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Decoding of Nonverbal Language in Alcoholism: A Perception or a Labeling Problem?

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Alcohol-dependent patients have difficulty recognizing social cues such as emotional facial expressions, prosody, and postures. However, most researchers describing these difficulties rely on labeling tasks. It therefore remains difficult to disentangle genuine emotion-decoding problems from emotion-labeling impairments. In the present study, 35 recently detoxified alcohol-dependent patients were compared with 35 matched controls on four emotion-pairing tasks to explore the distinction between labeling and perceptual abilities. First, 2 tasks were used to assess emotion-labeling ability (labeling task) and working memory (necessary to process emotional stimuli; control matching task). Next, 2 experimental pairing tasks were used to explore unimodal, Face–face or voice–voice) and cross-modal, Face–voice or voice–face) matching abilities in the absence of any labeling requirement. Patients had difficulty accurately processing voices in unimodal tasks and correctly matching emotional stimuli in cross-modal tasks. Specifically, they did not correctly identify neutral stimuli in unimodal or cross-modal tasks and did not correctly identify fear in cross-modal tasks. Reaction times were also slower in these patients. However, accuracy and reaction time (RT) differences between patients and controls were accounted for by including anxiety and depression scores as covariates in the model. These results suggest that emotion-decoding difficulties observed in recently detoxified alcohol-dependent patients are not due to a specific emotion-labeling impairment, but rather involve perceptual difficulties or later integrative processing steps in the brain. Future studies should directly compare depressed or nondepressed alcohol-dependent patients with depressive patients to disentangle the influences of these highly comorbid disorders on nonverbal language perception.

Keywords: alcohol dependence, emotion, prosody, vocal, face

Social cognition is impaired in alcohol-dependent individuals. Research over the last decade has shown that these individuals have difficulty accurately recognizing emotional signals conveyed by others in faces (Frigerio, Burt, Montagne, Murray, & Perrett, 2002; Kornreich et al., 2001; Philippot et al., 1999; Townshend & Duka, 2003), voices (Maurage et al., 2009; Monnot, Nixon, Lovallo, & Ross, 2001; Uekermann, Daum, Schlebusch, & Trenckmann, 2005), and postures (Maurage et al., 2009). These nonverbal language-decoding difficulties seem to persist even following abstinence of several months (Foisy et al., 2005; Foisy, Kornreich, Fobe, et al., 2007; Kornreich et al., 2001). It is important to note, it has been suggested that these difficulties in social cognition might have significant clinical consequences for alcohol-dependent individuals: Interpersonal problems seem to be associated with both emotional facial expression (EFE)-decoding problems (Kornreich et al., 2002) and emotional empathy deficits

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(Maurage et al., 2011) in this population. Furthermore, treatment dropout rates are associated with the severity of EFE-decoding problems (Foisy, Kornreich, Fobe et al., 2007), and emotional disturbances are involved in a high proportion of relapses following detoxification treatment (Zywiak, Westerberg, Connors, & Maisto, 2003). These findings led to the proposal that social perception difficulties may cause discomfort and stress in social situations, which then predisposes individuals to alcohol consumption and relapse (Kopelman, 2008; Uekermann & Daum, 2008). Alternatively, abnormalities in information processing may be present before the onset of alcohol-dependence, as at-risk populations (i.e., offspring of alcohol-dependent individuals) show diminished amygdala activation when viewing EFE (Glahn, Lovallo, & Fox, 2007) and reduced amygdala volume (Hill et al., 2001). On the other hand, it has been suggested that prefrontal vulnerability to chronic alcohol consumption may be responsible for social cognition deficits in alcohol-dependent patients (Uekermann, Channon, Winkel, Schlebusch, & Daum, 2007; Uekermann & Daum, 2008).

Although further research is thus needed to understand the causal relationship between emotional impairments and alcohol-dependence, recent results have shown that difficulties in social cognition are not limited to the decoding of nonverbal cues but extend to other emotional domains, such as affective humor processing, theory-of-mind tasks (Uekermann et al., 2007), irony comprehension (Amenta, Noël, Verbanck, & Campanella, 2013), and decoding of emotion in music (Kornreich et al., 2013). Finally, consistent with a specific social cognition problem, it has been shown that EFE-decoding impairments do not seem to be due to a more general visuospatial problem, as object recognition (Maurage, Campanella, Philippot, Martin, & de Timary, 2008) and facial identity recognition (Foisy, Kornreich, Petiau et al., 2007; Maurage et al., 2008) are preserved in alcohol-dependent individuals.

Overall, although emotional perception appears specifically impaired in alcohol-dependent individuals, an alternative explanation is possible: EFE-decoding abnormalities could be due to *labeling* difficulties instead of *perceptual* problems, per se. Following a circumscribed lesion of the right temporal lobe, Rapcsak, Comer, and Rubens, (1993) described a patient who presented with a selective impairment in naming EFE, demonstrating that dissociation between these two functions is neurologically possible. In this case, anomia for EFE could be best-interpreted as a category-specific bidirectional visual–verbal disconnection between intact visual semantic and verbal semantic representations for EFE (Rapcsak et al., 1993). Further evidence for the labeling–perception distinction comes from the finding that, compared with Alzheimer's disease patients and controls, patients with semantic dementia are most impaired in the recognition of facial and musical emotions (Hsieh, Hornberger, Piguet, & Hodges, 2012).

The involvement of labeling problems in emotion decoding has been explored in several populations: Older adults are less accurate than younger ones in identifying EFE. This reduced accuracy could be due to difficulties labeling and not to perceptual problems, per se (Orgeta, 2010; Ruffman, Ng, & Jenkin, 2009). However, the prosody-decoding abnormalities in older adults remain even in pairing tasks, which do not require labeling (Mitchell & Kingston, 2011). The distinction between labeling and pure perceptual problems has also been investigated among children: Emotion labeling in children with specific language impairment is less accurate than in controls, and this impairment may be attributed to semantic fields overlapping (Delaunay-El Allam, Guidetti, Chaix, & Reilly, 2011). Children with Asperger's syndrome perform as accurately as controls at matching body postures, but they are significantly less accurate than controls in verbally identifying the same stimuli (Doody & Bull, 2013).

In line with these results, one hypothesis is that a labeling impairment plays a key role in the emotion-decoding deficit repeatedly observed in alcohol-dependent patients. Indeed, it has been shown that patients who have undergone multiple detoxifications and relapse display complex changes in brain connectivity, which may contribute to the altered processing of emotional signals (O'Daly et al., 2012). Connectivity changes could disrupt cognitive evaluation of emotional significance, the process in which a verbal label is attached to a perception. However, this potential role played by impaired labeling has not been specifically tested, as most studies examining nonverbal decoding in alcohol-dependent patients have used labeling tasks, making it difficult to disentangle perceptual and labeling problems. As far as we know, only two studies partially explored this question. First, Maurage et al. (2009) have studied semantic comprehension of written emotional scenarios in alcohol-dependent patients, showing that these patients were able to correctly identify the emotion related to these scenarios. However, this study did not directly explore labeling of nonverbal emotional stimuli. Second, Uekermann et al. (2005) have used an extensive battery of affective stimuli, the Tübingen Affect Battery, including subtests requiring discrimination, naming, pointing, or matching of facial stimuli and other subtests in which linguistic and affective stimuli had to be discriminated and named. They found that alcohol-dependent patients presented deficits only for the processing of affective prosody. However, methodological differences in the different subtests exploring facial and vocal stimuli hamper any direct comparison between these subtests and any specific differentiation between perception and labeling deficits. For example, subtests of facial stimuli comprised of pairs of stimuli in the facial identity- and facial affect-discrimination matching tasks, whereas in naming-emotions tasks, subjects were instructed to freely label emotions seen in faces in one subtest and to point to a face showing a specific emotion between five faces in another one. Moreover, contrary to earlier studies exploring emotion decoding in alcohol-dependence, the subtests did not include any time limit, making it difficult to compare these results with earlier ones and reducing the ecological value of this experimental design, as EFEs usually have a short duration in real-life situations.

On the basis of these limitations, the main aim of the present study was to use four pairing tasks to specifically explore the distinction between labeling and perceptual abilities during emotion decoding in alcohol dependence (see Figures 1 and 2). Namely, one pair of tasks F1-2 was first used to test emotion-labeling abilities (i.e., labeling tasks, see Figure 2A) and one pair of tasks was used to control for the global concentration or working memory necessary to process emotional stimuli (i.e., control matching task, see Figure 2B). Then, two experimental pairing tasks were used to explore unimodal (i.e., face–face or voice–voice, see Figure 2C) and cross-modal (i.e., face–voice or voice–face, see Figure 2D) matching abilities in the absence of any labeling. As the four tasks are based on the exact same design, their results can be directly compared with disentangle the respective influence of labeling and perception in the emotion-decoding deficit related to alcohol-dependence. If difficulties processing nonverbal stimuli in previous studies are specifically due to a labeling problem,

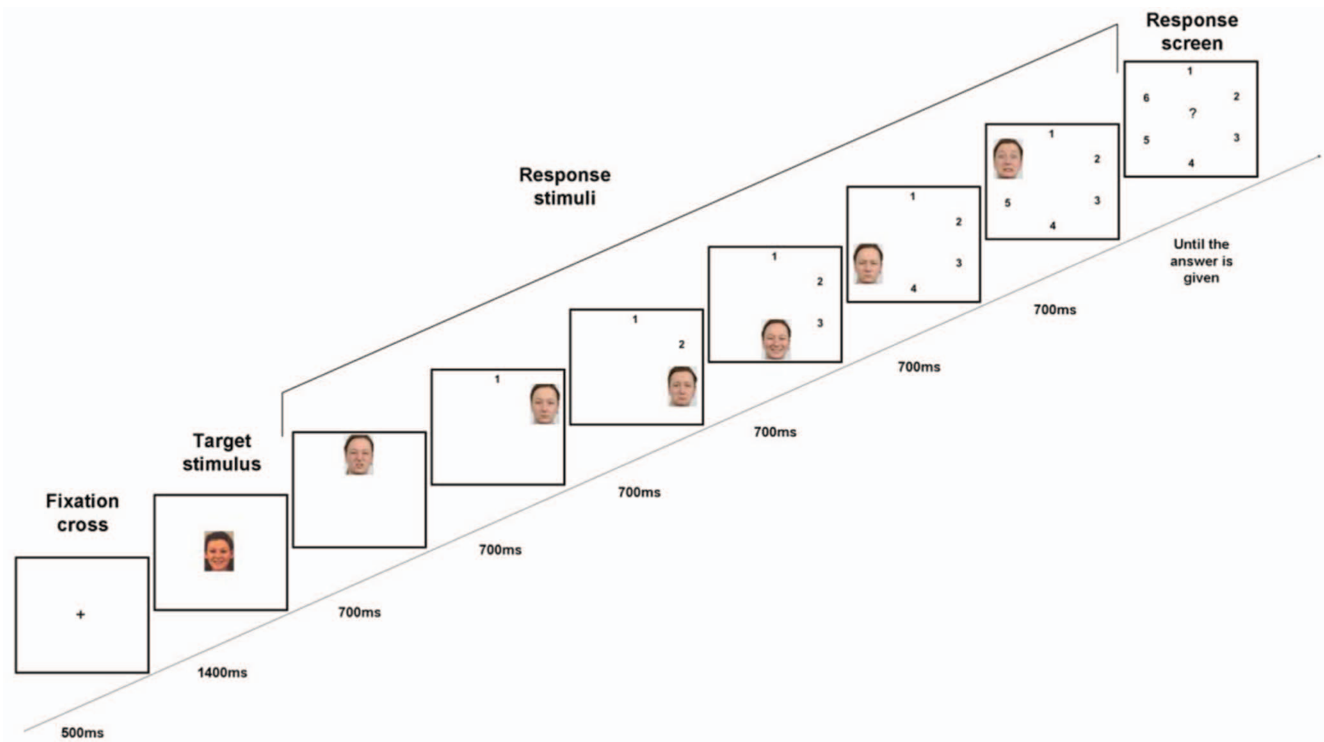

Figure 1. General timeline for each trial. The trials are characterized by the successive appearance of (1) a fixation cross; (2) the target stimulus; (3) the six response stimuli; (4) the response screen, where the participant has to choose which of the six response stimuli presented the same emotion as the target stimulus initially shown (here, the correct answer is "4"). This example is related to the unimodal face–face condition (FF). See the online article for the color version of this figure.

then impaired accuracy should only be found in the first two tasks (see Figure 2A).

Method

Subjects

Thirty-five inpatients (12 women), diagnosed with alcohol dependence (AD) according to the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM–IV*; APA, 1994) criteria, were recruited during the 3rd or 4th week of their detoxification treatment (Brugmann Hospital, Free University of Brussels, Belgium). A clinical interview and a mental state examination were systematically conducted to ascertain that inclusion/exclusion criteria were met. Participants with a history of bipolar disorder, schizophrenia, other drug dependence (besides tobacco), or dementia, assessed during the intake interview, were excluded.

Patients were matched for age, gender, and education level with a control group (CR) composed of 35 volunteers who were free of any history of psychiatric disorder or drug/substance abuse. The control group was recruited from the investigators' social environment, and participants were not paid. Exclusion criteria for both groups included major medical problems, neurological disease (including epilepsy), reported visual/hearing impairment, and polysubstance abuse. Education level was assessed according to the number of years of education since completing primary school. Demographic and clinical variables are presented in Table 1. Participants were T1 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 Brugmann Hospital.

Measures (Experimental Tasks)

An emotion-matching task was used in which a target stimulus (i.e., an emotional facial expression or emotional sound) was first presented, followed by six response stimuli (i.e., six words or faces or sounds) successively appearing around this target stimulus (see Figures 1 and 2). Participants then had to decide which response stimulus presented the same emotion as the target.

The visual stimuli, namely EFE, were selected from two validated batteries, the *Karolinska Directed Emotional Faces* (Battery 1: Lundqvist, Flykt, & Öhman, 1988) and the Radboud Face Database (Battery 2: Langner et al., 2010). Four identities (two males) were chosen in each battery, and six emotional categories were used for each identity (i.e., anger, disgust, fear, happiness, neutral, sadness), so that there were 24 pictures per battery (4 identities × 6 emotions). The experiment thus comprised 48 visual stimuli (2 batteries × 24 pictures), which were placed on a white background and resized to a 6 × 4.5-cm format (visual angle: 8.5 × 6.4°) using Photoshop 6.0.

The auditory stimuli, namely emotional prosody sounds, were selected from a validated battery (Maurage, Joassin, Philippot, &

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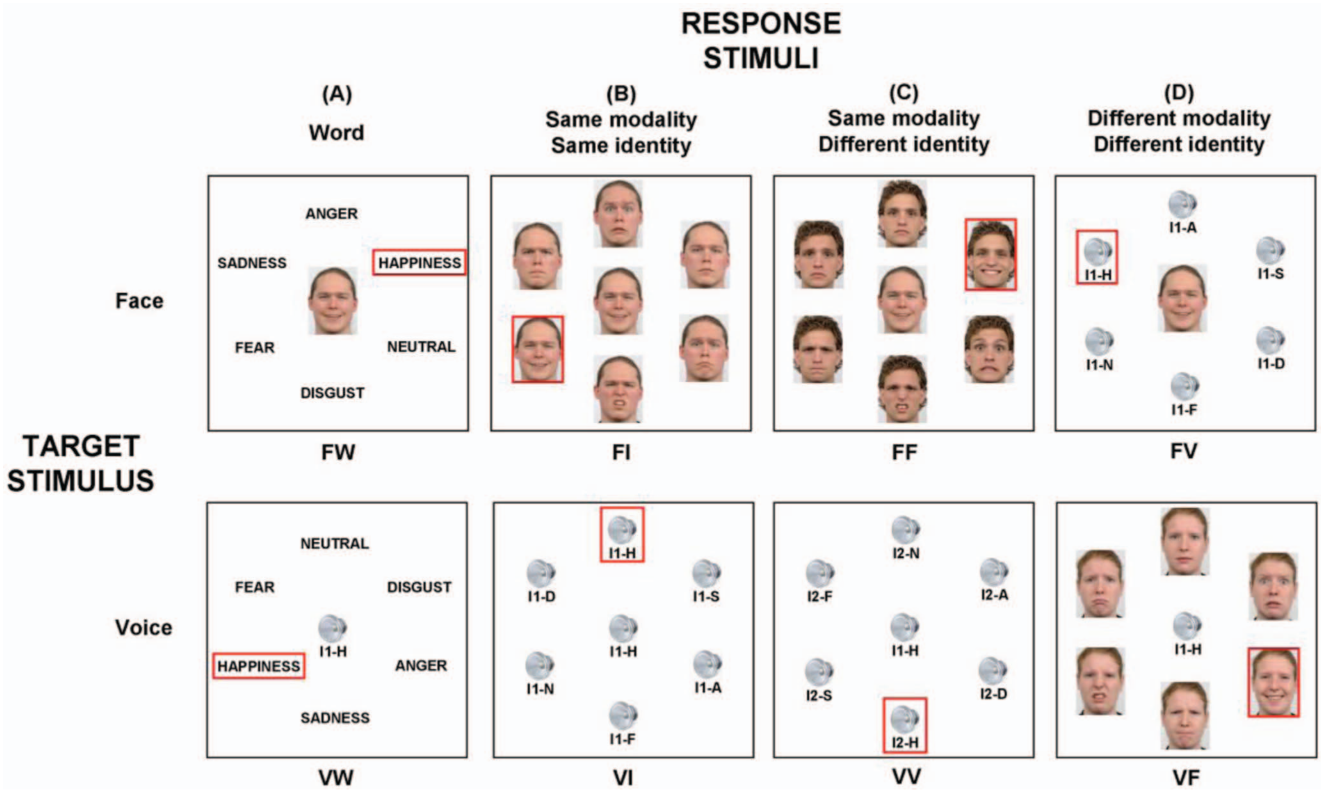

Figure 2. Description of the experimental conditions. The experimental design is composed of eight conditions, namely (A) labeling tasks (FW–VW); (B) control matching tasks (FI–VI); (C) unimodal tasks (FF–VV), (D) crossmodal tasks (FV–VF). For each condition, the target stimulus is presented in the centre of the screen and the response stimuli are presented successively around it. Please note that, while this figure depicts all stimuli at once, they were actually presented successively in the task (see Figure 1). The correct answer (here "happiness" for every condition) is surrounded by a red rectangle. I1 = Identity 1; I2 = Identity 2; A = anger; D = disgust; F = fear; H = happiness; N = neutral; S = sadness. See the online article for the color version of this figure.

Campanella, 2007) and consisted of audiotapes (mono, 44,100 Hz, 32bit) enunciating either an interjection (i.e., "ah" syllable) or a semantically neutral word (i.e., "paper") with an emotional prosody. Four identities (two males) were chosen for each stimulus type (i.e., interjection or word), and the six emotional categories were used for each identity (i.e., anger, disgust, fear, happiness, neutral, and sadness), so that there were 24 sounds per stimulus type (4 identities × 6 emotions). The experiment thus comprised 48 auditory stimuli (2 stimuli types × 24 sounds), which were standardized for duration (700 ms) and amplitude (70 dB).

The experiment consisted of four tasks (see next paragraph), all based on the same general experimental design (see Figure 1): Each trial started with a fixation cross presented at the center of the screen for 1000 ms and replaced by the target stimulus for 1400 ms (i.e., presentation of the face for visual stimuli or two successive presentations of the sound for auditory stimuli). Then, the target stimulus disappeared, and six response stimuli (each corresponding to one of the emotional categories: anger, disgust, fear, happiness, neutral, and sadness) successively appeared for 700 ms each around the center of the screen. After being presented, each response stimulus was immediately replaced by a number between 1 and 6), which remained on the screen during the presentation of the other response stimuli. After the six response stimuli had been presented, a response screen appeared (i.e., a question mark at the center of the screen, surrounded by the six numbers), and the participants had to decide which of the response stimuli depicted the same emotion as the target stimulus initially presented by clicking on the corresponding number. Although presentation time for each stimulus was 700 ms, there was no time limit for responding. Reaction times and responses were recorded. The order of the response stimuli was randomized across trials, as well as the emotional category of the target stimulus.

The four experimental tasks (see Figure 2), presented in random order across participants, were (a) a control-labeling task, in which the response stimuli were written words corresponding to the emotional labels/categories (i.e., anger, disgust, fear, happiness, neutral, or sadness written in black on a white background; see Figure 2A; (b) a control-matching task, in which the response stimuli had the same identity as the target stimulus. Participants thus had to identify the response stimulus corresponding to the picture identical to the target stimulus; see Figure 2B; (c) a unimodal matching task, in which the response stimuli had different identities than the target stimulus, but were presented in the same modality; see Figure 2C; and (d) a cross-modal matching task, in which the response stimuli had different identities than the target stimulus, and were related on the other modality; see Figure

Table 1
Results for Demographic, Psychopathological, and Alcohol-Consumption Measures for Alcohol-Dependent (AD) and Control (CR) participants: Mean (SD)

Variable	AD (n = 35)	CR (n = 35)
Sex (male/female)	23/12	23/12
Age	41.74 (8.4)	44.37 (10.57)
Education level	8.4 (4.25)	8.46 (3.07)
Alcohol dependence duration (in years)	11.03 (8.85)	—
Alcohol intake per day (in grams)***	190.57 (140.5)	6.60 (7.13)
Number of previous detoxification stays	2.06 (2.25)	—
Abstinence duration (in days)	23.71 (4.91)	—
Family history alcohol dependence/drug dependence[a]	25/7	6/2
Tobacco use	34	14
Cigarettes per day***	19.03 (15.97)	3.26 (7.36)
Current medication: antidepressants/neuroleptics/ mood stabilizers/benzodiazepines	13/3/1/1	0/0/0/0
Prior use of opiates/cannabis/amphetamines/ hallucinogens/inhalants/benzodiazepines	8/13/7/5/2/14	0/1/3/3/1/0
Number of previous depressive episodes**	1.83 (3)	.25 (.71)
MAST***	25.43 (4.99)	.74 (1.6)
BECK***	10.26 (5.61)	1.8 (2.35)
STAI-A (State)***	49.06 (11.57)	37.77 (10.93)
STAI-B (Trait)***	48.69 (13.83)	34.09 (11.29)

Note. MAST = Michigan Alcohol Screening Self-Administered Test; BECK = Beck Depression Inventory; STAI = State–Trait Anxiety Inventory.
[a] Presence of at least one first-degree relative (father and/or mother) with alcohol or drug dependence.
** $p < .01$. *** $p < .0001$.

2D. Each task was separated into two subtasks according to the modality of the target stimulus (visual or auditory). The experiment thus comprised eight experimental conditions (4 tasks × 2 modalities), each based on the combination between one type of target and one type of response stimuli (target–response): (a) face–word (FW) and voice–word (VW) for the control-labeling task; (b) face–same identity (FI) and voice–same identity (VI) for the control-matching task; (c) face–face (FF) and voice–voice (VV) for the unimodal matching task; (d) face–voice (FV) and voice–face (VF) for the cross-modal matching task. Target and response stimuli were always congruent for gender and, in the unimodal task, were always based on a different battery (i.e., Battery 1 for target stimulus and Battery 2 for response stimulus, or the inverse) or stimulation type (e.g., interjection for target stimulus and word for response stimuli, or the inverse). Each experimental condition was associated with one experimental block comprising 48 trials (one for each visual and auditory stimulus) presented in random order. Each block lasted for 6–8 min (7–10 s per trial, depending on participants' RTs), with the total experiment duration of about 60 min. Before each condition, participants underwent a short training block (five randomly selected trials) to become familiar with the task.

Control Measures

The following variables were evaluated using validated self-completed questionnaires: the Michigan Alcohol Screening Self-Administered Test (MAST) of alcohol-dependence severity (Selzer, Vinokur, & van Rooijen, 1975), the Beck Depression Inventory–Short Version to measure depression (Beck, Steer, & Carbin, 1988), and the State and Trait Anxiety Inventory–Forms A and B (STAI-A, STAI-B) to measure state–trait anxiety (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983).

Results

Statistical Analyses

A repeated-measures multivariate analysis of variance (ANOVA) was computed for each task, separately for accuracy and RTs, with modality (visual, auditory) and emotion (anger, disgust, fear, happiness, neutral, sadness) as within-subjects factors, and group (alcohol-dependent, control) as a between-subjects factor. As our main focus was to explore the effect of alcohol-dependence on emotion decoding, the only interactions tested were those involving groups. Greenhouse–Geisser corrections were applied where appropriate, and post hoc pairwise comparisons were conducted when needed. *T* tests were conducted to test the group differences on demographic and psychopathological measures. Two complementary analyses were performed for each experimental task: (a) the influence of control measures (STAI-A, STAI-B, Beck) on accuracy and RTs was systematically explored using analysis of covariance (ANCOVA) when differences between groups on these measures were significant; and (b) correlations between duration of alcohol dependence, MAST scores, mean daily usual consumption, number of previous depression episodes and accuracy scores/RTs were explored in the alcohol-dependent group when differences with the controls appeared on these variables.

Control Measures

Recently detoxified alcohol-dependent individuals (AD) and controls (CR) were similar in terms of age, gender, and education level, thus confirming successful matching between groups. The two groups differed significantly for all tested psychopathological dimensions: Alcohol-dependence severity, $t(68) = 27.88$, $p < .0001$; depression,

$t(68) = 8.231$, $p < .0001$; state anxiety, $t(68) = 4.2$, $p < .0001$; and trait anxiety, $t(68) = 4.84$, $p < .0001$ (see Table 1).

Main Tasks (see Table 2)

Control-labeling task.

Accuracy. No main effect was found for group, $F(1, 68) = 1.548$, $p = .218$; $\eta^2 = .022$, nor were there any significant interactions with group.

Reaction times. A main effect of group was found, $F(1, 68) = 5.634$; $p = .02$; $\eta^2 = .077$, with AD ($M = 1.3$; $SD = 1.1$) having slower RTs than CR ($M = 0.8$; $SD = 0.3$). No significant interactions with group were found.

Complementary analyses. When depression and anxiety scores were included in the model as covariates, the difference between groups was no longer significant for RTs, $F(1, 45) = 0.252$; $p = .617$; $\eta^2 = .004$. Moreover, a correlation was found between RT and the number of previous depressive episodes, $r = .756$, $p < .0001$, in the AD group.

Control-matching task.

Accuracy. No main effect was found for group, $F(1, 68) = 3.541$, $p = .064$; $\eta^2 = .049$, nor any were there any significant interactions with group.

Reaction times. A main effect of group was found, $F(1, 68) = 3.391$; $p = .05$; $\eta^2 = .055$, with AD ($M = 1.13$; $SD = 1.1$) having slower RTs than CR ($M = 0.75$; $SD = 0.3$). No significant interactions with group were found.

Complementary analyses. When depression and anxiety scores were put included in the model as covariates, the difference between groups was no longer significant for RTs, $F(1, 65) = 0.001$; $p = .982$; $\eta^2 = 0$. Moreover, a correlation was found between RT and the number of previous depressive episodes, $r = -0.680$, $p < .0001$, in the AD group.

Unimodal matching task.

Accuracy (% correct). No main effect was found for group, $F(1, 68) = 3.364$; $p = .071$; $\eta^2 = .047$, but a significant interaction was found between group and modality, $F(1, 68) = 5.197$, $p = .027$; $\eta^2 = .071$, where AD had significantly lower accuracy ($M = 46.55$; $SD = 13.59$) than CR ($M = 54.4$; SD: 12.11) for voices, $t(68) = 2.554$, $p = .013$, but not for faces (AD: $M = 74.05$; $SD = 12.98$; CR: $M = 75.54$; $SD = 9.54$), $t(68) = 0.546$, *ns*. There was also a significant interaction between group and emotion, $F(5, 340) = 3.416$, $p = .005$; $\eta^2 = .048$, where AD had significantly lower accuracy for neutral stimuli than CR, $t(57.504) = 3.586$, $p = .001$ (see Table 3).

Complementary analyses. When depression and anxiety scores were included in the model as covariates, the interactions between group and modality, $F(1, 65) = 2.888$; $p = .094$; $\eta^2 = .043$, and between group and emotion, $F(5, 325) = 1.134$; $p = .342$; $\eta^2 = .017$, were no longer significant.

Reaction times. A main effect of group was found, $F(1, 68) = 5.264$, $p = .025$; $\eta^2 = .072$, with AD having slower RTs than CR. No significant interaction with group was found.

Complementary analyses. When depression and anxiety scores were included as covariates in the model, the difference between groups was no longer significant for RTs, $F(1, 65) = 0.468$; $p = .496$; $\eta^2 = .007$. Moreover, a significant correlation was found between RTs and number of previous depressive episodes ($r = -0.514$, $p = .002$) in the AD group.

Cross-modal matching task.

Accuracy. AD had significantly lower accuracy than CR, $F(1, 68) = 4.427$, $p = .039$; $\eta^2 = .061$. There were no significant interactions involving group. However, as the interaction emotion x group showed a trend toward significance, $F(5, 340) = 2.139$; $p = .06$; $\eta^2 = .031$ and as we anticipated differences between groups especially for neutral stimuli, we conducted additional *t* tests. AD were significantly less accurate than CR for neutral, $t(58.142) = 3.575$; $p = .001$, and for fear stimuli, $t(68) = 2.343$; $p = .022$; see Table 3.

Complementary analyses. When depression and anxiety scores were included in the model, the difference between groups was not significant for global accuracy, $F(1, 65) = 0.588$; $p = .446$; $\eta^2 = .009$), nor separately for neutral, $F(1, 65) = 0.749$; $p = .39$; $\eta^2 = .011$) or fear stimuli, $F(1, 65) = 1.778$; $p = .187$; $\eta^2 = .027$). Additionally, there was a correlation between accuracy for neutral stimuli and the number of previous depressive episodes ($r = -0.428$; $p = .01$) in the AD group.

Reaction times. A main effect of group was found, $F(1, 68) = 6.628$, $p = .012$; $\eta^2 = .089$, with AD having slower RTs than CR. No significant interactions with group were found.

Table 2
Mean Accuracies and Reaction Times for the Different Tasks

Outcome	AD: *M* (*SD*)	CR: *M* (*SD*)
Accuracy (% correct)		
Control-labelling task	80.15 (8.47)	82.71 (8.74)
Control-matching task	92.08 (8.33)	95.27 (4.72)
Unimodal matching task	60.3 (11.79)	64.97 (9.39)
Crossmodal matching task	61.82 (12.84)	68.1 (12.12)*
Reaction time (seconds)		
Control labelling task	1.3 (1.1)	.8 (.3)*
Control matching task	1.13 (1.1)	.75 (.3)*
Unimodal matching task	1.77 (1.19)	1.26 (.59)*
Crossmodal matching task	1.55 (1.14)	1.02 (.49)*

Note. AD = alcohol dependent; CR = control.
* $p < .05$.

Table 3
Accuracies per Emotion in Unimodal and Cross-Modal Matching Tasks (% Correct)

Variable	AD: *M* (*SD*)	CR: *M* (*SD*)
Unimodal matching task		
Anger	54.64 (15.41)	58.21 (15.52)
Disgust	64.11 (9.51)	65 (8.86)
Happiness	72.68 (13.82)	77.68 (12.06)
Neutral	65.98 (21.4)	81.25 (13.56)**
Fear	57.14 (17.1)	59.64 (17.63)
Sadness	55.89 (15.31)	56.25 (14.85)
Cross-modal matching task		
Anger	58.75 (17.63)	63.21 (19.98)
Disgust	46.61 (16)	50.54 (17.31)
Happiness	76.96 (17.6)	81.61 (15.45)
Neutral	71.07 (19.12)	84.82 (12.34)**
Fear	60.36 (19.17)	70.71 (17.79)*
Sadness	57.14 (20.29)	57.68 (18.88)

Note. AD = alcohol dependent; CR = control.
* $p < .05$. ** $p = .001$.

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Complementary analyses. When depression and anxiety scores were included as covariates in the model, the difference between groups was no longer significant for RTs, $F(1, 65) = 0.727; p = .397; \eta^2 = .011$). There was a correlation between the number of previous depressive episodes and RT in the AD group ($r = .428$; $p = .001$).

Discussion

Recently detoxified alcohol-dependent patients displayed no difficulties in control-labeling and control-matching tasks compared with healthy control participants. Alcohol-dependent patients did show diminished accuracy in unimodal matching tasks for voices but not for faces, and specific accuracy problems for neutral stimuli in these tasks. They also had difficulty accurately processing neutral and fear stimuli in cross-modal matching tasks. However, depression and anxiety levels seemed to account for these difficulties, as shown by ANCOVAs.

Similarly, RTs were systematically slower in recently detoxified alcohol-dependent patients, but these differences from controls were also accounted for when anxiety and depression scores were included as covariates in statistical analyses.

Our study provides evidence that perception per se is involved in the difficulties recently detoxified alcohol-dependent patients have in correctly processing emotion in nonverbal stimuli, rather than labeling or semantic problems. Neither working-memory problems nor attention problems (as assessed through the matching control task) nor semantic labeling (as assessed trough the labeling task) could account for this deficit, which is crucial to suggesting that the emotion-decoding deficit in recently detoxified alcohol-dependent patients is not due to a global cognitive deficit or to an emotion-labeling impairment. Moreover, as this emotion-decoding deficit was present in our experimental tasks that did not require labeling processes, we can conclude that emotion decoding in recently detoxified alcohol-dependent patients involves genuine perception problems.

Diminished accuracy for neutral stimuli in unimodal and cross-modal tasks is consistent with previous research finding overinterpretation of emotional signals in alcohol dependence, leading to erroneous detection of emotional content in neutral stimuli (Maurage, Campanella, Philippot, Martin, & de Timary, 2008; Kornreich et al., 2013). This bias could have clinical consequences, as neutral faces might be interpreted by patients as showing negative emotions toward them.

The differences in accuracy observed between controls and recently detoxified alcohol-dependent patients were no longer significant when anxiety or depression scores were included as covariates in the model. This result contradicts previous research (Kornreich et al., 2013) that found no influence of depression scores on decoding accuracy in recently detoxified alcohol-dependent patients. These discrepancies might be due to the stimuli we used in the present study, especially with respect to the face stimuli. The emotions displayed were stereotypical expressions, in contrast to other studies that used lower intensity levels of emotions or morphed stimuli. Furthermore, the pairing tasks did not involve subtle evaluation of emotions, as subjects were not required to make ratings on several emotional scales. Emotion-decoding task demands are likely partly responsible for the discrepancies in results reported in the literature (Donadon & Osório, 2014; D'Hondt, Campanella, Kornreich, Philippot, & Maurage, 2014).

However, alcoholism and depression are highly comorbid conditions (Gilman & Abraham, 2001). It has been shown that patients with depressive and anxiety disorders also display emotion-decoding difficulties (Demenescu, Kortekaas, den Boer, & Aleman, 2010; Naranjo et al., 2011). It is therefore very difficult to disentangle the respective roles of these disorders in the abnormalities we observed. Executive functioning deficits, which are present in both disorders (Langenecker et al., 2005), could underlie these abnormalities. Further studies should directly compare depressed patients, alcohol-dependent patients, and controls on their decoding abilities.

The finding that labeling problems were not the cause of emotion-decoding difficulties in recently detoxified alcohol-dependent patients is consistent with another line of research: event-related potential studies have shown that the difficulties for alcohol-dependent patients in processing emotional cues in faces originates at early visual and face-processing stages: P100 and P170 abnormalities have been described (Maurage, Campanella, Philippot, Pham, & Joassin, 2007) independently of depressive problems (Maurage et al., 2008a), as have attentional problems for the specific emotion of anger, resulting in N2b/P3a delayed latencies and diminution of amplitude (Maurage et al., 2008b).[1] Fn1

When emotion-decoding abilities were tested in more ecologically valid conditions (i.e., by using cross-modal stimuli based on synchronized face–voice pairs), the alcohol-dependent patients showed larger impairments (see Maurage & Campanella, 2013, for a review). Alcohol-dependent participants did not demonstrate the "cross-modal facilitation effect" classically observed in controls (Maurage et al., 2007), and they showed differences in brain activations specifically related to cross-modal integration, as indexed by a reduction in frontal activity (Maurage, Philippot et al., 2008; Maurage & Campanella, 2013).

Early perceptual processing difficulties are not mutually exclusive with later processing disruptions. Indeed, it has been proposed that social cognition impairments are consistent with the frontal lobe hypothesis of alcohol dependence (Uekermann & Daum, 2008). Furthermore, changes in connectivity following chronic alcohol consumption have been shown both in subcortical and cortical regions (O'Daly et al., 2012). Major changes in connectivity could be present at the early perception level (Maurage, Philippot, et al., 2007; Maurage et al., 2008a), in fronto-parietal mirror-neuron systems (Kornreich et al., 2013), and/or in top-down frontal, emotional, integrative processes (Uekermann & Daum, 2008).

Limitations of this study: The patients tested were in their 3rd week of the detoxification process, and our results are therefore not generalizable to other stages. Emotional stimuli were images of stereotypical expressions, and differences in performance between groups might be larger with subtler, more ecologically valid stimuli. There was no depression control group, and it is therefore difficult to disentangle the effect of depression from the effect of chronic alcohol consumption on our accuracy and RT results.

In conclusion, it is well-known that nonverbal emotion decoding is impaired in recently detoxified alcohol-dependent patients, and

[1] P100, P170, and N2b/P3a are event related potentials waves.

the present study extends and clarifies these earlier results by showing that these emotion-decoding impairments, when present, are not due to difficulties in emotion labeling, but involve perception problems and possibly later integrative steps.

Alcohol dependence is highly comorbid with depression, which has also been associated with nonverbal emotion-decoding problems. Therefore future studies directly comparing depressed patients with depressed or nondepressed alcohol-dependent patients should help clarify the respective responsibility of those two conditions in nonverbal decoding impairments.

References

Amenta, S., Noël, X., Verbanck, P., & Campanella, S. (2013). Decoding of emotional components in complex communicative situations (irony) and its relation to empathic abilities in male chronic alcoholics: An issue for treatment. *Alcoholism: Clinical and Experimental Research, 37,* 339–347. http://dx.doi.org/10.1111/j.1530-0277.2012.01909.x

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.

Beck, A. T., Steer, R. A., & Carbin, M. G. (1988). Psychometric properties of the Beck Depression Inventory: Twenty-five years of evaluation. *Clinical Psychology Review, 8,* 77–100. http://dx.doi.org/10.1016/0272-7358(88)90050-5

Delaunay-El Allam, M., Guidetti, M., Chaix, Y., & Reilly, J. (2011). Facial emotion labeling in language impaired children. *Applied Psycholinguistics, 32,* 781–798. http://dx.doi.org/10.1017/S0142716411000063

Demenescu, L. R., Kortekaas, R., den Boer, J. A., & Aleman, A. (2010). Impaired attribution of emotion to facial expressions in anxiety and major depression. *PLoS ONE, 5,* e15058. http://dx.doi.org/10.1371/journal.pone.0015058

D'Hondt, F., Campanella, S., Kornreich, C., Philippot, P., & Maurage, P. (2014). Below and beyond the recognition of emotional facial expressions in alcohol dependence: From basic perception to social cognition. *Neuropsychiatric Disease and Treatment, 10,* 2177–2182.

Donadon, M. F., & Osório, Fde. L. (2014). Recognition of facial expressions by alcoholic patients: A systematic literature review. *Neuropsychiatric Disease and Treatment, 10,* 1655–1663.

Doody, J. P., & Bull, P. (2013). Evidence for impaired verbal identification but intact nonverbal recognition of fearful body postures in Asperger's syndrome. *Journal of Autism and Developmental Disorders, 43,* 1652–1661. http://dx.doi.org/10.1007/s10803-012-1715-5

Foisy, M.-L., Kornreich, C., Fobe, A., D'Hondt, L., Pelc, I., Hanak, C., . . . Philippot, P. (2007). Impaired emotional facial expression recognition in alcohol dependence: Do these deficits persist with midterm abstinence? *Alcoholism: Clinical and Experimental Research, 31,* 404–410. http://dx.doi.org/10.1111/j.1530-0277.2006.00321.x

Foisy, M.-L., Kornreich, C., Petiau, C., Parez, A., Hanak, C., Verbanck, P., . . . Philippot, P. (2007). Impaired emotional facial expression recognition in alcoholics: Are these deficits specific to emotional cues? *Psychiatry Research, 150,* 33–41. http://dx.doi.org/10.1016/j.psychres.2005.12.008

Foisy, M.-L., Philippot, P., Verbanck, P., Pelc, I., van der Straten, G., & Kornreich, C. (2005). Emotional facial expression decoding impairment in persons dependent on multiple substances: Impact of a history of alcohol dependence. *Journal of Studies on Alcohol, 66,* 673–681. http://dx.doi.org/10.15288/jsa.2005.66.673

Frigerio, E., Burt, D. M., Montagne, B., Murray, L. K., & Perrett, D. I. (2002). Facial affect perception in alcoholics. *Psychiatry Research, 113,* 161–171. http://dx.doi.org/10.1016/S0165-1781(02)00244-5

Gilman, S. E., & Abraham, H. D. (2001). A longitudinal study of the order of onset of alcohol dependence and major depression. *Drug and Alcohol Dependence, 63,* 277–286. http://dx.doi.org/10.1016/S0376-8716(00)00216-7

Glahn, D. C., Lovallo, W. R., & Fox, P. T. (2007). Reduced amygdala activation in young adults at high risk of alcoholism: Studies from the Oklahoma family health patterns project. *Biological Psychiatry, 61,* 1306–1309. http://dx.doi.org/10.1016/j.biopsych.2006.09.041

Hill, S. Y., De Bellis, M. D., Keshavan, M. S., Lowers, L., Shen, S., Hall, J., & Pitts, T. (2001). Right amygdala volume in adolescent and young adult offspring from families at high risk for developing alcoholism. *Biological Psychiatry, 49,* 894–905. http://dx.doi.org/10.1016/S0006-3223(01)01088-5

Hsieh, S., Hornberger, M., Piguet, O., & Hodges, J. R. (2012). Brain correlates of musical and facial emotion recognition: Evidence from the dementias. *Neuropsychologia, 50,* 1814–1822. http://dx.doi.org/10.1016/j.neuropsychologia.2012.04.006

Kopelman, M. D. (2008). Alcohol and frontal lobe impairment: Fascinating findings [Commentary]. *Addiction, 103,* 736–737. http://dx.doi.org/10.1111/j.1360-0443.2008.02225.x

Kornreich, C., Blairy, S., Philippot, P., Dan, B., Foisy, M., Hess, U., . . . Verbanck, P. (2001). Impaired emotional facial expression recognition in alcoholism compared with obsessive-compulsive disorder and normal controls. *Psychiatry Research, 102,* 235–248. http://dx.doi.org/10.1016/S0165-1781(01)00261-X

Kornreich, C., Blairy, S., Philippot, P., Hess, U., Noël, X., Streel, E., . . . Verbanck, P. (2001). Deficits in recognition of emotional facial expression are still present in alcoholics after mid- to long-term abstinence. *Journal of Studies on Alcohol, 62,* 533–542. http://dx.doi.org/10.15288/jsa.2001.62.533

Kornreich, C., Brevers, D., Canivet, D., Ermer, E., Naranjo, C., Constant, E., . . . Noël, X. (2013). Impaired processing of emotion in music, faces and voices supports a generalized emotional decoding deficit in alcoholism. *Addiction, 108,* 80–88. http://dx.doi.org/10.1111/j.1360-0443.2012.03995.x

Kornreich, C., Philippot, P., Foisy, M. L., Blairy, S., Raynaud, E., Dan, B., . . . Verbanck, P. (2002). Impaired emotional facial expression recognition is associated with interpersonal problems in alcoholism. *Alcohol and Alcoholism, 37,* 394–400. http://dx.doi.org/10.1093/alcalc/37.4.394

Langenecker, S. A., Bieliauskas, L. A., Rapport, L. J., Zubieta, J. K., Wilde, E. A., & Berent, S. (2005). Face emotion perception and executive functioning deficits in depression. *Journal of Clinical and Experimental Neuropsychology, 27,* 320–333. http://dx.doi.org/10.1080/13803390490490515720

Langner, O., Dotsch, R., Bijlstra, G., Wigboldus, D. H. J., Hawk, S. T., & van Knippenberg, A. (2010). Presentation and validation of the Radboud Faces Database. *Cognition and Emotion, 24,* 1377–1388. http://dx.doi.org/10.1080/02699930903485076

Lundqvist, D., Flykt, A., & Öhman, A. (1988). *The Karolinska Directed Emotional Faces–KDEF* [CD ROM]. Solna, Sweden: Department of Clinical Neuroscience, Psychology Section, Karolinska Institutet.

Maurage, P., & Campanella, S. (2013). Experimental and clinical usefulness of crossmodal paradigms in psychiatry: An illustration from emotional processing in alcohol-dependence. *Frontiers in Human Neuroscience, 7,* 394. http://dx.doi.org/10.3389/fnhum.2013.00394

Maurage, P., Campanella, S., Philippot, P., Charest, I., Martin, S., & de Timary, P. (2009). Impaired emotional facial expression decoding in alcoholism is also present for emotional prosody and body postures. *Alcohol and Alcoholism, 44,* 476–485. http://dx.doi.org/10.1093/alcalc/agp037

Maurage, P., Campanella, S., Philippot, P., de Timary, P., Constant, E., Gauthier, S., . . . Verbanck, P. (2008a). Alcoholism leads to early perceptive alterations, independently of comorbid depressed state: An ERP study. *Clinical Neurophysiology, 38,* 83–97. http://dx.doi.org/10.1016/j.neucli.2008.02.001

Maurage, P., Campanella, S., Philippot, P., Martin, S., & de Timary, P. (2008). Face processing in chronic alcoholism: A specific deficit for emotional features. *Alcoholism: Clinical and Experimental Research, 32,* 600–606. http://dx.doi.org/10.1111/j.1530-0277.2007.00611.x

Maurage, P., Campanella, S., Philippot, P., Pham, T. H., & Joassin, F. (2007). The crossmodal facilitation effect is disrupted in alcoholism: A study with emotional stimuli. *Alcohol and Alcoholism, 42,* 552–559. http://dx.doi.org/10.1093/alcalc/agm134

Maurage, P., Campanella, S., Philippot, P., Vermeulen, N., Constant, E., Luminet, O., & de Timary, P. (2008b). Electrophysiological correlates of the disrupted processing of anger in alcoholism. *International Journal of Psychophysiology, 70,* 50–62. http://dx.doi.org/10.1016/j.ijpsycho.2008.05.572

Maurage, P., Grynberg, D., Noël, X., Joassin, F., Philippot, P., Hanak, C., . . . Campanella, S. (2011). Dissociation between affective and cognitive empathy in alcoholism: A specific deficit for the emotional dimension. *Alcoholism: Clinical and Experimental Research, 35,* 1662–1668.

Maurage, P., Joassin, F., Philippot, P., & Campanella, S. (2007). A validated battery of vocal emotional expressions. *Neuropsychological Trends, 2,* 63–74.

Maurage, P., Philippot, P., Joassin, F., Pauwels, L., Pham, T., Prieto, E. A., . . . Campanella, S. (2008). The auditory–visual integration of anger is impaired in alcoholism: An event-related potentials study. *Journal of Psychiatry & Neuroscience, 33,* 111–122.

Maurage, P., Philippot, P., Verbanck, P., Noel, X., Kornreich, C., Hanak, C., & Campanella, S. (2007). Is the P300 deficit in alcoholism associated with early visual impairments (P100, N170)? An oddball paradigm. *Clinical Neurophysiology, 118,* 633–644. http://dx.doi.org/10.1016/j.clinph.2006.11.007

Mitchell, R. L. C., & Kingston, R. A. (2011). Is age-related decline in vocal emotion identification an artefact of labelling cognitions? *International Journal of Psychological Studies, 3,* 156–163. http://dx.doi.org/10.5539/ijps.v3n2p156

Monnot, M., Nixon, S., Lovallo, W., & Ross, E. (2001). Altered emotional perception in alcoholics: Deficits in affective prosody comprehension. *Alcoholism: Clinical and Experimental Research, 25,* 362–369. http://dx.doi.org/10.1111/j.1530-0277.2001.tb02222.x

Naranjo, C., Kornreich, C., Campanella, S., Noël, X., Vandriette, Y., Gillain, B., . . . Constant, E. (2011). Major depression is associated with impaired processing of emotion in music as well as in facial and vocal stimuli. *Journal of Affective Disorders, 128,* 243–251. http://dx.doi.org/10.1016/j.jad.2010.06.039

O'Daly, O. G., Trick, L., Scaife, J., Marshall, J., Ball, D., Phillips, M. L., . . . Duka, T. (2012). Withdrawal-associated increases and decreases in functional neural connectivity associated with altered emotional regulation in alcoholism. *Neuropsychopharmacology, 37,* 2267–2276. http://dx.doi.org/10.1038/npp.2012.77

Orgeta, V. (2010). Effects of age and task difficulty on recognition of facial affect. *The Journals of Gerontology: Series B. Psychological Sciences and Social Sciences, 65,* 323–327. http://dx.doi.org/10.1093/geronb/gbq007

Philippot, P., Kornreich, C., Blairy, S., Baert, I., Den Dulk, A., Le Bon, O., . . . Verbanck, P. (1999). Alcoholics' deficits in the decoding of emotional facial expression. *Alcoholism: Clinical and Experimental Research, 23,* 1031–1038.

Rapcsak, S. Z., Comer, J. F., & Rubens, A. B. (1993). Anomia for facial expressions: Neuropsychological mechanisms and anatomical correlates. *Brain and Language, 45,* 233–252. http://dx.doi.org/10.1006/brln.1993.1044

Ruffman, T., Ng, M., & Jenkin, T. (2009). Older adults respond quickly to angry faces despite labeling difficulty. *The Journals of Gerontology: Series B. Psychological Sciences and Social Sciences, 64,* 171–179. http://dx.doi.org/10.1093/geronb/gbn035

Selzer, M. L., Vinokur, A., & van Rooijen, L. (1975). A self-administered Short Michigan Alcoholism Screening Test (SMAST). *Journal of Studies on Alcohol, 36,* 117–126. http://dx.doi.org/10.15288/jsa.1975.36.117

Spielberger, C. D., Gorsuch, R. L., Lushene, R. L., Vagg, P. R., & Jacobs, G. A. (1983). *Manual for the State–Trait Anxiety Inventory*. Palo Alto, CA: Consulting Psychologists Press.

Townshend, J. M., & Duka, T. (2003). Mixed emotions: Alcoholics' impairments in the recognition of specific emotional facial expressions. *Neuropsychologia, 41,* 773–782. http://dx.doi.org/10.1016/S0028-3932(02)00284-1

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. http://dx.doi.org/10.1111/j.1360-0443.2006.01656.x

Uekermann, J., & Daum, I. (2008). Social cognition in alcoholism: A link to prefrontal cortex dysfunction? *Addiction, 103,* 726–735. http://dx.doi.org/10.1111/j.1360-0443.2008.02157.x

Uekermann, J., Daum, I., Schlebusch, P., & Trenckmann, U. (2005). Processing of affective stimuli in alcoholism. *Cortex: A Journal Devoted to the Study of the Nervous System and Behavior, 41,* 189–194.

Zywiak, W. H., Westerberg, V. S., Connors, G. J., & Maisto, S. A. (2003). Exploratory findings from the Reasons for Drinking Questionnaire. *Journal of Substance Abuse Treatment, 25,* 287–292. http://dx.doi.org/10.1016/S0740-5472(03)00118-1

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