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Keyword: Heroin addiction, Alexithymia, Emotion processing, Accuracy, Reaction Times, Sadness.

Introduction

Drug addiction is a social-health problem with alarming statistics around the world. From a social standpoint, substance addiction is frequently associated with deficient interpersonal relationships, especially from the interpersonal point of view (Kornreich et al., 2002), which could be due to impaired processing of emotional information related to social interactions (Kornreich, et al., 2003).

The study of emotional processing has represented an useful tool to explore interpersonal abilities in addicts, given the role of emotion processing in social attitude (e.g., Niedenthal et al., 2005; Vicario & Newman, 2013; Vicario, Rafal & Avenanti, 2015). Emotion recognition difficulties in opiate addicts could affect interpersonal relationships, since the ability to accurately decode facial expressions is an important component of functional/well-adjusted social interactions.

The current literature provides contrasting results about the emotion recognition performance in this clinical category (see Kun & Demetrovics, 2010 for a review). Kornreich et al. (2003) studied emotion recognition performance in four different groups of participants: recently detoxified alcoholics (RA); opiate addicts under methadone maintenance treatment (OM); detoxified opiate addicts (OA); detoxified subjects with both alcohol and opiate dependence antecedents (DAO); Results showed a lower accuracy in emotion recognition in all clinical groups, compared to healthy controls. In contrast, Martin et al., (2006) found that opiate users receiving methadone maintenance were more accurate than ex-opiate users in rehabilitation to recognize facial expression of disgust. On the other hand, they were generally slower than controls in recognizing all expressions. Finally, the study by Zhou et al., (2012) has shown that abstinent heroin abusers display a heightened detection of negative emotion when searching stimulus displays with a varying number of neutral faces for the positive or negative faces.

A psychological construct that could help to understand and disentangle these differences in the emotional recognition performance in opiate addicts is alexithymia. The term alexithymia was coined by Sifneos (1973), to indicate "*a deficit in the cognitive processing of emotions"* (see Taylor & Bagby, 2013). In the specific, alexithymia is characterized by a reduced ability to identify and describe feelings, a difficulty to distinguish among different feelings, an externally oriented cognitive approach to reality and a difficulty to modulate feelings (Porcelli et al., Taylor, 2014). Alexithymia has been also associated to impaired ability in recognize facially expressed emotions (see Grynberg et al., 2012 for a recent review). For example, Prkachin, Casey & PrKachin (2009) found impaired ability in detecting affective expressions in population with alexithymia. In particular, the correlation analyses documented higher difficulty in recognizing emotions such as sadness, anger, and fear. In similar fashion, Gil et al., (2009) reported a significant and negative correlation between facial emotion recognition and alexithymia severity in a group of twenty patients with somatoform disorders. Therefore, one could hypothesize a key role of alexithymia symptoms in the emotional recognition deficit of addicts, given the relevance of this disorder in this clinical category (Craparo, 2014; Craparo et al., 2014a; Faraci et al., 2013; Torrado, Ouakinin & Bacelar-Nicolau, 2013; Craparo et al., 2014b; Craparo et al., 2014c). Indeed, as reported by Farges et al., (2004), the incidence of alexithymia symptoms in addicts is of the 43.5%, compared to the 24.6% of healthy controls.

The research on addicts has also provided evidence of neurobiological alterations in addicts, which might explain the emotional recognition deficit if this clinical population. For instance, Kornreich et al. (2003) proposed that the origin of this deficit might be due to the chronic abuse of drugs, which might cause deleterious effects on brain functions decoding facial expressions. This suggestion appears likely, given the evidence of a deranged activity of several key regions for emotion (and reward) processing such as the insula, the cingulate cortex, and the amygdale in addicts (Naqvi & Bechara, 2009; Di chiara et al., 1999; Vicario et al., 2014). However, these dysfunctions should not be conceived as separate from alexithymia symptoms, rather, as a possible neural substrates. In fact, the research has linked alexithymic features to an abnormal activity of amygdale (kugel et al., 2005) and the frontocingulate cortices (Berthoz et al., 2002).

In the current research we wanted to addressed, for the first time, the impact of alexithymia symptoms in emotional processing of heroin addicts. Indeed, despite previous studies have shown that these two phenomena are closely linked in other clinical populations such as, for example, in adults with in adults with somatoform disorders (Pedrosa et al., 2009), this remains to be investigated in heroin addicts. Thus we measured participants' accuracy (i.e., proportion of correct answers) and reaction times (RTs) in detecting affective expressions. According to the previous works documenting a role of alexithymia symptoms in emotional recognition deficits, we expect to detect a positive relationship between alexithymia symptoms severity and the difficulty in detecting negative emotions.

Methods

Participants

Sixty-two participants were recruited for the current study. The drug addiction group was composed of thirty-one participants (4 cocaine/heroin addicts, 25 males, average age 34.83 ± 8.6); The thirty-one healthy participants (control group) was composed by 25 males, average age 33.83 ± 8.70). No between group difference has been detected with respect to the age ($t=0.45$, $p=0.65$). The clinical group was recruited in two special sanitary treatment centers for drug addictions in Enna and Florence (Italy). Procedures of inclusion were: i) diagnosis of heroin addiction; ii) no previous experience of psychotherapy; iii) no diagnosis of severe mental illness (e.g. psychosis, schizophrenia, depression major, anxiety, posttraumatic stress disorder); iv) absence of other forms of addiction (according to the Addictive Behavior Questionnaire, Caretti in press). With respect to the clinical group, the temporal exposition to drugs ranged between 5 and 8 years. The healthy group was recruited among university students. This study was conducted in accordance with the requirements of the Helsinki convention and approved by the local ethical committee of Kore University. An informed consent has been obtained by all participants.

Measures and Stimuli

The 20-item Toronto alexithymia scale (TAS-20) is a self-report scale useful to measure of alexithymia. It is composed of three factor: 1) Difficulty identifying feelings (DIF); 2) Difficulty describing feelings; 3) Externally oriented thinking. Bagby et al. (1994) proposed three cut-off scores in order to discriminate alexithymic (≥ 61), borderline (score range between 51 to 60), and no alexithymic individuals (≤ 50). A set of picture representing the six basic emotions: happiness, sadness, fear, disgust, contempt and anger. We used photos of easy emotional intensity level from the Facial Action Coding System (Ekman, Friesen & Hager, 1978). Stimuli were presented in a random order via Personal Computer.

Procedure

Participants were invited to fill out the TAS-20 questionnaire, evaluate and categorize facial emotion expressions elicited from vision of photos representing the basic emotions (fear, anger, disgust, happy, sadness, surprise, contempt). They were asked to name the emotion displayed in each photo presented in a random order. Accuracy and reaction Times (RT) (using an electronic chronometer) were recorded. The administration, of both questionnaire and pictures was done into a silent room of the center for drug addicts, by using a face-to-face method. The average time of each session was about 45 minutes.

Data analysis

The four participants using both cocaine and heroin were excluded from the analysis, to have a homogeneous clinical group. We first used the no parametric Mann Withney U-test to compare the TAS-20 scores of our heroin addicts vs. control participants. Data were also entered in a repeated Measure Anova to detect any between group difference with respect to the examined variables (Accuracy and RTs). Moreover, correlation analyses between the TAS-20 scores and the RTs were performed by using the Spearman's correlation rank coefficient, to test the different impact of alexithymia severity on the emotional recognition performance of both the clinical and the control groups. For all tests, the level of statistical significance was set at $p< 0.05$. Data analyses were performed using the Statistica software, version 8.0, StatSoft, Inc., Tulsa USA.

Results

Alexithymia index: As expected, we detected a significant between groups difference (Z=3.75, $p<0.001$) comparing TAS-20 scores of addicts (M=57.6 ± 16.7 SD) with respect to controls (M=41.83 ± 10.5 SD). This shows that control participants are, on the average, not affected by alexithymia (i.e., TAS-20 score ≤ 50), while addicts participants can be classified in the borderline category with respect to the alexithymia index (i.e., TAS-20 score > 50 and < 60).

Emotions recognition accuracy: The repeated measure ANOVA detected a significant main effect for the Group factor [$F(1,60)=5.68$, $p=0.021$], documenting a lower accuracy (i.e., proportion of correct responses) of the clinical sample (M=0.650 ± 0.037) in detecting emotional stimuli compared to the control sample (M=0.774 ± 0.035). We also detected a significant main effect of the Emotion factor [$F(6,354)=18.0$, $p< 0.001$]. However, the Group x Emotion interaction term was not significant [$F(6,354)=1.47$, $p=0.189$]. The figure 1A shows details concerning the participants' performance with respect to the accuracy in the detection of the seven emotions.

Emotion recognition reaction times: We detect a significant main effect for the Group factor [$F(1,55)=4.85$, $p=0.032$], documenting higher RTs of the clinical sample (M=7.74 ± 0.608) in detecting emotional stimuli compared to the control sample (M=5.909 ± 0.567). In similar fashion, we documented a significant main effect for the Emotion factor [$F(6,156)=14.7$, $p<0.001$]. In contrast, no significant difference has been reported for the Group x Emotion interaction term [$F(6,156)=0.86$, $p=0.522$]. The figure 1B shows details concerning the participants' performance with respect the RTs in the detection of the seven emotions.

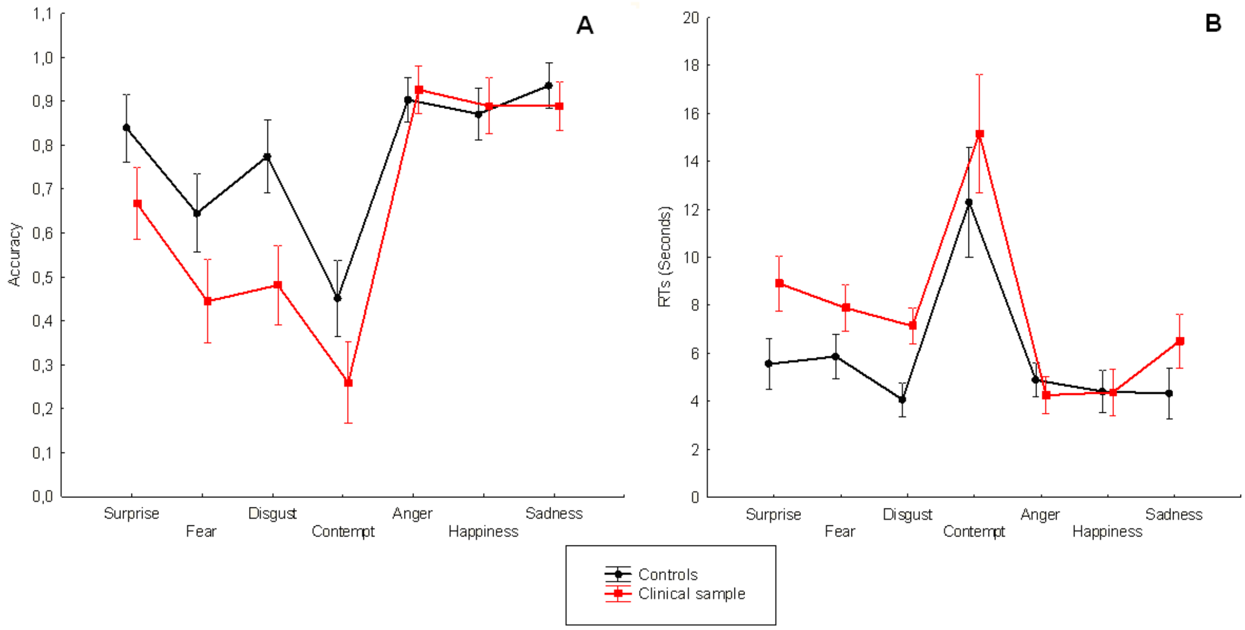

Figure 1. ***A***. The figure shows the proportion of correct responses (i.e., accuracy) of healthy controls and heroin addicts (i.e., clinical sample) in the recognition of the facial expressions of emotions. The figure shows relevant differences for the recognition of Surprise, Fear, Disgust and Contempt. ***B.*** The figure shows RTs of healthy controls and heroin addicts (i.e., clinical sample) in the recognition of the facial expressions of emotions. The figure shows relevant differences only for the detection of Surprise, Fear, Disgust, Contempt and Sadness. Vertical Bars indicate standard error.

Correlation analyses: We detected a significant positive correlation between TAS-20 scores and RTs in the recognition of the expression of *sadness* ($r=0.43$, $p=0.024$) in heroin addicts (see figure 2). No further significant correlations have been reported for the other emotions in both heroin addicts and healthy controls ($p> 0.100$).

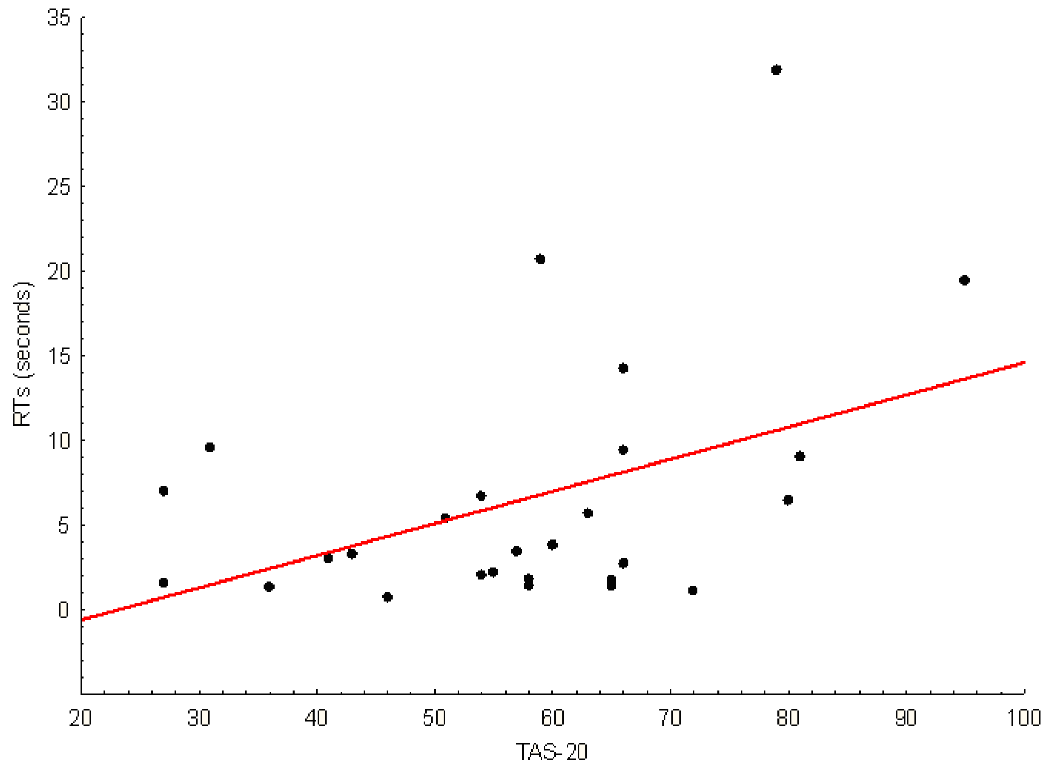

Figure 2. The figure shows a positive correlation between RTs in the recognition of the expression of sadness and alexithymia symptoms severity (TAS-20 scores).

Discussion

Several studies have linked alexithymia to addiction. Moreover**,** alexithymia has been associated to deficits in emotion recognition performance. However, the literature documents contrasting results while examining emotion recognition performance in addicts, with evidence of lower (e.g., Kornreich et al., 2003) and higher (e.g., Martin et al., 2006; Zhou et al., 2012) accuracy in the examined performance. Nevertheless, no research has directly investigated the link between alexithymia symptoms and emotion recognition performance in heroin addicts.

Overall, in the current research we show that heroin addicts are less accurate and slower in the recognition of facial expressions of emotions, compared to healthy controls. This result corroborates the research of Kornreich et al. (2003) which as reported a similar pattern of results; while appears in contrast with the study of Zhou et al. (2012), documenting a better performance in the recognition of negative emotions and with the study of Martin et al. (2006), reporting higher accuracy in disgust recognition. However, our data support to the RTs results reported by Zhou et al. (2012), as we found that heroin addicts are slower in the emotion recognition. In fact, these authors documented a similar pattern of results (i.e., slower RTs), although only for the recognition of facial expressions of negative emotions.

A novel result emerging from our analysis is the positive correlation between RTs in the recognition of the expression of sadness and alexithymia severity in the clinical sample. In particular, we found that the higher the alexithymia symptoms severity the higher the RTs required to recognize this emotional expression. In contrast, no correlations have been documented for the other facial expressions. Several studies have described a deficit in sadness recognition in relation to psychopathic traits (e.g., Stevens, Charman, & Blair, 2001; Blair & Coles, 2000). For example, Blair & Coles (2000) found that high levels of affective-interpersonal disturbance, in the form of unemotional traits, cause problems in the recognition of sadness. The evidence of common attributes sharing, between psychopathic traits and alexithymia (see Lander et al., 2012), might explain why we only detected a selective correlation between RTs in sadness recognition and alexithymia symptoms. Moreover, psychopathy commonly comorbid with drug addiction including heroin addiction (Vassileva et al., 2007; Gori et al., 2014). However, this hypothesis remains speculative since we did not directly investigated psychopathy in our clinical sample.

An alternative, not mutually exclusive, hypothesis for explaining the reported relationship between alexithymia symptoms and impaired recognition of the expression of sadness might refer to the existence of deranged activity in correspondence of a common neural circuit involved in sadness processing and alexithymia symptoms. In fact, the activity of the amygdala and fronto-temporal regions, two neural structures involved in the processing of sad facial expressions (Blair et al., 1999; Goldin et al., 2005), have been reported to be abnormal in people affected by alexithymic traits (e.g., kugel et al., 2005).

Overall, our results add new insights to the current interpretation of affective deficits in heroin addiction, providing evidence of a direct link between alexithymia symptoms and emotional recognition performance in this clinical sample. In particular, they suggest that alexithymia might be responsible of a selective deficit of our heroin addicts in detecting the expressions of *sadness*. On the other hand, the absence of significant correlations with respect to the detection the other facial expressions of emotions suggest that the lower performance in emotion detection of our addicts might be due to other factors more directly related to the neural effects of heroin exposure. In particular, one could speculate that the lower accuracy in the emotion detection of addicts might be due to the effects of long-term heroin assumption on neural structures critically involved in emotion recognition such as the insula, the amygdala, orbitofrontal cortex, the anterior cingulated cortex and the basal ganglia (e.g., see Adolphs, 2002 for a review). In fact, there is evidence (Liu, et al., 2011; Li et al., 2003) documenting functional dysregulation of these regions in heroin abusers.

Future works devoted to investigate emotion processing in addiction might expand the current investigation by exploring the links between alexithymia, psychopathic traits, drug exposure, withdrawal symptoms and emotion recognition.

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