THE CROSS-MODAL FACILITATION EFFECT IS DISRUPTED IN ALCOHOLISM: A STUDY WITH EMOTIONAL STIMULI

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Abstract — Aim: Chronic alcoholism is classically associated with major deficits in the visual and auditory processing of emotions. However, the cross-modal (auditory-visual) processing of emotional stimuli, which occurs most frequently in everyday life, has not yet been explored. The aim of this study was to explore cross-modal processing in alcoholism, and specifically the auditory-visual facilitation effect. Methods: Twenty patients suffering from alcoholism, and 20 matched healthy controls had to detect the emotion (anger or happiness) displayed by auditory, visual or auditory-visual stimuli. The stimuli were designed to elicit a facilitation effect (namely, shorter reaction times (RTs) for cross-modal condition than for uni-modal ones). RTs and performances were recorded. Results: While the control subjects elicited a significant facilitation effect, alcoholic individuals did not present this effect, as no significant differences between RTs according to the modality were shown. This lack of facilitation effect is the marker of an impaired auditory-visual processing. Conclusion: Cross-modal processing of complex social stimuli (such as faces and voices) is crucial for interpersonal relations. This first evidence for a cross-modal deficit in alcoholics contribue to explaining the contrast observed between experimental results describing, up to now, mild impairments in emotional facial expression (EFE) recognition in alcoholic subjects (e.g. Oscar-Berman et al., 1996), and the many clinical observations suggesting massive problems.

INTRODUCTION

In their natural social surroundings, human beings are continually immersed in a complex stream of stimulations from different sensory modalities (sounds, pictures, odours, ...), which interact to create an integrated representation of the environment. Cross-modal processes refer to this mechanism underlying the construction of an unified and coherent representation on the basis of different stimulations, issued from distinct sensory modalities but concerning the same object or situation (Driver and Spence, 2000). Experimental studies were mainly devoted to the exploration of ‘uni-modal’ phenomena. Recently, due to technical developments, and to the awareness that cross-modal processing (at behavioural and cerebral levels) constitutes a crucial ability in our daily interactions, these integrative processes became a central field of research in psychology and neuroscience (see Calvert, 2001; Lalanne and Lorenceau, 2004; Ameli et al., 2005 for reviews).

At a behavioural level, many cross-modal studies described an ‘inhibition effect’. This effect is determined by a deteriorated or biased performance in cross-modal conditions (i.e. when two stimuli from different modalities are presented simultaneously) as compared to uni-modal ones. For instance, in the auditory-visual domain, two striking examples of such interference are the McGurk (McGurk and McDonald, 1976) and the ventriloquist effects (e.g. Alais and Burr, 2004). In the first one, the simultaneous presentation of a syllable (e.g./ba/) and an incongruent lip movement (e.g./da/) leads to the false perception of the syllable/ba/. In the second one, the origin of a sound is attributed by mistake to the dummy and not to the artist’s mouth. These two examples show that vision can alter audition. Research in this domain (e.g. Joassin et al., 2004) showed that the main factors leading to an inhibition effect are differences in the complexity, spatial distance and/or temporal asynchrony between the stimulations.

Conversely, a ‘facilitation effect’ (Frans et al., 1995; Calvert et al., 2001; Teder-Sälejärvi et al., 2002), namely, shorter reaction times (RTs) when participants are confronted with congruent bi-modal stimuli as compared with uni-modal ones, is frequently observed when a spatio-temporal proximity and an identical identity exist between stimuli. This effect recently led to a growing interest in the neuro-cognitive literature as it allows exploring the cognitive and cerebral correlates of an efficient cross-modal processing. Indeed, the facilitation effect is considered as the behavioural marker of a successful cross-modal integration between stimuli of different modalities (Calvert et al., 2001). Co-activation models (Miller, 1982; Schröger and Widmann, 1998) explain this facilitation effect on the basis of an interaction between modalities, by postulating either a late interaction after modality-specific processing (‘independent coactivation model’) or an early integration and mutual influence between stimuli from the beginning of the process (‘interactive coactivation model’). If the timing and localization of the integration process is still unclear, several studies, using basic stimuli (e.g. flashes and bursts) or even more ecological stimuli like emotional (Pourtois et al., 2000) or neutral (Jeassin et al., 2004) faces and voices, described cerebral processes and areas specifically dedicated to the cross-modal integration (e.g. Mittner et al., 1999; Calvert et al., 2000; Bushara et al., 2001; Molholm et al., 2002). The existence of ‘specific integrative activities’, different from those generated in response to uni-modal activities, is suggested and these integrative processes seem to be disturbed in some psychiatric populations (e.g. schizophrenia, Surguladze et al., 2001).
The current study will explore cross-modal processing in alcoholism on the basis of emotional auditory and visual stimuli. Indeed, chronic alcoholism is associated with a wide range of cognitive, psychological and interpersonal impairments (e.g. Wenger et al., 2001). Behavioural studies showed that alcoholic individuals present general deficits in visual (Blasewicz et al., 1977; Kramer et al., 1989) and auditory (Spitzer and Ventry, 1980; Spitzer, 1981) processing, and this impairment has been notably confirmed by electrophysiological explorations (e.g. Cadaveira et al., 1991; Ogura and Miyazato, 1991; Bijl et al., 2005; Marco et al., 2005; Maurage et al., 2007). More specifically, alcoholic individuals are particularly impaired for the decoding of emotions. Concerning the visual modality, many studies (e.g. Philippot et al., 1999; Frigerio et al., 2002; Townsend and Duka, 2003) showed that alcoholism is associated with a misinterpretation and overestimation of the emotions expressed by the human face, namely the emotional facial expressions (EFE), (e.g. Ekman, 1972, 1977; Ekman et al., 1980). Similarly, at the auditory level, alcoholism leads to deficits in the decoding of emotional prosody (Monnot et al., 2001; Uekermann et al., 2005). To sum up, it has been established that alcoholism is associated with deficits in the decoding of visual and auditory emotional stimuli, when these stimuli are presented in isolation (i.e. in uni-modal paradigms).

However, it is unclear whether this deficit is maintained, reduced or even increased when alcoholic individuals are, as in everyday life, confronted simultaneously with congruent visual and auditory stimulations. Exploring these cross-modal processing with emotional stimuli thus seems crucial, as the ubiquity of the cross-modal interactions is particularly apparent in the field of emotional processing. Emotional feelings and the ability to interpret and correctly react to emotional situations are always based on several sensory aspects: EFE, affective prosody, postures, or even gustatory and olfactory stimuli with an affective valence (e.g. Winston et al., 2005; Greimel et al., 2006; Shepherd, 2006). The uni-modal exploration is thus clearly insufficient to apprehend the complexity of the emotional processes. Only a few studies have explored the cross-modal integration of complex emotional stimuli, among healthy (e.g. Dolan et al., 2001; Pourtois et al., 2005) and psychopathological populations (e.g. Surguladze et al., 2001). As the cross-modal processing of emotional information has not yet been investigated in chronic alcoholism, the present study explored this issue. Moreover, as the facilitation effect is a marker of cross-modal integration (Calvert, 2001), this study was based on the elicitation of this effect. Cross-modal integration of the stimuli in chronic alcoholism was assessed behaviourally.

Cross-modal (auditory-visual) stimuli were used in order to determine to which extent the ‘uni-modal’ emotional deficit described in alcoholism (in visual and auditory modalities) is present in situations with higher ecological validity, namely, when patients are confronted with synchronized visual and auditory emotional signals. This study is thus the first attempt to explore, in chronic alcoholism, the potential deficit of the mechanisms by which the brain establishes relationships between auditory and visual stimuli.

METHODS AND SUBJECTS

Participants

Twenty inpatients (three of them women), diagnosed with alcohol dependence according to DSM-IV criteria, were recruited during the third week of their treatment in a detoxification centre (‘Les Marronniers’ Hospital, Tourna, Belgium). They had all abstained from alcohol for at least two weeks (the number of days since last drink ranged from 15 to 22 days; mean 18.4, SD 3.47), were free of any other psychiatric diagnosis (the presence of a comorbidity with any other psychiatric disease constituted an exclusion criteria), and were all right-handed. The mean alcohol consumption among patients just before detoxification was 17.9 standard drinks per day (SD 5.32), the mean number of prior detoxification treatments was 3.1 (SD 1.4), and the mean duration of alcohol dependence was 15.6 years (SD 10.8, ranging from 7 to 29 years of abuse). Patients were matched for age, gender and education with a control group composed of 20 volunteers who were free of any history of psychiatric disorder or drug/substance abuse, and whose personal alcohol consumption was lower than five standard drinks per week. Control subjects abstained from any alcohol consumption at least three days before testing. Moreover, patients and control subjects were assessed for several psychological measures, in order to evaluate the presence of sub-clinical comorbid psychopathologies and deficits. The following variables were evaluated using validated self-completion questionnaires (mentioned in brackets): State and trait anxiety (State and Trait Anxiety Inventory, form 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). Exclusion criteria for both groups included major medical problems, central nervous system disease (including epilepsy), visual or auditory impairment and polysubstance abuse. Each participant had a normal-to-corrected vision and a normal audition.

Education level was assessed according to the number of years of education completed since starting primary school. 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.

Task and procedure

We used an emotion-detection task in which participants were confronted with faces and voices, presented separately (uni-modal conditions) or simultaneously (cross-modal condition). Two categories of faces and voices were used and varied in terms of emotional content (anger or happiness). In the cross-modal condition, faces and voices were always congruent (i.e. depicting the same emotion).

The visual stimuli, namely EFE, were selected from the standardized set of Ekman and Friesen (1976) pictures: Two ‘persons’ (one male), each displaying two emotions (anger and happiness) were chosen. Facial characteristics have been found to be recognized more rapidly than vocal
ones (Ellis et al., 1997; Schweinberger et al., 1997; Joassin et al., 2004), but it has been shown that increasing the perceptual difficulty of faces can make them more difficult to recognize than voices (Hanley et al., 1998; Hanley and Turner, 2000). We thus decided to complicate the visual stimuli in order to obtain a similar difficulty level in vision and audition, leading to a facilitation (rather than an interference) effect in cross-modal conditions. On the basis of a morphing software (Morph 2.5, Gryffon Software Corp.), a continuum between the happy (H) and angry (A) faces was computed for each "person", leading to pictures depicting different levels of morphing (i.e. 10%-H-90%-A, 20%-H-80%-A, ...). These blended faces were presented in a preliminary study to 40 participants (32 females, mean age = 19.32, SD: 1.72) in order to find the morphing level leading to similar results (RTs and error rates) as the auditory stimuli. These participants had a normal audition and a normal-to-corrected vision, were free of any history of psychiatric disorder or drug/substance abuse (including binge drinking habits), and their personal alcohol consumption was lower than seven standard drinks per week. Participants had to determine as quickly as possible which emotion was displayed in the stimulus. At the lower morphing levels (i.e. 10, 20 and 30% of an emotion, and 90, 80 and 70% of the other, respectively), RTs and accuracy figures remained better for visual than for auditory stimuli (t(39) ≥ 2.61, P < 0.05), indicating that faces were not complex enough. However the morphing levels ‘40%-H-60%-A’ and ‘60%-H-40%-A’ led to similar RTs (t(39) = 1.15, NS) and accuracy (t(39) = 0.93, NS) in visual and auditory conditions. These two levels were thus chosen for the experiment. As illustrated in Figure 1, four visual stimuli (2 morphing levels x2 persons) were used in the task.

The auditory stimuli were audiotaught consisting in the enunciation of a semantically neutral name (namely "paper") with an emotional prosody. These stimuli were selected from a standardized battery of emotional prosody (Maurage et al., submitted), based on a pilot study (conducted on 70 participants, 43 females, mean age = 18.74, SD = 0.89). Four auditory stimuli were selected as best expressing the emotions

![Fig. 1. Illustration of the visual stimuli used in this study, varying according to the gender (female above, male below) and to the dominant emotion (happiness on the left, anger on the right).](image-url)
of interest: Two voices (one male), and two auditory tapes for each (angry and happy prosody).

Four auditory-visual (cross-modal) stimuli were also created, based on the combination of a visual and an auditory stimulus (congruent for emotion and gender). The study thus comprised 12 stimuli and 8 experimental conditions (2 emotions × 3 stimulus modalities).

Participants were confronted with a total of 4 blocks, each defined by 6 series of 12 stimuli, so that the study consisted in 28 stimuli (48 per condition). Within a series, all stimuli were presented in the same modality (auditory, visual or both). The order of the 4 blocks varied across participants. Participants sat in a dark room on a chair placed 50 cm from the screen. Visual stimuli subtended a visual angle of 6° × 8°. Auditory stimuli were presented via binaural headphones. Each stimulus (face, voice or both) was presented for 700 ms. The stimuli were followed by a black screen (during 1,800 ms). From the stimulus onset, participants had 2,000 ms to answer. Participants had to decide as quickly as possible which emotion was displayed in the stimulus by pressing the button corresponding to this emotion (for example, 'anger') with their right forefinger. RTs and error rates were recorded. Emphasis was made on speed and accuracy. Only correct responses were considered for analysis of RTs.

Pretest

In order to ensure that the present procedure generates a facilitation effect in the cross-modal condition, a pre-test was conducted on 20 control subjects (mean age: 19.4, SD: 3.1.38). These control subjects were free of any history of psychiatric disorders or drug/substance abuse (including binge drinking habits), and their personal alcohol consumption was lower than seven standard drinks per week. As predicted, the selected stimuli gave rise to a significant facilitation effect. Concerning accuracy, auditory-visual stimuli led to lower error rates than auditory [t(19) = 2.39, P < 0.05] and visual ones [t(19) = 5.89, P < 0.001]. Moreover, the RTs (presented in Figure 2) showed similar results: auditory-visual conditions led to shorter RTs than auditory [t(19) = 3.17, P < 0.01] and visual [t(19) = 4.76, P < 0.001] ones, which did not differ [t(19) = 0.71, NS]. This pre-test thus confirmed that the selected design is associated with a facilitation effect in control population, and that an efficient integration processing is demonstrated in this experimental paradigm.

RESULTS

Psychological measures

As shown in Table 1, alcoholic individuals and controls were similar in terms of age [F(1, 38) = 0.001, NS], gender and education [F(1, 38) = 0.19, NS]. Moreover, the two groups did not significantly differ on anxiety state [F(1, 38) = 0.96, NS], anxiety trait [F(1, 38) = 0.89, NS], interpersonal problems [F(1, 38) = 0.38, NS] and alexithymia [F(1, 38) = 0.14, NS]. In fact, the only significant difference between groups concerned the depression scale [F(1, 38) = 23.53, P < 0.001], showing higher scores for alcoholics as compared to controls. However, these differences are unlikely to have influenced the experimental results, as (i) no significant Pearson's correlations were shown between any psychological measure and any behavioural data (P > 0.05 for every correlation) and (ii) a complementary analysis was conducted, including the depression score as covariate in our ANOVA statistical analyses, and showing no significant influence of this factor on the results (P > 0.05 for every test).

Accuracy. These results are shown in Table 2. A 3 × 2 × 2 ANOVA with modality (auditory, visual and auditory-visual) and emotion (anger and happiness) as within-factors and group (alcoholic individuals and controls) as between-factor was carried out. A main effect of modality [F(2, 76) = 59.119, P < 0.001, η² = 0.61] was found: There were more errors for visual than for auditory [t(39) = 8.52, P < 0.01] and auditory-visual [t(39) = 7.33, P < 0.01] stimuli. Moreover, we found an interaction effect between group and modality [F(2, 76) = 5.00, P < 0.05, η² = 0.12]: Alcoholics made more errors than controls in the visual conditions [t(19) = 2.22, P < 0.05], but not in the auditory [t(19) = 0.62, NS] and audio-visual ones [t(19) = 0.77, NS].

Latencies. A 3 × 2 × 2 ANOVA with modality and emotion as within-factors, and group as between-factors was computed. As shown in Table 2 and Figure 3, two main effects were found: (i) group [F(1, 38) = 31.97, P < 0.001, η² = 0.45], indicating longer RTs for the alcoholic group;

![Fig. 2. Behavioural results of the pre-test phase for the three modalities (A = Auditory, V = Visual, AV = Auditory-Visual). Latencies (on the left) and accuracy (on the right) illustrates the facilitation effect observed (*)P < 0.05, **P < 0.01).](image-url)
Table 1. Patient and control characteristics (mean (SD))

<table>
<thead>
<tr>
<th>Group</th>
<th>Age (years) (range)</th>
<th>Age range</th>
<th>ELb</th>
<th>% femaleb</th>
<th>MACc</th>
<th>BDId</th>
<th>Statb A</th>
<th>Statb B</th>
<th>HPe</th>
<th>TAS-20f</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls (N = 20)</td>
<td>24–62</td>
<td>44.6 (13.1)</td>
<td>15</td>
<td>0.57 (0.2)</td>
<td>2.05 (2.16)</td>
<td>30 (8.10)</td>
<td>35.45 (8.38)</td>
<td>1.03 (0.59)</td>
<td>40.10 (8.22)</td>
<td></td>
</tr>
<tr>
<td>Alcoholics (N = 20)</td>
<td>26–57</td>
<td>44.6 (8.5)</td>
<td>15</td>
<td>17.92 (5.3)</td>
<td>8.25 (5.29)</td>
<td>32.7 (9.21)</td>
<td>38.2 (9.97)</td>
<td>1.14 (0.52)</td>
<td>43.05 (9.32)</td>
<td></td>
</tr>
</tbody>
</table>

a EL = Education Level.
b % female = Percentage of female subjects in the group.
c MAC = Mean Alcohol Consumption (number of standard drinks per day) just before detoxification.
d BDI = Beck Depression Inventory (Beck and Steer, 1987).
e Stat = StateTrait Anxiety Inventory (Spielberger et al., 1983).
f HPI = Inventory of Interpersonal Problems (Horowitz et al., 1985).
g TAS-20 = Twenty-item Toronto Alexithymia Scale—II (Bagby et al., 1994).

Table 2. Behavioral results: Reaction Times [RTs, ms (SD)] and Performance [Perf., % of correct responses, (SD)]

<table>
<thead>
<tr>
<th>Modality</th>
<th>Emotion</th>
<th>Control subjects (N = 20)</th>
<th>Alcoholics subjects (N = 20)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>RTs (ms) (SD)</td>
<td>Perf.</td>
</tr>
<tr>
<td>Auditory</td>
<td>Anger</td>
<td>857 (142)</td>
<td>95.5 (6.8)</td>
</tr>
<tr>
<td></td>
<td>Happiness</td>
<td>754 (132)</td>
<td>94.7 (8.6)</td>
</tr>
<tr>
<td>Visual</td>
<td>Anger</td>
<td>800 (123)</td>
<td>82.8 (15.1)</td>
</tr>
<tr>
<td></td>
<td>Happiness</td>
<td>795 (128)</td>
<td>81.6 (18.2)</td>
</tr>
<tr>
<td>Auditory-visual</td>
<td>Anger</td>
<td>761 (126)</td>
<td>95.4 (15.5)</td>
</tr>
<tr>
<td></td>
<td>Happiness</td>
<td>713 (140)</td>
<td>92.9 (10.0)</td>
</tr>
</tbody>
</table>

(ii) emotion $F(1, 38) = 10.69, P < 0.01, \eta^2 = 0.22$, indicating longer RTs for the anger than for happiness stimuli. This emotion main effect was modulated by an interaction effect, namely emotion X modality $F(2, 76) = 14.86, P < 0.001, \eta^2 = 0.28$. The auditory anger condition led to longer RTs than the other conditions $t(19) > 2.51, P < 0.05$. Finally, and more importantly, an interaction effect was found between condition and modality $F(2, 76) = 3.59, P < 0.05, \eta^2 = 0.09$: while in the general group no differences were found between modalities, in the control group auditory-visual condition led to shorter RTs than auditory $t(19) = 4.88, P < 0.05$ and visual $t(19) > 5.59, P < 0.05$ conditions, thus showing a facilitation effect, absent among alcoholic subjects.

In order to confirm that alcoholic subjects were significantly more impaired for the cross-modal condition as compared to uni-modal ones, an ANOVA analysis was conducted to compare the difference of deficit (namely Alcoholics RTs minus Controls RTs) for each condition. A significant effect was found $F(1, 19) = 38.41, P < 0.001, \eta^2 = 0.37$, confirmed by paired $t$-tests: Cross-modal conditions led to significantly higher RT differences between controls and alcoholics than auditory $t(19) = 3.45, P < 0.01$ and visual $t(19) = 2.99, P < 0.01$ ones, which did not differ $t(19) = 0.72, NS$.

Complementary analysis. Finally, it should be noted that, as the gender and age range varied between the pretest and experimental phases, and could have influenced the results, these potential bias have been explored. Indeed, gender and age were introduced as covariates in our ANOVA statistical analyses (for the preliminary study, for the pretest as well as for the experiment itself), and Pearson's correlations were computed between the results and these variables. We did not find any significant influence of the gender or age variables on the results ($P > 0.05$ for every test and correlation).

DISCUSSION

The central aim of this study was to explore the integrity of the cross-modal processing among alcoholic subjects. Indeed, while it has been extensively observed that alcoholism is associated with a wide range of cognitive and neuropsychological impairments (and notably a deficit in the processing of uni-modal auditory or visual stimuli), no study has been conducted yet to determine whether alcoholism hampers cross-modal processing. This lack of research is surprising because cross-modal situations are the most frequent in everyday life, particularly when emotional abilities are involved. Thus, as alcoholism is associated with various problems in ecological contexts (notably in emotional and social situations), and as our social environment is characterized by multi-modal stimulation, the cross-modal processing was tested on the basis of complex social stimuli, namely facial expressions and voices. The use of modified visual stimuli (as shown in the pre-test) resulted in the use of identical complexity in both visual and auditory stimulations. This technique resulted in the facilitation effect presumed to be the mark of the cross-modal integration.

This study first confirmed the uni-modal deficit, namely the impaired processing of EFE and emotional prosody; Alcoholics subjects were slower to determine the emotion presented in the stimuli, and the deficit did not differ in intensity between auditory and visual stimuli. This cannot be explained by the fact that alcoholism is associated with an impairment of visuomotor abilities, as accuracy scores confirmed this uni-modal...
impairment. Indeed, alcoholic subjects made more errors than controls, particularly in the visual conditions (a ceiling effect was observed in auditory and auditory-visual conditions and the two groups did not significantly differ on these modalities). These results are in line with previous ones (e.g., Philippot et al., 1999; Monnot et al., 2001; Townshend and Duka, 2003), and confirm that alcoholism leads to deleterious effects for the processing of visual and auditory emotional stimuli.

The main result of this study concerns cross-modal processing. Indeed, while a facilitation effect was found among control subjects (namely faster RTs for the cross-modal conditions as compared to uni-modal ones), no differences between modalities were observed in the alcoholic group. As the facilitation effect is the behavioral marker of the efficient cross-modal processing, these results showed that alcoholism is associated with an impaired auditory-visual integration of complex and ecological stimuli. Moreover, a complementary analysis, directly comparing the alcoholics’ deficit for each modality, confirmed that this cross-modal deficit is significantly more extensive than the uni-modal (auditory and visual) impairment.

This first observation of an absence of facilitation effect in alcoholism, indexing an impaired cross-modal integration, may have important clinical implications. Indeed, as the cross-modal situations are very frequent in everyday life, we suggest that earlier studies based on uni-modal stimulations (and often using basic stimuli) have underestimated the deficits in alcoholism. This cross-modal impairment could also explain the hiatus between the relatively mild deficit frequently observed in experimental situations among alcoholic subjects (e.g., Oscar-Berman et al., 1990; Beatty et al., 2000; Uekermann et al., 2005) and the patent impairments observed in ecological situations, and notably in clinical observations. Moreover, as emotions are often expressed simultaneously in different modalities (particularly in vocal and facial expression) and as the efficient decoding of emotions is a crucial ability to develop and maintain satisfactory interpersonal relations (e.g., Feldman et al., 1991), the impairment of emotional cross-modal processing in alcoholism could have deleterious consequences on social integration (Nixon et al., 1992), leading to a vicious circle: A deficit in the decoding of emotional signs (particularly in cross-modal situations), provoked by alcoholism, worsens interpersonal problems (Kornreich et al., 2002), which in turn could increase alcohol consumption used as a coping strategy (Kornreich et al., 2001).

The implications of such results for both experimental and clinical endeavours are the following: In research on alcoholism, these results should lead to a re-evaluation of earlier studies using uni-modal stimuli and showing limited impairments in chronic alcoholics. Also, these results should encourage future studies to use cross-modal stimuli in order to correctly evaluate any cognitive and emotional deficits in social stimuli processing. For clinical settings, these study results should encourage the incorporation of cross-modal aspects of communication during the patient’s evaluation, notably by developing more realistic testing of emotion comprehension in alcoholics. Therapeutic interventions could also be improved through communication re-education programmes, focusing on cross-modal processing of the expression and identification of emotions in social settings.

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