional judgements on different rating scales, each one associated with an emotional word. This methodology is valid only if all subjects have the same definition of the emotional labels (i.e. if words like ‘anger’ or ‘happiness’ have an identical conceptual value for every subject). This assumption has never been tested yet, but its invalidation would lead to a complete reevaluation of earlier results. Indeed, emotion decoding (particularly when labelled rating scales are used) is not independent of language (e.g. Halberstadt and Niedenthal, 2001), and the poor EFE decoding performance in alcoholism could thus be at least partly explained by linguistic biases (namely an ‘affect labelling’ impairment) rather than to an impaired emotional perception.

Our results give a first insight concerning this alternative hypothesis by showing that alcoholism is not associated with a perception alteration for emotional scripts. This result suggests that the impairment of emotional perception in alcoholism is not due to a general linguistic impairment associated with emotion labelling, as no differences were observed between alcoholics and controls for emotional judgements on semantic materials.

Summary, limitations and conclusion

To sum up, the main results of this study are (1) the confirmation of the impairment in EFE decoding among alcoholics using an easier design (full-blown emotional stimuli); (2) the generalization of this impairment to other visual (postures) and auditory emotional stimuli (emotional prosody); (3) the observation of a variability of this impairment across emotions, and specifically an overestimation of anger; (4) the invalidation of the possible alternative explanation of this alteration, based on the hypothesis of an ‘affect labelling’ impairment (Lieberman *et al*., 2007).

These results should of course be confirmed in future studies, exploring notably the variation of the impairment across other emotions (e.g. disgust) and stimuli types (e.g. emotional scenes). These future studies should also rule out some possible alternative explanations of our results, notably the possibility that they could be partially explained by the general cognitive deficit present in alcoholism. Indeed, the impairments observed here are particularly marked for complex emotional judgement (e.g. anger stimuli) as compared to easier ones (e.g. happiness stimuli). While earlier studies (e.g. Maurage *et al*., 2008) showed that the emotional deficit in alcoholism is specific for emotional features and absent in non-emotional tasks with the same difficulty, this potential influence of the reduced cognitive resources among alcoholics should be investigated.

Nevertheless, this first observation of a generalized emotion decoding impairment in alcoholism, independently of the stimulus type and modality, clearly calls for reconsidering the emotional perception in alcoholism, at fundamental and clinical levels. Future studies should explore how these visual and auditory impairments interact in crossmodal situations (i.e. when stimuli coming from different sensorial modalities are presented simultaneously), which are the most common in everyday life (Campanella and Belin, 2007). Indeed, it has been recently demonstrated that interactions and mutual influence exist between faces, voices and postures (Van den stock *et al*., 2007), and that alcoholic subjects could be particularly impaired for crossmodal stimulations (Maurage *et al*., 2007a). More generally, the observation of an impaired emotional processing in visual but also in auditory modalities should lead to a diversification of the stimuli used in experimental paradigms as well as in therapeutic programmes. The development of more ecological stimuli, among which crossmodal ones, should constitute a central concern in the future.

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REFERENCES

Bagby RM, Taylor GJ, Parker JD. (1994) The twenty-item Toronto alexithymia scale—II. Convergent discriminant and concurrent validity. *J Psychosom Res* **38**:33–40.

Balconi, M (2008) *Emotional Face Comprehension, Neuropsychological Perspectives*. 1st edn. New York: Nova Publishers.

Barrett LF, Lindquist KA, Gendron M. (2007) Language as context for the perception of emotion. *Trends Cogn Sci* **11**:327–32.

Bartek JK, Lindeman M, Hawks JH. (1999) Clinical validation of characteristics of the alcoholic family. *Nurs Diagn* **10**:158–68.

Beck AT, Steer RA. (1987) *Beck Depression Inventory Manual*. 1st edn. San Antonio: Psychological Corporation.

Bouhuys AL, Geerts E, Gordijn MC. (1999) Depressed patients' perceptions of facial emotions in depressed and remitted states are associated with relapse: a longitudinal study. *J Nerv Ment Dis* **187**:595–602.

Bushman BJ, Cooper HM. (1990) Effects of alcohol on human aggression: an integrative research review. *Psychol Bull* **107**:341–54.

Campanella S, Belin P. (2007) Integrating face and voice in person perception. *Trends Cogn Sci* **11**:535–43.

Camras LA, Holland EA, Patterson MJ. (1993) Facial expression. In Lewis M, Haviland JM (eds). *Handbook of Emotions*. New York: Guilford, 199–208.

Carton JS, Kessler EA, Pape CL. (1999) Nonverbal decoding skills and relationship well-being in adults. *J Nonverbal Behav* **23**:91–100.

Coulson M. (2004) Attributing emotion to static body postures: recognition accuracy, confusion, and viewpoint dependence. *J Nonverbal Behav* **28**:117–39.

de Gelder B. (2006) Towards the neurobiology of emotional body language. *Nat Rev Neurosci* **7**:242–9.

Ekman P, Friesen WV. (1976) *Pictures of Facial Affect*. 1st edn. Palo Alto, CA: Consulting Psychologists Press.

Ethofer T, Pourtois G, Wildgruber D. (2006) Investigating audiovisual integration of emotional signals in the human brain. *Prog Brain Res* **156**:345–61.

Feldman RS, Philippot P, Custrini RJ. (1991) Social competence and non-verbal behaviour. In Feldman RS (ed). *Fundamentals of Non-Verbal Behavior*. New York: Cambridge University Press, 329–50.

Frigerio E, Burt DM, Montagne B *et al.* (2002) Facial affect perception in alcoholics. *Psychiatry Res* **113**:161–71.

Furlanetto LM, Mendlowicz MV, Bueno JR. (2005) The validity of the beck depression inventory-short form as a screening and diagnostic instrument for moderate and severe depression in medical inpatients. *J Affect Disord* **86**:87–91.

Gotlib IH, Krasnoperova E, Yue DN *et al.* (2004) Attentional biases for negative interpersonal stimuli in clinical depression. *J Abnorm Psychol* **113**:121–35.

Hadjikhani N, de Gelder B. (2003) Seeing fearful body expressions activates the fusiform cortex and amygdala. *Curr Biol* **13**:2201–5.

Halberstadt JB, Niedenthal PM. (2001) Effects of emotion concepts on perceptual memory for emotional expressions. *J Pers Soc Psychol* **81**:587–98.

Horowitz LM, Rosenberg SE, Baer BA *et al.* (1988) Inventory of interpersonal problems: psychometric properties and clinical applications. *J Consult Clin Psychol* **56**:885–92.

Karno MP, Longabaugh R. (2004) What do we know? Process analysis and the search for a better understanding of Project MATCH's anger-by-treatment matching effect. *J Stud Alcohol* **65**:501–12.

Kornreich C, Blairy S, Philippot P *et al.* (2001) Impaired emotional facial expression recognition in alcoholism compared with obsessive-compulsive disorder and normal controls. *Psychiatry Res* **102**:235–48.

Kornreich C, Philippot P, Foisy ML *et al.* (2002) Impaired emotional facial expression recognition is associated with interpersonal problems in alcoholism. *Alcohol Alcohol* **37**:394–400.

Lieberman MD, Eisenberger NI, Crockett MJ *et al.* (2007) Putting feelings into words: affect labelling disrupts amygdala activity in response to affective stimuli. *Psychol Sci* **18**:421–8.

Lindquist KA, Barrett LF, Bliss-Moreau E *et al.* (2006) Language and the perception of emotion. *Emotion* **6**:125–38.

Magnée MJ, Stekelenburg JJ, Kemner C *et al.* (2007) Similar facial electromyographic responses to faces, voices, and body expressions. *Neuroreport* **18**:369–72.

Marlatt CA. (1979) *Alcohol Use and Problem Drinking: A Cognitive Behavioral Analysis*. 1st edn. New York: Academic.

Maurage P, Campanella S, Philippot P *et al.* (2007a) The crossmodal facilitation effect is disrupted in alcoholism: a study with emotional stimuli. *Alcohol Alcohol* **42**:552–9.

Maurage P, Joassin F, Philippot P *et al.* (2007b) A validated battery of vocal emotional expressions. *Neuropsychol Trends* **2**:63–74.

Maurage P, Campanella S, Philippot P *et al.* (2008). Face processing in chronic alcoholism: a specific deficit for emotional features. *Alcohol Clin Exp Res* **32**:600–6.

McKeon A, Frye MA, Delanty N. (2007) The alcohol withdrawal syndrome. *J Neurol, Neurosurg Psychiatry* **78**:1324–6.

Meeren HK, van Heijnsbergen CC, de Gelder B. (2005) Rapid perceptual integration of facial expression and emotional body language. *Proc Natl Acad Sci USA* **102**:16518–23.

Mendlewicz L, Linkowski P, Bazelmans C *et al.* (2005) Decoding emotional facial expressions in depressed and anorexic patients. *J Affect Disord* **89**:195–9.

Monnot M, Lovallo WR, Nixon SJ *et al.* (2002) Neurological basis of deficits in affective prosody comprehension among alcoholics and fetal alcohol-exposed adults. *J Neuropsychiatry Clin Neurosci* **14**:321–8.

Monnot M, Nixon S, Lovallo W *et al.* (2001) Altered emotional perception in alcoholics: deficits in affective prosody comprehension. *Alcohol Clin Exp Res* **25**:362–9.

Oatley K, Johnson-Laird PN. (1987) Towards a cognitive theory of emotions. *Cogn Emot* **1**:29–50.

Oscar-Berman M, Hancock M, Mildworf B *et al.* (1990) Emotional perception and memory in alcoholism and aging. *Alcohol Clin Exp Res* **14**:383–93.

Philippot P, Coats EJ, Feldman RS. (2003) *Nonverbal Behavior in Clinical Context*. 1st edn. New York: Oxford University Press.

Philippot P, Kornreich C, Blairy S *et al.* (1999) Alcoholics' deficits in the decoding of emotional facial expression. *Alcohol Clin Exp Res* **23**:1031–8.

Power M, Dalgleish T. (1997) *Cognition and Emotion: From Order to Disorder*. 1st edn. Hove: Psychology Press.

Rossignol M, Philippot P, Douilliez C *et al.* (2005) The perception of fearful and happy facial expression is modulated by anxiety: an event-related potential study. *Neurosci Lett* **377**:115–20.

Scherer KR. (1986) Vocal affect expression: a review and a model for future research. *Psychol Bull* **99**:143–65.

Smith ML, Cottrell GW, Gosselin F *et al.* (2005) Transmitting and decoding facial expressions. *Psychol Sci* **16**:184–89.

Spielberger DC, Gorsuch RL, Lushene R *et al.* (1983) *Manual for the State-Trait Anxiety Inventory*. 1st edn. Palo Alto, CA: Consulting Psychology Press.

Stewart SA. (2005) The effects of benzodiazepines on cognition. *J Clin Psychiatry* **66**:9–13.

Surguladze S, Brammer MJ, Keedwell P *et al.* (2005) A differential pattern of neural response toward sad versus happy facial expressions in major depressive disorder. *Biol Psychiatry* **57**:201–9.

Townshend JM, Duka T. (2003) Mixed emotions: alcoholics' impairments in the recognition of specific emotional facial expressions. *Neuropsychologia* **41**:773–82.

Uekermann J, Daum I, Schlebusch P *et al.* (2005) Processing of affective stimuli in alcoholism. *Cortex* **41**:189–94.

Van Den Stock J, Righart R, de Gelder B. (2007) Body expressions influence recognition of emotions in the face and voice. *Emotion* **7**:487–94.

Vermeulen N, Luminet O, Cordovil de Sousa M *et al.* (2008) Categorical perception of anger is disrupted in alexithymia : evidence from a visual ERP study. *Cogn Emot* **22**:1052–67.

Wall AM, Wekerle C. (2002) *The Violence and Addiction Equation: Theoretical and Clinical Issues in Substance Abuse and Relationship Violence*. 1st edn. New York: Brunner-Routledge.