ALCOHOLISM CLINICAL & EXPERIMENTAL RESEARCH

Dissociating Affective and Cognitive Theory of Mind in Recently Detoxified Alcohol-Dependent Individuals

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Background: Emotional and interpersonal impairments have been widely described in alcohol dependence, and their role in relapse has been clearly established. However, several components of social cognition have not been well explored in this context. Particularly, Theory of Mind (ToM) abilities, which are critical social skills enabling one to understand others' perspectives, and which have been largely investigated in other psychiatric populations, remain to be measured using ecological tasks in individuals with alcohol dependence. This study evaluated ToM abilities in close to real-life situations among alcohol-dependent individuals and differentiated its affective and cognitive subcomponents.

Methods: Thirty-two alcohol-dependent individuals (in their third week of abstinence) and 32 matched healthy controls performed the Movie for Assessment of Social Cognition (MASC), a multiple-choice task requiring the identification of the emotions, thoughts, and intentions expressed in 45 short video sequences depicting real-life social interactions.

Results: Alcohol-dependent individuals showed a global ToM impairment, indexed by a reduced MASC global score. However, exploration of ToM's subcomponents showed that the overall deficit was driven by a massive reduction in affective ToM, with the cognitive subcomponent preserved.

Conclusions: Ecological ToM evaluation shows that alcohol dependence is not related to a generalized ToM deficit but rather to dissociation between a preserved cognitive subcomponent and an impaired affective one. These results underscore the importance of ecological measures to precisely investigate each subcomponent of social cognition in alcohol-dependent individuals. They further show that alcohol dependence is closely associated with emotional-affective impairments, pointing to the need to develop rehabilitation programs focusing on these components in clinical settings.

Key Words: Alcohol Dependence, Theory of Mind, MASC, Social Cognition.

BEYOND ITS well-established cerebral and cognitive adverse consequences (Bülher and Mann, 2011; Stavro et al., 2013), alcohol dependence is also associated with emotional and interpersonal impairments. Early work mainly focused on the decoding of emotional facial expressions (Kornreich et al., 2001; Philippot et al., 1999) and emotional prosody (Maurage et al., 2009; Monnot et al., 2002), globally showing that alcohol-dependent individuals (ALC) present a reduced ability to identify the emotions expressed by faces or voices, particularly for negative affects (D'Hondt et al., 2014). More recent explorations have gone beyond these emotional decoding impairments by investigating other aspects of social cognition that directly underlie interpersonal abilities. It has indeed been shown that alcohol dependence is associated with strong deficiencies in a large range of social abilities, notably revealed by the misunderstanding of humor and irony (Amenta et al., 2013; Uekermann et al., 2007), maladaptive self-standards in social interactions (Maurage et al., 2013), or impaired conditional reasoning related to social rules (Kornreich et al., 2011). These data support the proposal of Uekermann and Daum (2008) that alcohol dependence is associated with a global deficit in Theory of Mind (ToM). ToM can indeed be globally defined as the ability to infer mental states from others' social signals to predict their behaviors or actions (Premack and Woodruff, 1978) and is classically divided into affective (i.e., the ability to detect and experience others' feelings and emotions) and cognitive (i.e., the ability to identify others' thoughts or intentions) subcomponents (Shamay-Tsoory et al., 2007). Very recent studies have confirmed this proposal of a ToM deficit in alcohol dependence by directly showing ToM impairments using specific tasks such as the Faux-Pas task (Thoma et al., 2013), the False-Beliefs task (Maurage et al., 2015), the Versailles-Situational Intention Reading (Nandrino et al., 2014), or the Theory of Mind Assessment Scale

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(Bosco et al., 2014). The latter one, based on a multilevel assessment of ToM, described a generalized ToM deficit in alcohol dependence, including first-person (i.e., identifying one's own feelings) and third-person (i.e., identifying others' feelings) levels, as well as first-order (i.e., understanding what others feel about an external event) and second-order (i.e., understanding what others feel about another individual's feelings) perspectives. It is also worth noting that this ToM impairment is not present among non-alcohol-dependent young adults with alcohol-dependent parents, suggesting that these impairments might be the direct consequence of installed alcohol dependence (Kopera et al., 2014). As a whole, and as further confirmed by a recent meta-analysis (Onuoha et al., 2016), alcohol dependence appears to be directly associated with large-scale impairments in ToM abilities, which might be partly underpinned by cognitive impairments (e.g., autobiographical memory [Nandrino et al., 2014]).

Importantly, as emotional and interpersonal abilities are critical for the maintenance of social bonds by enabling the rapid identification of others' affective state and adapted reactions to these social signals (D'Hondt et al., 2014), these deficits may reduce the quality of social interactions in ALC. As increasing alcohol consumption is in return a frequent coping strategy to face these relational problems (e.g., Spada and Wells, 2006; Swendsen et al., 2000), affective and social impairments can reinforce a vicious circle favoring the persistence of excessive alcohol consumption (Kornreich et al., 2002). While ALC are often unable to notice the presence of this vicious circle because of anosognosia and metacognitive impairments (see, e.g., LeBerre et al. [2010] for an exploration of metamemory deficits), the key role played by these deficits is further illustrated by the fact that emotional (e.g., negative affects) and interpersonal (e.g., social pressure) variables constitute crucial relapse factors (Shafiei et al., 2014; Zywiak et al., 2003). Evaluating and remediating social cognition thus constitute a crucial therapeutic challenge to reduce the burden related to alcohol dependence. However, the development of such clinical tools is currently hampered by the limited ecological validity of the tasks used earlier, complicating their adaptation for clinical settings and the development of programs directly linked to real-life situations.

Indeed, while constituting a valuable first step toward a better understanding of ToM abilities in ALC, earlier studies present two main limits. First, they focused on ToM tasks with very limited ecological value as they were based on verbal material (i.e., written descriptions of social scenarios [Thoma et al., 2013]), unimodal and artificial situations unrelated to real-life interactions (e.g., identifying character beliefs regarding the location of an object in a box [Maurage et al., 2015]), or interviews focusing on self-reported ToM abilities (Bosco et al., 2014). Second and centrally, earlier works did not investigate the distinction between affective and cognitive ToM. Indeed, some tasks were purely focused on cognitive ToM (e.g., False-Beliefs task [Maurage et al., 2015]; Versailles-Situational Intention Reading [Nandrino et al., 2014]), while others presented affective and cognitive items but regrouped them into a global score (Bosco et al., 2014; Thoma et al., 2013). However, this distinction between affective and cognitive ToM is of crucial interest in alcohol dependence, as earlier results in this population have shown (i) a specific deficit for emotional empathy (with conversely preserved cognitive empathy), these abilities being strongly related to ToM (Ferrari et al., 2014; Maurage et al., 2011b); and (ii) a marked deficit for emotional ToM in the "Reading the Mind in the Eyes" test (Baron-Cohen et al., 2001), with, conversely, a preserved processing of nonemotional mental states (Maurage et al., 2011a; Nandrino et al., 2014). These results suggest that alcohol dependence may not be related to a global ToM impairment as reported earlier, but rather to a dissociation between affective and cognitive subcomponents. While this dissociation bears essential fundamental and clinical implications, it has not yet been explored using specific ToM tasks.

In view of the limits related to earlier studies, the main aim of this work was to explore the hypothesis of a dissociation between affective and cognitive subcomponents of ToM in alcohol dependence by means of a more ecological evaluation of ToM abilities. The Movie for Assessment of Social Cognition (MASC, Dziobek et al., 2006) appears to be an ideal tool to reach this objective, as this task was developed to ecologically evaluate ToM abilities by asking participants to identify the emotions, thoughts, and intentions expressed in videos depicting real-life social interactions. Moreover, the MASC allows dissociating errors related to overmentalizing (i.e., presenting an excess of ToM by overinterpreting social situations) from those related to undermentalizing (i.e., presenting a lack or absence of ToM). Another strength of this task is that it offers the opportunity to compute affective and cognitive scores by dissociating items related to these two ToM subcomponents. The MASC has been widely used in neurological and psychiatric populations, notably showing that ToM is preserved in obsessive-compulsive disorders (Buhlmann et al., 2015) but is globally impaired in multiple sclerosis (Kraemer et al., 2013), borderline personality disorder (Ritter et al., 2011), and unipolar depression (Wolkenstein et al., 2011). Error analysis also allowed to go beyond the mere description of ToM impairment; for example, in schizophrenia positive correlations have been found between overmentalizing and positive symptoms (Fretland et al., 2015), and between undermentalizing and negative symptoms (Montag et al., 2011). Centrally, this test has also proven its usefulness to detect dissociations between ToM subcomponents, participants with euthymic bipolar disorder (Montag et al., 2010), social anxiety, body dysmorphic disorder (Buhlmann et al., 2015), showing preserved affective ToM but impaired cognitive ToM.

Despite its reliability to dissociate ToM subcomponents, the MASC has, to our knowledge, not been used to a large degree in addictive disorders, as only one study applied this task in dependent cocaine users (Preller et al., 2014), centrally

reporting a general ToM impairment in this population. While underlining the potential interest of the MASC to explore ToM modifications in substance-related disorders, this study did not distinguish affective and cognitive subscales, and further explorations are thus needed to determine the possible differential deficit across these subscales in addictive states. This study is therefore the first to use the MASC in ALC, to test the hypotheses that these individuals present ToM deficits when confronted with close to real-life situations and that a dissociation will be observed between impaired affective subcomponent and preserved cognitive dissociation.

MATERIALS AND METHODS

Participants

Sixty-four adults with normal-to-corrected vision took part in the study: 32 ALC diagnosed with alcohol dependence according to DSM-IV criteria (APA, 2000), and 32 healthy controls (HC). Alcohol dependence diagnosis was established during a semi-structured interview performed by a trained psychiatrist. This exhaustive interview was also used to precisely determine medical history, alcohol consumption characteristics, and psychiatric comorbidities (explored by means of the Mini International Neuropsychiatric Interview [MINI]; Sheehan et al., 1998). Participants with alcohol dependence were recruited during their third week of detoxification (Saint-Luc Hospital, Brussels, Belgium), and all had abstained from alcohol for at least 14 days. They were free of any other psychiatric diagnosis, except nicotine dependence. Healthy participants were free of any history of psychiatric disorder or drug/substance abuse (excluding nicotine dependence), as assessed by the MINI. The mean AUDIT score (classically used as a global screening of alcohol consumption in the general population [Saunders et al., 1993]) in HC was 3.2 (SD = 1.6), all HC presenting low-risk alcohol consumption (i.e., AUDIT score lower than 8). Group characteristics are shown in the Table 1. HC were free of any medication, but 21 ALC still received low doses of benzodiazepines (mean = 18.6 milligrams of diazepam per day, SD = 14.8). Education level was assessed according to the number of years of education completed since starting primary school. Exclusion criteria for both groups included major medical problems, neurological disease, and poly-substance abuse (excluding nicotine dependence). All participants were right-handed, as evaluated by the Edinburgh Handedness Inventory (Oldfield, 1971). Participants were informed with full details regarding the aims of the study, provided written informed consent to take part in the study and were tested individually in a quiet room. The study was approved by the Ethical Committee of the Medical School (Université catholique de Louvain) and carried out according to the Declaration of Helsinki, as revised in 1989. Participants were not paid for their participation. This experiment was part of a larger project, in collaboration with the GDR 3557, investigating social cognition impairments in alcohol dependence.

Procedure and Measures

Control Measures. Validated self-completion questionnaires were used to assess depression (Beck Depression Inventory; Beck and Steer, 1987) and state-trait anxiety (State and Trait Anxiety Inventory; Spielberger et al., 1983).

Experimental Measure. The MASC (Dziobek et al., 2006) has been administered to explore subtle ToM abilities. This task is based on a 15-minute movie consisting of a succession of 45 short video clips (with a duration ranging from 3 to 71 seconds and a resolution of 480×640 pixels) showing social interactions between four characters (two women, two men) having dinner at one of the character's apartment. During each video, interactions between characters are depicted (e.g., misunderstandings, flirting), the characters expressing positive (e.g., joy, gratitude) or negative (e.g., contempt, irritation) emotions, feelings, intentions, and thoughts with different intensities. The participant is instructed to attentively watch the movie to infer characters' thoughts or feelings, as the movie will be stopped periodically and he/she will be required to answer questions during these breaks. Task instructions do not provide any information regarding the specific aspects to be detected to correctly answer, the accurate interpretation of each interaction being based on verbal (the semantic content of characters' speech), nonverbal (facial expressions, prosody, body language), and contextual cues. After each video, a question related to the characters' feelings/emotions (affective ToM, i.e., What does "X" feel?) or intentions/thoughts (cognitive ToM, i.e., What does "X" think? or Why does "X" say/do that?) appears on the screen together with four possible answers. Each possible answer is related to a response type, namely correct answer (accurate identification of characters' feeling, emotion, thought, or intention), excessive ToM (overmentalization or overinterpretative ToM), reduced ToM (undermentalization or insufficient ToM), absence of ToM (complete lack of ToM or literal understanding), each type of error thus being possible for each item. An example of the task is given in Fig. 1. Three experimental measures were computed. First, the total score, namely the number of correct answers given (maximum score = 45), is computed. Second is the computation of two subscales, affective ToM and cognitive ToM,

Table 1. Characteristics of the Alcohol-Dependent (ALC) and Healthy Control (HC) Groups: Mean (SD) [Range]

	ALC (N = 32)	HC (N = 32)	Group comparison (p-value)
Alcohol consumption			
Number of detoxification treatments	0.75 (0.8) [0–3]	–	–
Alcohol dependence duration (years)	7.6 (6.8) [2–30]	–	–
Alcohol consumption (units[a] per day)	21.1 (9.7) [5–40]	0.37 (0.9) [0–3]	<0.001
Demographic measures			
Gender ratio (M/F)	18/14	15/17	0.456
Age (in years)	47.7 (10.1) [28–71]	45.8 (9.9) [29–63]	0.451
Education level (in years)	13.9 (1.6) [11–18]	15.2 (1.9) [12–17]	0.138
Psychological measures			
BDI[b]	10.6 (7.9) [1–26]	2.4 (3.1) [0–13]	<0.001
STAI-A[c]	40 (15.23) [20–71]	29.4 (7.3) [20–45]	<0.001
STAI-B[c]	47.6 (12.3) [23–70]	37.3 (9.6) [20–57]	<0.001

[a]An alcohol unit corresponds to 10 grams of pure ethanol.
[b]BDI, Beck Depression Inventory (Beck and Steer, 1987).
[c]STAI, State and Trait Anxiety Inventory (Spielberger et al., 1983).

Fig. 1. Illustration of the experimental task. Example of an MASC item (related to the cognitive subscale), with a description of the video (upper part) and of the multiple-choice task (lower part) with the four possible answers (correct ToM, excessive ToM, reduced ToM, absence of ToM).

respectively, related to questions focused on characters' feelings/emotions (e.g., surprise, disappointment, happiness) or characters' intentions/thoughts (e.g., action plans, aims, beliefs). In line with the methodology proposed in earlier MASC studies (e.g., Buhlmann et al., 2015; Preißler et al., 2010; Ritter et al., 2011; Smeets et al., 2009; Wingenfeld et al., 2014), the 15 items specifically related to affective ToM and the 18 items specifically related to cognitive ToM were selected among the 45 items to compute the subscales (with a maximum score of 15 and 18, respectively). The score of each subscale is the number of correct answers for the associated items. Third and finally, the number of each type of error for the whole task and for each subscale is computed. A MASC control condition, based on six nonsocial questions related to physical events (e.g., What was the color of "X's" tokens during the board game?) and presented during the task (three items), or at the end of the task (three items), is also proposed, beyond the 45 ToM-related items, to control for nonsocial inference and to check that the participant has correctly understood the global context. To avoid an effect of the number of items related to each experimental measure, the number of correct answers given was transformed for each experimental variable (i.e., total score, affective subscale, cognitive subscale, control condition, error types) into a percentage of answers for the statistical analyses. The MASC has previously shown excellent psychometric properties, with high interjudge reliability, internal consistency (Cronbach's alpha higher than 0.82 for the total scale and each subscale), and test–retest stability (Dziobek et al., 2006; Ritter et al., 2011). The validated French version of the MASC was used, implemented in Microsoft Powerpoint, with each video being followed by the question and the four response choices presented simultaneously on a slide. The total duration of the task was about 45 minutes.

Data Analytic Plan

Statistical analyses were performed using IBM SPSS Statistics (Version 22.0; IBM Corp., Armonk, NY), and the following strategy was used. First, between-group comparisons were performed on demographic (age, gender, educational level) and psychological (depression, trait-state anxiety) characteristics. Second, a univariate analysis of variance was performed to compare groups' performance on MASC's global result and control condition. Third, a repeated-measures analysis of variance was performed, with groups as between-subjects factor and subscales performance (affective ToM, cognitive ToM) as within-subject variable. Fourth, a repeated-measures analysis of variance was performed, with groups as between-subjects factor and MASC error types' percentages (i.e., excessive ToM, reduced ToM, absence of ToM) as within-subject variable, for the global MASC and for each subscale. As group effects on errors are mirrored by group effects on accuracy, only the main effect of error type and the interaction between group and error type are presented. Significant main effects and interactions were followed by univariate contrasts (post hoc independent-samples *t*-tests). Alpha level was set at 0.05. Finally, complementary correlational analyses were performed using Pearson's correlations (corrected for multiple comparisons using the Bonferroni procedure) to explore the influence of potentially confounding factors (i.e., psychological variables, medication, consumption characteristics, and gender) on experimental results and to test the link between MASC's subscales.

RESULTS

Demographic and Psychological Measures

As shown in Table 1, there were no significant group differences for age [$t(62) = 0.76$, $p = 0.45$], gender [$\chi^2(1,n = 62) = 0.56$, $p = 0.46$], or education level [$t(62) = 1.50$, $p = 0.14$], but the two groups significantly differed for depression [$t(62) = 5.48$, $p < 0.001$], state anxiety

[$t(62) = 3.54$, $p < 0.001$], and trait anxiety [$t(62) = 3.78$, $p < 0.001$].

Experimental Measures

Total Score and Control Condition. Groups did not differ regarding non-ToM control items [mean performance: ALC: 76.5 ± 18.86%; HC: 80.73 ± 12.77%; $F(1, 62) = 1.07$, $p = 0.30$], but, as shown in Fig. 2 (upper part), ALC showed significantly reduced MASC total performance [mean performance: ALC: 62.71 ± 6.55%; HC: 71.31 ± 5.71%; $F(1, 62) = 31.41$, $p < 0.001$].

Affective Versus Cognitive Subscales. A main group effect was found, with ALC presenting lower scores than HC [$F(1, 62) = 14.12$, $p < 0.001$]. No significant subscale main effect was found [$F(1, 62) = 0.16$, $p = 0.69$]. Centrally and as illustrated in Fig. 2 (lower part), a group × subscale interaction was found [$F(1, 62) = 4.09$, $p = 0.047$]: groups did not differ for cognitive ToM [mean performance: ALC: 63.71 ± 12.62%; HC: 67.19 ± 9.81%; $t(62) = 1.23$, $p = 0.224$] but ALC presented significantly lower scores than HC for affective ToM [mean performance: ALC: 59.8 ± 7.47%; HC: 69.8 ± 8.29%; $t(62) = 5.07$, $p < 0.001$].

Error Types. *Global score*: A significant error type effect was found [$F(2, 124) = 62.79$, $p < 0.001$], with lower error rates related to the absence of ToM than to excessive ToM [$t(63) = 9.86$, $p < 0.001$] and reduced ToM [$t(63) = 13.55$, $p < 0.001$], which did not significantly differ from each other [$t(63) = 0.13$, $p = 0.89$]. No group × error type interaction was found [excessive ToM: ALC, 15.76 ± 6.78%, HC, 11.94 ± 4.29%, reduced ToM: ALC, 15.21 ± 4.73%, HC, 12.2 ± 4.15%, absence of ToM: ALC, 6.32 ± 2.53%, HC, 4.51 ± 3.17%, $F(2, 124) = 0.69$, $p = 0.50$].

Cognitive subscale: A significant error type effect was found [$F(2, 124) = 49.45$, $p < 0.001$], with lower error rates related to the absence of ToM than to excessive ToM [$t(63) = 8.77$, $p < 0.001$] and reduced ToM [$t(63) = 4.14$, $p < 0.001$], and to reduced ToM than to excessive ToM [$t(63) = 6.38$, $p < 0.001$]. No group × error type interaction was found [excessive ToM: ALC, 18.23 ± 10.10%, HC, 18.06 ± 7.06%; reduced ToM: ALC, 10.76 ± 6.61%, HC, 10.24 ± 5.84%; absence of ToM: ALC, 7.29 ± 5.72%, HC, 4.51 ± 4.56%; $F(2, 124) = 0.65$, $p = 0.53$].

Affective subscale: A significant error type effect was found [$F(2, 124) = 60.23$, $p < 0.001$], with lower error rates related to the absence of ToM than to excessive ToM [$t(63) = 10.08$, $p < 0.001$] and reduced ToM [$t(63) = 11.55$, $p < 0.001$], and to excessive ToM than to reduced ToM [$t(63) = 2.34$, $p = 0.02$]. A group × error type interaction was found [$F(2, 124) = 3.81$, $p = 0.04$]: ALC made more errors than HC for reduced ToM [ALC: 22.08 ± 8.87%, HC: 14.37 ± 7.59%, $t(62) = 3.73$, $p < 0.001$], but not for excessive ToM [ALC: 14.37 ± 7.96%, HC: 13.33 ± 8.63%, $t(62) = 0.50$, $p = 0.62$] or for the absence of ToM [ALC: 3.75 ± 4.46%, HC: 2.49 ± 3.57%, $t(62) = 1.65$, $p = 0.10$].

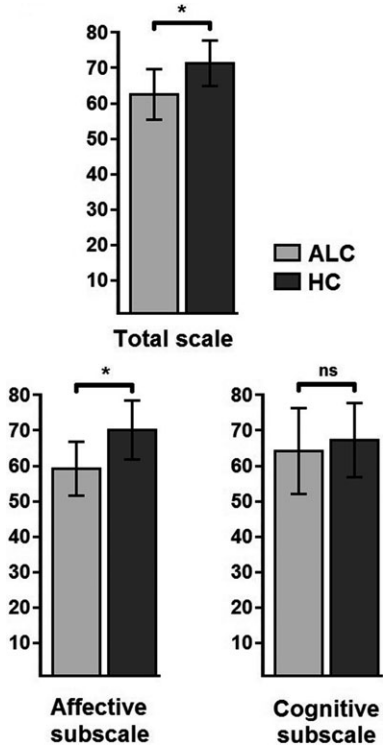

Fig. 2. Percentage of correct answers related to the global score (upper part) and to affective–cognitive subscales (lower part) of the MASC in alcohol-dependent individuals (ALC) and healthy controls (HC). NS, nonsignificant; *$p < 0.001$.

Complementary Analyses. Complementary analyses were performed to:

Test for psychological variables effects: Pearson's correlations were performed in the whole sample and in each group between depression/anxiety measures and experimental results (total and subscales scores, error types). No significant correlation was observed ($p > 0.05$ for every correlation).

Test for medication effect: Pearson's correlations were performed in ALC between benzodiazepine consumption and experimental results. No significant correlation was observed ($p > 0.05$ for every correlation).

Test for the consumption variables effect: Pearson's correlations were performed in ALC between alcohol dependence characteristics (i.e., number of previous detoxification treatments, alcohol dependence duration, daily alcohol consumption before detoxification) and experimental results. No significant correlation was observed ($p > 0.05$ for every correlation).

Test for the gender effect: Independent-samples t-tests were performed to compare the percentage of correct answers between male and female participants for the total score and each subscale in the whole sample and in each group. No significant differences were observed between genders, either in the whole sample [$t(62)<0.59$, $p > 0.56$] or in

each group [ALC: $t(30)<1.78$, $p > 0.87$; HC: $t(30)<1.23$, $p > 0.22$].

Test for the link between MASC's subscales: Pearson's correlations were performed in the whole sample and in each group between affective and cognitive subscales' performance, these correlations being nonsignificant for the whole sample ($\rho = 0.15$, $p = 0.22$), ALC ($\rho = 0.02$, $p = 0.92$), and HC ($\rho = 0.21$, $p = 0.24$).

DISCUSSION

The present study investigated social cognition in alcohol dependence by means of a close to real-life and realistic task allowing to clearly dissociate affective and cognitive ToM. A first important result is the ecological confirmation that, when ToM abilities are explored as a unitary phenomenon, alcohol dependence is associated with globally altered capacities. Indeed, ALC showed strongly reduced total MASC score compared to HC. This global ToM deficit, observed here at the third-person level (as participants had to identify characters' feelings and thoughts), is in line with those reported in earlier studies (Maurage et al., 2015; Thoma et al., 2013) and confirms that alcohol dependence is related to a genuine difficulty in interpreting others' mental state rather than to a merely reduced ability to inhibit self-perspective (Maurage et al., 2015). It moreover offers empirical evidence to the proposal, up to now only supported by nonexperimental self-reported measures (Bosco et al., 2014), that ToM impairments encompass first-order but also second-order ToM, as several MASC items required the understanding of what a character thinks about another character's desires or beliefs. Centrally, the experimental design proposed by the MASC involves actual social interactions, and the present results show that the conclusions proposed in earlier studies (based on tasks distant from real-life situations, see Onuoha et al., 2016, for a recent review) can be generalized to more ecological situations. Therefore, they likely constitute a more reliable evaluation of the genuine difficulties presented by ALC in everyday life social interactions. Importantly, similar ToM deficits have been identified using the MASC in recreational and dependent cocaine users (Preller et al., 2014), suggesting that ToM impairments might constitute a common and core characteristic of various addictive states, even at the early stages of drug abuse.

However, beyond the findings with the global MASC score, the main result of the present study is the observed dissociation between affective and cognitive ToM. While distinct results related to these two subcomponents have been reported in other psychiatric states (Buhlmann et al., 2015; Montag et al., 2010), underscoring the need to consider them separately, earlier studies on alcohol dependence mostly focused on a general exploration of ToM abilities. Indeed, only one study (Nandrino et al., 2014) explored these two components, showing preserved cognitive and impaired affective social cognition, but using different instruments (i.e., "Reading the Mind in the Eyes" questionnaire for affective ToM, Versailles-Situational Intention Reading task for cognitive ToM) hampering a direct comparison between the two subcomponents. Our results thus go further by showing, for the first time in an integrated task, that ALC present a strong impairment for affective ToM but a preservation of cognitive ToM, leading to crucial new fundamental and clinical insights (Onuoha et al., 2016). The complementary analysis showing the absence of correlation between the scores obtained for each subscale in HC and ALC further reinforces the proposal that affective and cognitive MASC subscales are related to distinct abilities and that focusing on the total score is not pertinent to explore ToM deficits. In other words, the global deficit observed for ToM actually masks a different pattern between its two subscales: a massive difficulty to detect emotional verbal, nonverbal, and environmental cues to correctly infer other people's feelings and affects, but a preserved ability to use cognitive cues to infer others' beliefs, intentions, or thoughts (at least in the context offered by the MASC). This clear dissociation reinforces earlier results showing a similar dissociation between emotional and cognitive empathy (Maurage et al., 2011b) and suggesting a specific deficit for affective ToM (Maurage et al., 2011a). The data on social cognition, together with reports of emotional decoding deficits, suggest a specific "affect processing system" impairment in alcohol dependence (D'Hondt et al., 2014; Marinkovic et al., 2009). Interestingly, two previous studies showed a dissociation between affective and cognitive components of social cognition in other addictive states, by means of the Multifaceted Empathy Test (MET, Dziobek et al., 2008). On the one hand, results similar to those in the present study were obtained with the MET in cocaine abusers (Preller et al., 2014). In contrast, the acute use of MDMA appears to increase affective ToM, with unchanged cognitive subcomponent (Schmid et al., 2014). While the respective impact of acute and chronic drug use should be further investigated, these preliminary results raise the hypothesis that various addictive substances might have a differential impact on affective ToM, without significantly modifying cognitive ToM. Finally, it should be noted that the analysis of error types enabled us to go further by showing that, while the reduced global ToM performance appeared to rely on greater undermentalizing errors (i.e., reduced ToM or absence of ToM), it was also associated with a higher rate of overmentalizing mistakes (namely erroneous and exaggerated interpretations of social situations). The errors on the affective subscale seemed centrally related to reduced ToM in ALC, as the study groups did not differ on the two other error types (i.e., excessive ToM and absence of ToM). These results suggest that the affective ToM deficit in ALC is specifically related to reduced ToM abilities.

The control of potential biases and the rigor of the experimental design reduce potential alternative explanations for these results. First, while depression and anxiety are known to strongly modulate ToM abilities (Buhlmann et al., 2015; Wolkenstein et al., 2011), no significant correlation was

found between experimental results and depression or anxiety measures. While this control cannot totally exclude an influence of these variables on the results, and while other uncontrolled psychological variables might have an influence, these complementary analyses enabled us to exclude a strong impact of the most frequent comorbidities on our experimental variables. Second, while general intellectual functioning influences ToM performance, it appears that the global cognitive deficiencies frequently reported in ALC (Stavro et al., 2013) did not play a key role in the results observed, as the education level was matched between groups, and particularly because ALC showed a preserved performance in the MASC control condition developed to detect such global cognitive impairment. However, as the education level mainly indexes crystallized intelligence, it might not constitute a reliable estimate of the cognitive abilities required during ToM tasks (mainly relying on fluid intelligence). Moreover, as cognitive functions were not directly assessed in the present study, we cannot exclude the possibility that the present results might at least partly be explained by underlying cognitive deficits. Third, the dissociation between affective and cognitive subscales cannot be explained by a lower level of difficulty of the cognitive items or by a ceiling effect for the cognitive subscale, as: (i) the reverse pattern has been described in several other psychiatric conditions; (ii) the correct response rates were lower than 70% for both subscales among controls; and (iii) there was no main effect of the subscale in our analyses. Interestingly, the reverse dissociation (i.e., preserved affective but impaired cognitive ToM subcomponent) has been reported in euthymic bipolar (Montag et al., 2010), social anxiety, and body dysmorphic disorders (Buhlmann et al., 2015). The present results, which are the first to show this reverse pattern in psychiatry, thus demonstrate the presence of a double dissociation between ToM subcomponents, strengthening the proposal that ToM should be considered as a double-process phenomenon, affective and cognitive ToM constituting distinct abilities (Frith and Singer, 2008).

The clear dissociation between affective and cognitive ToM observed here suggests that future studies should go beyond the mere exploration of global ToM deficits, as such an approach misses more subtle and differentiated performance patterns. Additional research is required to confirm and extend the present results by systematically dissociating ToM subcomponents in tasks presenting a high ecological value. In the present study, the alcohol-dependent group was quite homogeneous on alcohol dependence characteristics (e.g., disease duration, alcohol consumption), which might explain why no significant correlations were found with experimental measures; however, the influence of psychological and consumption variables on ToM should be further explored. Indeed, earlier studies have suggested that ToM impairments might be influenced by the duration of alcohol dependence, by the intensity of alcohol consumption, and by current craving for alcohol (Maurage et al., 2015). In the same vein, while it has been shown that ToM impairments are not present in high-risk populations (i.e., children of ALC) before the development of alcohol dependence (Kopera et al., 2014), the causal link between ToM impairments and alcohol dependence should be further investigated, particularly in longitudinal studies. In addition, future research should explore the psychological processes responsible for affective ToM impairments and determine whether this deficit originates at the perceptual (e.g., inaccurate visual analysis of emotional scene), identification (e.g., wrong interpretation of affective cues), or mnesic (e.g., erroneous matching with memorized emotional labels) level, notably in view of the large-scale metamemory impairments observed in this population, which might influence social interactions (LeBerre et al., 2010). Another important research question concerns the evolution of ToM deficits during the course of alcohol dependence. The present study reported large changes in ToM in recently detoxified ALC, but these deficits could resolve with prolonged abstinence. It has indeed been suggested that cognitive (Pitel et al., 2009) and cerebral (Segobin et al., 2014) deficits present a partial recovery following mid-term abstinence, and conversely that emotional deficits persist despite abstinence (Kornreich et al., 2001). The maintenance or spontaneous restoration of social cognition abilities with abstinence should thus be further investigated, beyond the focus on short-term abstinence seen in the ALC that participated in the present study.

Future research should also aim to address several limitations in the present study. First, despite being based on real-life social interactions and thus providing strong ecological validity, the MASC uses a forced-choice answer method while, in real life, ToM abilities are expressed through spontaneous and unrestricted evaluation of social situations. By constraining the response choice, the MASC procedure reduces its ecological validity as it evaluates the ability to correctly choose between several possible answers rather than to produce a genuine identification of others' mental states. Second, MASC results are exclusively based on accuracy, with no recording of reaction times. As appropriate real-life social interactions rely on accurate but also rapid ToM abilities to enable one to rapidly understand and react to others' thoughts or feelings, future studies should also take into account the speed of ToM abilities. Third, the present study focused on the MASC and did not explore its links with and differences from other social cognition measures or more direct evaluation of social interactions. Future studies should thus extend the present data by directly exploring their links with other social cognition indexes, notably following the example of the study on cocaine use, which showed correlations between impaired ToM abilities and reduced real-life social network and interactions (Preller et al., 2014).

Despite these limits, the observation of a specific impairment for affective ToM clearly adds to the literature showing emotional and interpersonal deficits in alcohol dependence (D'Hondt et al., 2014; Maurage et al., 2012, 2013). At the clinical level, this underscores the urgency to take into

account this affect processing deficit in the evaluation and restoration of alcohol-related impairments, particularly by proposing therapeutic programs specifically dedicated to the remediation of emotional and social deficits. Empirically validated remediation programs in addiction have focused on cognition factors (Sofuoglu et al., 2013), but they should also target affective and relational deficits. Social cognition training should start in the abstinent period, in view of the role played by affective and interpersonal deficits in the relapses occurring in the weeks or months following detoxification. These programs should then be adapted and reevaluated in mid- or long-term abstinence, according to the potential spontaneous recovery of social cognition abilities. Such interventions have been developed and applied in schizophrenia (e.g., Peyroux and Franck, 2014) and could be adapted for use in alcohol dependence. As the social cognition deficit may not be homogeneous across ALC, these interventions should be individually tailored on the basis of a rigorous evaluation of the deficits. The present design did not allow us to directly compare the clinical utility of the MASC with other classically used social cognition measures. However, the MASC, by providing an integrated, easy-to-use, brief evaluation of both affective and cognitive ToM, with demonstrated high sensitivity and specificity (Dziobek et al., 2006), represents a useful tool to evaluate ToM abilities in ALC.

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