# Impaired emotion recognition is linked to alexithymia in heroin addicts

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Several investigations document altered emotion processing in opiate addiction. Nevertheless, the origin of this phenomenon remains unclear. Here we examined the role of alexithymia in the ability (i.e. number of errors – *accuracy* - and reaction times - *RTs*) of thirty-one heroin addicts and thirty-one healthy controls to detect several affective expressions. Results show generally lower accuracy and higher RTs in the recognition of facial expressions of emotions for patients, compared to controls. The hierarchical multivariate regression analysis shows that alexithymia might be responsible of the between groups difference with respect to the RTs in emotion detection.

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31 **Introduction**

32 Drug addiction is a social-health problem with alarming statistics around the world.
33 From a social standpoint, the addiction to drugs is frequently associated with deficient
34 interpersonal relationships (Kornreich et al., 2002). This could be due to impaired processing of
35 emotional information related to social interactions (Kornreich, et al., 2003), though other factors
36 such as the degree of dependence and the drug related life style may be also be involved in such
37 impairments.

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

43 The current literature provides contrasting results about emotion recognition performance in this
44 clinical condition (see Kun & Demetrovics, 2010 for a review). Kornreich et al. (2003) studied
45 emotion recognition in four different groups of participants: recently detoxified alcoholics (RA);
46 opiate addicts under methadone maintenance treatment (OM); detoxified opiate addicts (OA);
47 detoxified subjects with both alcohol and opiate dependence antecedents (DAO); Results showed
48 a lower emotion recognition accuracy in all clinical groups, compared to healthy controls. In
49 contrast, Martin et al., (2006) found that opiate users receiving methadone maintenance were

more accurate than ex-opiate users in rehabilitation in recognizing facial expressions 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 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). Specifically, alexithymia is characterized by a reduced ability to identify and describe feelings, a difficulty to distinguish between 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 with an impaired ability to recognize facially expressed emotions (see Grynberg et al., 2012 for a recent review). For example, Prkachin, Casey and PrKachin (2009) found an impaired ability in detecting affective expressions in populations with alexithymia. In particular, the correlational 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. The research by Lindsay and Ciarocchi (2009) proposes 2 different potential explanations. One might refer to the mood, which is more negative in substance abusers (Lindsay and Ciarocchi, 2009), compared to controls. In fact, Haviland et al. (1994) found that negative mood (i.e., depression) predicts alexithymia. The alternative explanation might refer to the inaccurate belief / low-motivation of addicts. As explained by the authors, if people believe that they are not able to deal effectively with their

emotions, they may be less motivated to do so. Less motivation, in turn, may lead to more alexithymic behaviour. For these reasons, one could hypothesize a key role of alexithymia in the emotional recognition deficit of addicts, given the relevance of this disorder in this clinical condition (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 prevalence of alexithymia in addicts is 43.5%, compared to 24.6% in healthy controls, as documented by using the TAS-20. The study of alexithymia in heroin addiction is important, because it can provide insights about the origin of the emotional processing deficit in this clinical population, as reported by the literature.

The research on addicts has also provided evidence of neurobiological alterations in addicts, which might explain the emotional recognition deficit in 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 involved in decoding facial expressions. This suggestion appears likely, given the evidence of the impaired 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, rather as possible neural substrates. In fact, research has linked alexithymic features to abnormal activity of the amygdale (Kugel et al., 2005) and the frontocingulate cortices (Berthoz et al., 2002).

In the current research we addressed, for the first time, the impact of alexithymia in the emotional processing deficits of heroin addicts. Indeed, despite previous studies having shown that these two phenomena are closely linked in other clinical populations such as 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 previous studies documenting a role of alexithymia in emotional recognition deficits, we expect to detect a positive relationship between alexithymia severity and the difficulty in detecting negative emotions.

## Methods

*Participants*

Sixty-two participants were selected 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 four participants consuming both cocaine and heroin were excluded from the analysis in order to have a homogeneous clinical group. The clinical group was selected in two special sanitary treatment centers for drug addictions in Enna and Florence (Italy). All patients were undergoing methadone treatment. The methadone dosage ranged between 20 a 80 mg per day. No psychosocial treatment was provided. Inclusion criteria were: i) diagnosis of heroin addiction; ii) no previous experience of psychotherapy; iii) no diagnosis of severe mental illness (e.g. psychosis, schizophrenia, major depression, anxiety, post-traumatic stress disorder); iv) absence of other forms of addiction (according to the Addictive Behaviour Questionnaire, Caretti in press); v) the use of other drugs. The clinical diagnosis was made by a psychiatrist, according to the DSM V criteria, by structured clinical interview. Moreover, all patients underwent blood and urine tests to confirm the type of drug metabolites. The urine test were negative for cannabis use. The period of drug-taking ranged between 5 and 8 years. The healthy group was selected

among university students and patients' relatives. They were screened through a clinical interview, aiming to mainly exclude any form of addiction. This study was conducted in accordance with the requirements of the Helsinki convention and approved by the local ethical committee of Kore University. Informed consent was obtained from all participants.

*Measures and Stimuli*

The 20-item Toronto alexithymia scale (TAS-20) is a self-report scale used to measure alexithymia. It is composed of three subscales: 1) Difficulty identifying feelings (DIF); 2) Difficulty describing feelings (DDF); 3) Externally oriented thinking (EOT). Bagby et al. (1994) proposed three cut-off scores in order to discriminate alexithymic (≥ 61), borderline (score range between 51 to 60), and non alexithymic individuals (≤ 50). A set of pictures were used, representing the six basic emotions: happiness, sadness, fear, disgust, contempt and anger. For our sample we used an Italian validated version made by Bressi et al. (1996). The scale was administered, in a multicenter research project, in a nonclinical sample of 206 adults and a nonclinical sample (medical and psychiatric disorders) of 642 subjects, showing good psychometric properties (high reliability and validity; Bressi et al., 1996). In particular, as reported by the authors, the goodness-of-fit was evaluated using four criteria recommended by Cole (1987) and Marsh et al. (1988) viz., goodness-of-fit (GFI) ≥ 0.85; adjusted goodness-of-fit (AGFI) ≥ O.BO; the root-mean-square residual (RMSR) ≤0.10; and the Tucker-Lewis index (TLI) ≥ 0.80. For the normal adult sample, the (GFI) (0.88), the (AGFI) (0.84), RMSR (0.07), and TLI (0.80) all met the criteria standards, thus indicating adequacy of fit. Similar results were obtained with the clinical out-patient sample, with the GFI (0.95), AGFI (0.93) RMSR (0.05), and TLI (0.90) all meeting the criteria standards.

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 the 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 and in absence of specific cues. Accuracy and reaction times (RT) (using an electronic chronometer) were recorded. The administration of both questionnaire and pictures was done in 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*

We first used the two tailed t-test to compare the TAS-20 scores of our heroin addicts vs. control participants. Data including group and emotion as main factors were entered in a repeated-measures ANOVA to detect any between group difference with respect to the examined variables (Accuracy and RTs). Following this, we performed a hierarchical multivariate regression analysis using alexithymia (i.e., the TAS-20 score) as a predictor and emotional recognition performance (i.e., the overall average for both RTs and accuracy) as an outcome, controlling for the age of participants and the years of exposure to heroin. Finally, we performed a Pearson correlation analysis to investigate whether the exposure to heroin predicts alexithymia severity.

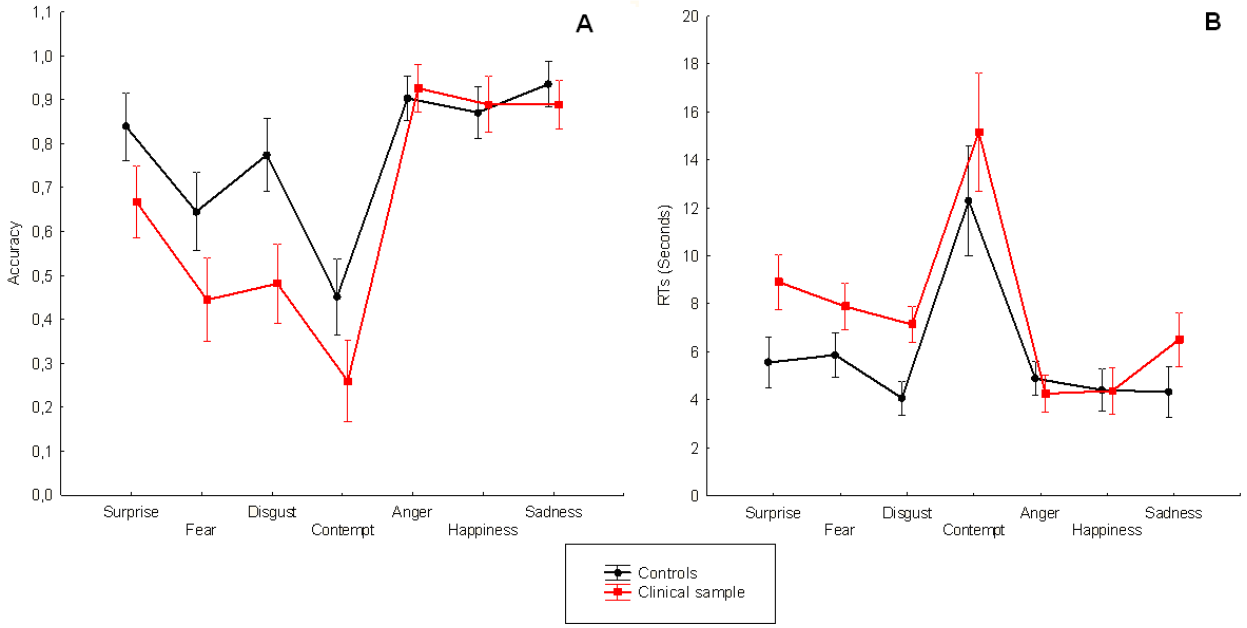
For all tests, the level of statistical significance was set at $p < 0.05$. Data analyses were performed using the Statistica software, version 8.0, StatSoft, Inc., Tulsa USA and IBM SPSS Statistics 20.

166

167 **Results**

168 *Alexithymia index*: As expected, we detected a significant between groups difference (t=4.36,
169 p<0.001) comparing TAS-20 scores of addicts (M=57.6 ± 16.7 SD) with respect to controls
170 (M=41.83 ± 10.5 SD). This shows that control participants are, on the average, not affected by
171 alexithymia (i.e., TAS-20 score ≤ 50), while addicts participants can be classified in the
172 borderline category with respect to the alexithymia index (i.e., TAS-20 score > 50 and < 60). No
173 gender difference is reported in both groups with respect to the TAS-20 scores (p>0.131).
174 Further analyses show significant difference between the three subscales, in both the clinical
175 [F(2,52)=18.52, p<0.001] and the control [F(2,52)=19.49, p<0.001] samples. In particular, we
176 documented a lower score in the DIF sub-scale, compared to the DDF (p<0.001) and the EOT
177 (p<0.001) scales in the clinical sample; Moreover, we documented higher scores in the EOT sub-
178 scale, compared to the DIF (p<0.001) and DDF (p<0.001) subscales of the control sample.
179 *Emotions recognition accuracy:* The repeated measure ANOVA detected a significant main
180 effect for the Group factor [F(1,60)=5.68, p=0.021], documenting a lower accuracy (i.e.,
181 proportion of correct responses) for the clinical sample (M=0.650 ± 0.037) in detecting
182 emotional stimuli compared to the control sample (M=0.774 ± 0.035). We also detected a
183 significant main effect of the Emotion factor [F(6,354)=18.0, p< 0.001]. However, the Group x
184 Emotion interaction term was not significant [F(6,354)=1.47, p=0.189]. No gender difference
185 was reported in emotion accuracy (p=0.851). The figure 1A shows details concerning the
186 participants' performance with respect to the accuracy in the detection of the seven emotions.
187 *Emotion recognition reaction times (RTs):* We detected a significant main effect for the Group
188 factor [F(1,55)=4.85, p=0.032], documenting higher RTs for the clinical sample (M=7.74 ±

189 0.608) in detecting emotional stimuli compared to the control sample (M=5.90 ± 0.567). In
190 similar fashion, we documented a significant main effect for the Emotion factor [F(6,156)=14.7,
191 p<0.001]. In contrast, no significant difference has been reported for the Group x Emotion
192 interaction term [F(6,156)=0.86, p=0.522]. The figure 1B shows details concerning the
193 participants' performance with respect the RTs in the detection of the seven emotions. No gender
194 difference is reported in emotion RTs (p=0.639)




195

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

*Hierarchical multivariate regression analysis:* With respect to the RTs variable, the initial analysis (model 1, i.e. including the age and the years of exposure to heroin as predictors) provides significant results [$F(2,57)=4.97$, $p=0.010$], with no effect of age on performance ($p=0.153$), while the years of exposure to heroin was significant ($p=0.036$). This model explain 15% of the variance. The inclusion of the alexithymia (TAS-20 score) variable as predictor (i.e. model 2, including age, years of exposure to heroin, alexithymia) cancels the effect of exposure to heroin ($p=0.420$), while the effect of the alexithymia variable was significant ($p=0.048$). This model explains 21% of the variance. With respect to accuracy parameters, both the model 1 [$F(2,57)=2.68$, $p=0.077$] and the model 2 [$F(2,57)=2.40$, $p=0.078$] were not significant.

## Discussion

Several studies (Craparo, 2014; Craparo et al., 2014a; Faraci et al., 2013; Torrado, Ouakinin & Bacelar-Nicolau, 2013; Craparo et al., 2014b; Craparo et al., 2014c) have linked alexithymia to addiction. Moreover**,** alexithymia has been associated with deficits in emotion recognition performance (e.g., see Taylor & Bagby, 2013). However, the literature documents contrasting results while examining emotion recognition performance in addicts, with evidence of both lower (e.g., Kornreich et al., 2003) and higher (e.g., Martin et al., 2006; Zhou et al., 2012) accuracy in this population. Nevertheless, no research has directly investigated the link between alexithymia 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 reported a similar pattern of results, whilst appearing to contrast with the study of Zhou et al. (2012) who documented better

performance in the recognition of negative emotions and also with the study of Martin et al. (2006), who reporting higher accuracy in disgust recognition. However, our data corroborates the results of Zhou et al. (2012), documenting slower RTs of heroin addicts in the overall emotion recognition, although only for the recognition of the expressions of negative emotions.

A novel result emerging from the hierarchical multivariate regression analysis, which fits with our main research hypothesis, is that alexithymia explains the between groups difference with respect to the RTs. This suggests that the poor performance of heroin addicts documented in our study can be explained, at least in part, by referring to their alexithymia traits. This is also in agreement with the research on somatoform disorder patients (Pedrosa Gil et al., 2009) and on Asperger syndrome (Kätsyri et al., 2008). Finally, we detected a positive correlation trend between years of exposure to heroin and TAS-20 scores, suggesting that the progressive use of this drug might increase alexithymia severity.

The slower performance in emotion recognition, as reported in our work, which depends on alexithymia, might originate from the effect of heroin exposure to the neural circuits that appear to be critical in emotion processing, 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) of functional dysregulation of these regions in heroin abusers. Interestingly, these neural regions have been reported to be impaired in people with alexithymia (Berthoz et al., 2002; Mantani et al., 2005). Therefore, according to our correlation analysis, one could hypothesize that the long term exposure to heroin might at least exacerbate alexithymia, resulting in this effect on the neural system.

Alexithymia has been well documented across different disorders, including autism and eating disorders. This may explain, at least in part, the emotional difficulties across these populations.

249 This leads to speculation that alexithymia intervention programs may lead to improvements in
250 social and emotional abilities across a wide range of clinical conditions.
251 Future works investigating emotion processing in addiction might expand the current
252 investigation by exploring the links between alexithymia, psychopathic traits, withdrawal
253 symptoms and emotion recognition.
254

255 **Limitations**

256 Several limitations should be mentioned with respect to the current study. Firstly, the distribution
257 of alexithymia scores and the gender variable was not balanced between our two groups of
258 participants. The clinical sample has been reduced because four participants were consuming
259 both cocaine and heroin. Further limitations might be referred to the absence of information
260 about the years of education; the methadone dosage and the presence of psychopathic traits. In
261 similar fashion, we did not investigated psychopathological symptoms in relation to alexithymia.
262 Finally, RTs were detected by using a stopwatch rather than a computerized system.
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264 **References**

265 Adolphs R. 2002. Neural systems for recognizing emotion. *Current Opinion in Neurobiology* 12:
266 169-77 Review.
267 Bagby RM, Taylor GJ Parker JDA. 1994. The twenty-item Toronto Alexithymia Scale. II.
268 Convergent, discriminant, and concurrent validity. *Journal of Psychiatric Research* 38: 33-40.
269 Berthoz S, Artiges E, Van De Moortele PF, Poline JB, Rouquette S, Consoli SM, Martinot JL
270 2002. Effect of impaired recognition and expression of emotions on frontocingulate cortices: an
271 fMRI study of men with alexithymia. *American Journal of Psychiatry* 159: 961-7.

272 Blair RJ, Coles M. 2000. Expression recognition and behavioural problems in early adolescence.
273 *Cognitive Development* 15: 421–434.
274 Blair RJ, Morris JS, Frith CD, Perrett DI, Dolan RJ 1999. Dissociable neural responses to facial
275 expressions of sadness and anger. *Brain* 122: 883–893
276 Bressi, C., Taylor, G. J, Parker, J. D. A., Bressi, S., Brambilla, V., Aguglia, E., Allegranti, S.,
277 Bongiorno, A., Giberti, F., Bucca, M., Todarello, O., Callegari, C., Vender, S., Gala, C.,
278 Invernizzi, G. (1996), "Cross validation of the factor structure of the 20-Item Toronto
279 Alexithymia Scale: an Italian multicenter study", *Journal of Psychosomatic Research*, 41, pp.
280 551-559.
281 Caretti V. In press. *Addictive Behav Questionn (ABQ*). Hogrefe. firenze.
282 Craparo G. 2014. The role of dissociation, affect dysregulation, and developmental trauma in
283 sexual addiction. *Clinical Neuropsychiatry* 11: 86-90.
284 Craparo G, Ardino V, Gori A, Caretti V. 2014a. The Relationships between Early Trauma,
285 Dissociation, and Alexithymia in Alcohol Addiction. *Psychiatric Investigation* 11: 330-335.
286 Craparo G, Gori A, Mazzola E, Petruccelli I, Pellerone M, Rotondo G. 2014b. Posttraumatic
287 stress symptoms, dissociation, and alexithymia in an Italian sample of flood victims.
288 *Neuropsychiatric Diseases Treatment* 10: 2281-2284. doi: 10.2147/NDT.S74317
289 Craparo G, Gori A, Petruccelli I, Cannella V, Simonelli, C. 2014. Intimate Partner Violence:
290 Relationships Between Alexithymia, Depression, Attachment Styles, and Coping Strategies of
291 Battered Women. *Journal of Sexual Medicine* 11: 1484-1494. doi: 10.1111/jsm.12505. Epub
292 2014 Mar 13
293 De Bernardis D, D'Albenzio A, Gambi F, Sepede G, Valchera A, Conti CM, Fulcheri M, Cavuto
294 M, Ortolani C, Salerno RM, Serroni N, Ferro FM. 2009. Alexithymia and Its Relationships

295 with Dissociative Experiences and Internet Addiction in a Nonclinical Sample. *Cyber*
296 *Psychological Behavior* 12: 67-69.

297 Di Chiara G, Tanda G, Bassareo V, Pontieri F, Acquas E, Fenu S, Cadoni C, Carboni E. 1999.
298 Drug addiction as a disorder of associative learning. Role of nucleus accumbens
299 shell/extended amygdala dopamine. *Annals of the New York Academic Science* 877: 461-485.

300 Ekman P, Friesen W, Hager JC 1978. *Facial Action Coding System Investigator's Guide*. 1978
301 Palo Alto: Consulting Psychol Press.

302 Faraci P, Craparo G, Messina R, Severino S. 2013. Internet Addiction Test (IAT): which is the
303 best factorial solution? *Journal of Medical Internet Research* 15: e225. doi:
304 10.2196/jmir.2935.

305 Farges F, Corcos M, Speranza M, Loas G, Perez-Diaz F, Venisse JL Jeammet, P. 2014.
306 Alexithymia, depression and drug addiction. *Encephale* 30: 201-11.

307 Gil FP, Ridout N, Kessler H, Neuffer M, Schoechlin C, Traue HC, Nickel M. 2006. Facial
308 Emotion Recognition and Alexithymia in Adults with Somatoform Disorders. *Depression and*
309 *Anxiety* 26: E26-E33.

310 Goldin PR, Hutcherson CA, Ochsner KN, Glover GH, Gabrieli JD, Gross JJ 2005. The neural
311 bases of amusement and sadness: A comparison of block contrast and subject-specific
312 emotion intensity regression approaches. *Neuroimage* 27: 26–36.

313 Gori A, Craparo G, Sareri GI, Caretti V, Giannini M, Meringolo P. 2014. Antisocial and
314 psychopathic personalities in a sample of addicted subjects: Differences in psychological
315 resourced, symptoms, alexithymia and impulsivity. *Comprehensive Psychiatry* 55: 1580-
316 1586. doi: 10.1016/j.comppsych.2014.05.023.

317 Grynberg D, Chang B, Corneille O, Maurage P, Vermeulen N, Berthoz S, Luminet O. (2012).
318 Alexithymia and the processing of emotional facial expressions (EFEs): systematic review,
319 unanswered questions and further perspectives. *PLoS One* 7: e42429. doi:
320 10.1371/journal.pone.0042429.

321 Kätsyri J, Saalasti S, Tiippana K, von Wendt L, Sams M (2008) Impaired recognition of facial
322 emotions from low-spatial frequencies in Asperger syndrome. *Neuropsychologia* 46: 1888–
323 1897. doi: 10.1016/j.neuropsychologia.2008.01.005

Kornreich C, Philippot P, Foisy ML, Blairy S, Raynaud E, Dan B, Hess U, Noël X, Pelc I, Verbanck P. 2002. Impaired emotional facial expression recognition is associated with interpersonal problems in alcoholism. *Alcohol Alcohol* 37: 394-400.

Kornreich C, Foisy ML, Philippot P, Dan B, Tecco J, Noël X, Hess U, Pelc I, Verbanck P. 2003. Impaired emotional facial expression recognition in alcoholics, opiate dependence subjects, methadone maintained subjects and mixed alcohol-opiate antecedents subjects compared with normal controls. *Psychiatry* Res*earch* 3: 251-260.

Kugel H, Eichmann M, Dannlowski U, Ohrmann P, Bauer J, Arolt V, Heindel W, Suslow T. 2008. Alexithymic features and automatic amygdala reactivity to facial emotion. *Neuroscience Letters* 435: 40-4.

Kun B, Demetrovics Z. 2010. Emotional intelligence and addictions: a systematic review. *Substance Use & Misuse* 45: 1131-1160

Lander GC, Lutz-Zois CJ, Rye MS, Goodnight JA. 2012. The differential association between alexithymia and primary versus secondary psychopathy. *Personality and Individual Differences*, 52: 45–50

Li Q, Wang Y, Zhang Y, Li W, Zhu J, Zheng Y, Chen J, Zhao L, Zhou Z, Liu Y, Wang W, Tian J 2013. Assessing cue-induced brain response as a function of abstinence duration in heroin-dependent individuals: an event-related fMRI study. *PLoS One* 8: e62911. doi: 10.1371/journal.pone.0062911.

Liu J, Qin W, Yuan K, Li J, Wang W, Li Q, Wang Y, Sun J, von Deneen KM, Liu Y, Tian J. 2011. Interaction between dysfunctional connectivity at rest and heroin cues induced brain responses in male abstinent heroin-dependent individuals. *PLoS One* 6: e23098. doi: 10.1371/journal.pone.0023098.

Mantani T, Okamoto Y, Shirao N, Okada G, Yamawaki S 2005. Reduced activation of posterior cingulate cortex during imagery in subjects with high degrees of alexithymia: a functional magnetic resonance imaging study. *Biological Psychiatry*, 57: 982-990. 10.1016/j.biopsych.2005.01.047.

Martin L, Clair J, Davis P, O'Ryan D, Hoshi R, Curran HV. 2006. Enhanced recognition of facial expressions of disgust in opiate users receiving maintenance treatment. *Addiction* 101: 1598-1605.

354 Naqvi NH, Bechara A. 2009. The hidden island of addiction: the insula. *Trends in Neuroscience*
355 1: 56-67.
356 Niedenthal PM, Barsalou LW, Winkielman P, Krauth-Gruber S, Ric F. 2005. Embodiment in
357 attitudes, social perception, and emotion. *Personality Social Psychological Review* 3: 184-
358 211.
359 Pedrosa Gil F, Ridout N, Kessler H, Neuffer M, Schoechlin C, Traue HC, Nickel M. 2009. Facial
360 emotion recognition and alexithymia in adults with somatoform disorders. Depression and
361 Anxiety 26:E26-33.
362 Porcelli P, Affatati V, Bellomo A, De Carne M, Todarello O, Taylor GJ. 2004. Alexithymia and
363 psychopathology in patients with psychiatric and functional gastrointestinal disorders.
364 *Psychoterapy and Psychosomatic* 73: 84-91.
365 PrKachin GC, Casey C, PrKachin KM. 2009. Alexithymia and perception of facial expressions
366 of emotion. *Personality and Individual Differences* 46: 412-417.
367 Rybakowski J, Ziółkowski M, Zasadzka T, Brzeziński R. 1998.
368 High prevalence of alexithymia in male patients with alcohol dependence. *Drug and*
369 *Alcohol Dependence* 21: 133-6.
370 Savov S, Atanassov N 2013. Deficits of affect mentalization in patients with drug addiction:
371 theoretical and clinical aspects. *ISRN Addict*. :250751. doi: 10.1155/2013/250751.
372 Sifneos PE. 1973. The prevalence of 'alexithymic' characteristics in psychosomatic patients.
373 *Psychotherapy and Psychosomatic* 22: 255-262.
374 Stevens D, Charman T, Blair RJ 2001. Recognition of emotion in facial expressions and vocal
375 tones in children with psychopathic tendencies. *Journal of General Psychology* 162: 201–211.
376 Taylor GJ, Bagby RM. 2013. Psychoanalysis and Empirical Research: The Example of
377 Alexithymia. *Journal of the American Psychiatric Association* 61: 99-133. doi:
378 10.1177/0003065112474066
379 Taylor, G., Bagby, R. and Parker, J. 1997. The development and regulation of affects.
380 in Disorders of Affect Regulation: Alexithymia in Medical and Psychiatric Illness, G. Taylor,
381 R. Bagby, and J. Parker, Eds., Cambridge University Press, Cambridge, UK.
382 Torrado MV, Ouakinin SS, Bacelar-Nicolau L. 2013. Alexithymia, Emotional Awareness and
383 Perceived Dysfunctional Parental Behaviors in Heroin Dependents. *International Journal of*
384 *Mental Health Addiction* 11: 6.

385 Vassileva J, Petkova P, Georgiev S, Martin EM, Tersiyski R, Raycheva M, Velinov V, Marinov
386 P. 2007. Impaired decision-making in psychopathic heroin addicts. *Drug and Alcohol*
387 *Dependence* 86:287–289
388 Vicario CM, Komeilipoor N, Cesari P, Rafal RD, Nitsche MA. 2014. Enhanced corticobulbar
389 excitability in chronic smokers during visual exposure to cigarette smoking cues. *The Journal*
390 *of Psychiatry and Neuroscience* 39: 232-8.
391 Vicario CM, Newman A 2013. Emotions affect the recognition of hand gestures. *Frontiers in*
392 *Human Neuroscience* 7, 906. doi: 10.3389/fnhum.2013.00906
393 Zhou Y, Zhu H, Jin X, Li X, Zhang M, Zhang F, Shen M. 2012.
394 Biased attention towards negative schematic expression in abstinent heroin abusers. *Journal*
395 *of Behavioral Theraphy and Experimental Psychiatry* 43: 705-10. doi: 10.1016/j.jbtep.2011.1