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## Joint effect of alexithymia and mood on the categorization of nonverbal emotional vocalizations

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### ABSTRACT

The role of stable factors, such as alexithymia (i.e., difficulties identifying and expressing feelings, externally oriented cognitive style), or temporary factors, such as affective states (mood), on emotion perception has been widely investigated in the literature. However, little is known about the separate or joint effect of the alexithymia level and affective states (positive affectivity, negative affectivity) on the recognition of nonverbal emotional vocalizations (NEV) (e.g., laughs, cries, or sighs). In this study, participants had to categorize NEV communicating 10 emotions by selecting the correct verbal emotional label. Results show that the level of alexithymia is negatively correlated to the capacity to accurately categorize negative vocalizations, and more particularly sad NEV. On the other hand, negative affectivity appeared negatively correlated with the ability to accurately categorize NEV in general, and negative vocalizations in particular. After splitting the results by the alexithymia level (high vs. low scorers), significant associations between mood and accuracy rates were found in the group of high alexithymia scorers only. These findings support the idea that alexithymic features act across sensory modalities and suggest a mood-interference effect that would be stronger in those individuals.

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### 1. Introduction

One of the most predominant activities we perform in our daily lives, as social beings, is communication, in which emotions are a crucial component. However, the ability to process and recognize emotional signals can vary greatly from one person to another, or even from one moment to another. In other words, the capability to identify our own and others' emotional states can be altered in a stable manner (e.g., by a personality trait) or temporarily (e.g., by a mood state).

Among stable factors that can impair emotional functioning, alexithymic traits have generated a lot of interest over the last decades. Alexithymia is a multifaceted construct that includes difficulties with identifying feelings and distinguishing between

feelings and the bodily sensations of emotional arousal, difficulties in describing feelings to others, and a cognitive style that is literal, utilitarian, and externally oriented (Taylor et al., 1997). These cognitive and affective characteristics were initially observed among patients with classic psychosomatic diseases and were later seen in other psychiatric patients (Taylor et al., 1997). Moreover, alexithymia has to be understood as a disability (i.e., on a continuum, even in the general population as a trait variable) in emotional processing, and as described recently, this view receives increasing evidence from laboratory research (Lumley et al., 2007). Indeed, a growing body of empirical work about the cognitive deficits in the processing of emotional information in high alexithymia scorers (HA) is now emerging. Up to now, the observed impairments in emotion recognition were mainly found using negative emotions (e.g., anger and sadness). Most previous studies have involved visual stimuli like emotional facial expressions (EFE), pictures, videos or words (Berthoz et al., 2002; Franz et al., 2004; Meriau et al., 2006, 2009; Nielson and Meltzer, 2009; Pollatos and Gramann, 2011; Ridout et al., 2010; Vermeulen and Luminet, 2009; Vermeulen et al., 2006, 2008). For example, HA have been found to be less efficient in detecting fearful, sad and

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angry faces, and tend to rate fearful faces as less intense than individuals with a lower level of alexithymia (LA) (Prkachin et al., 2009). Despite the importance of emotions conveyed through the auditory channel in social interactions, few studies have examined their processing in alexithymia (Goerlich et al., 2012, 2011, 2013; Schafer et al., 2007; Swart et al., 2009; Vermeulen et al., 2010). Some of these studies linked deficits in the identification of affective prosody to a high level of alexithymia. Among these studies, alexithymia was found to modulate electrophysiological responses to emotional information from speech prosody, suggesting an automatic affective processing deficit in HA (Goerlich et al., 2012, 2011) associated with reduced activation in the right superior temporal gyrus and amygdala during affective prosody categorization (Goerlich et al., 2013). Furthermore, HA tended to respond slower than LA when they had to categorize an emotion conveyed by the tone of a spoken sentence (with an incongruent emotional content) (Swart et al., 2009), and HA made more errors in identifying disgust expressed through nonsense syllables spoken in an emotional intonation (Goerlich et al., 2012). However, to date, only one study (Heaton et al., 2012) has investigated these alexithymic features using nonverbal emotional vocalizations (NEV) (e.g., laughter, sighs, wails, cries, and groans) (see e.g., Sauter and Eimer, 2010; Sauter et al., 2010; Sauter and Scott, 2007; Scott et al., 1997) and found a reduced ability to categorize NEV (i.e., happy, sad, anger, surprise, fear and disgust) associated to the level of alexithymia. Nonetheless, studies with this type of auditory stimulus would hold a substantial ecological validity, since NEV, along with emotional facial expressions, are commonly encountered in social interactions (i.e., to communicate emotional states) and are free of verbal bias (i.e., “only” emotional). Furthermore, most previous studies either focused exclusively on negative emotions or included one positive emotion, like happiness (i.e., a smiling face). As such, the use of NEV enables the examination of how alexithymia influences emotion processing with a variety of negative (e.g., fear, disgust, anger) and positive (e.g., sensual pleasure, relief, amusement) stimuli, representing different discrete emotional states across the valence spectrum.

Aside from trait-based deficits, individuals may encounter difficulties in the identification of others' emotions only in particular contexts. Among the factors composing such conditions are transient affective states. Indeed, more generally, the way attention is allocated seems to be influenced by mood (Jefferies et al., 2008; Vermeulen, 2010). More specifically, in studies on non-clinical populations, mood or state affect has consistently proved to influence the way emotional information is processed (Bouhuys, 1995; Chepenik et al., 2007; Egidi and Nusbaum, 2012; Herr et al., 2012; Lee et al., 2008; Lim et al., 2012; Niedenthal et al., 2000, 1997; Schmid and Schmid Mast, 2010). Most studies report a mood-congruency effect, acting as a filter in the perception of emotional stimuli and biasing the assessment congruently with the mood state. For example, studies using ambiguous emotional facial expressions (EFE) have showed that individuals who had been induced to be in a sad mood had a biased perception toward sadness or negative emotions in comparison to individuals in a happy or neutral mood condition (Bouhuys, 1995; Lee et al., 2008). Moreover, in a study using video clips of blended EFE (sequences of faces from emotionally intense to neutral), Niedenthal et al. (2000) found that mood-congruent emotional expressions were perceived to persist longer than the mood-incongruent ones. This congruency bias induced by mood states has been found at the neurophysiological level for auditory stimuli as well. Egidi and Nusbaum (2012) analyzed EEG recording of N400 peaks (indicators of effort of information integration) during the processing of sentences ending with emotional content. Their results showed that individuals reacted, according to their mood, to the incongruence of the stimuli by demonstrating larger peaks (e.g., for a

negative ending while in a happy mood). In contradiction with the mood-congruency effect, stated both in behavioral and neurophysiological studies, Chepenik et al. (2007) found a *general impairment*, during an EFE categorization task (i.e., anger, fear, sad, happy, neutral) when individuals were induced to be in a sad mood (vs. neutral). As emphasized by Schmid and Schmid Mast (2010), this inconsistency may be due to a methodological difference. Indeed, Chepenik and her colleagues used a categorization task with discrete emotions as categories (vs. intensity judgments or valence categorization in other studies), requiring more complex and analytical processing, thus limiting comparisons with the other studies. Overall however, these studies appear relatively homogenous in their methodologies. Firstly, mood states were generally induced and not merely measured, possibly reducing the ecological validity of these studies (i.e., not based on naturally occurring mood states). Secondly, the type of induced mood was preferentially sadness instead of other negative emotional states (e.g., anxiety, anger), which might influence emotional processing differently. And thirdly, the stimuli used were almost exclusively visual (except for spoken sentences in Egidi and Nusbaum, 2012), leaving unexplored the effect of mood on other types of emotional stimuli (e.g., NEV). This narrowness in the literature about mood effects on emotion perception appeals for new investigations to address these gaps.

Mood effects on emotion perception might also be influenced by personal lineaments. Indeed interactions between personality traits and mood in affective information processing have been reported in several studies (Rusting, 1998). For example, in an affective word evaluation task (i.e., emotional vs. neutral), Tamir and Robinson (2004) found an interaction between neuroticism and negative mood. Indeed, individuals with high neuroticism and negative affectivity showed greater performances (faster reaction times) than high neuroticism scorers who were low in negative affectivity, whereas the opposite pattern was found for individuals low in neuroticism. Despite the fact that mood states are related to alexithymia (i.e., more negative affect, less positive affect) (De Gucht et al., 2004; Parker et al., 2005; Vermeulen et al., 2007), to our knowledge, no study on the interaction between alexithymia and state affect during emotion processing has been conducted yet.

In this study, we examine whether alexithymia level and current mood state (subdivided into positive and negative affectivity) are linked to the ability to accurately identify nonverbal vocalizations of emotions (NEV). Similar to the impairments seen in the literature on the recognition of emotions from faces and voices, we hypothesized that alexithymic features should be associated with a reduced capacity to accurately recognize emotions from vocalizations, and particularly negative ones. We also expected to find a modulation of the performance on the NEV categorization task in relation to the scores on the mood scale, with a general impairment related to a high level of negative affectivity. Finally, we expected to find this pattern of mood effect enhanced in high alexithymia scorers (i.e., HA vs. LA). With the use of nonverbal auditory stimuli representing a large panel of negative and positive emotions, and of validated measures of alexithymia and general mood state, this study aimed at testing claims from the literature in a broadened experimental setting.

## 2. Methods

### 2.1. Participants and materials

Fifty-seven French speaking undergraduate students (from different university departments) or volunteers (78.9% female, age:  $M=24.23$ ;  $S.D.=8.26$ ) were tested individually. Task and stimuli were taken from Sauter et al. (2010) and consisted of nonverbal vocal expressions of 10 emotions (i.e., achievement/triumph,

amusement, anger, contentment, disgust, fear, sensual pleasure, relief, sadness, and surprise) produced by two male and two female speakers (e.g., laughter, sigh, wail, cry, and groan). A set of 100 vocalizations, representing 10 tokens for each category (five women and five men), was used. The sounds were down-sampled to 44.1 kHz, converted to mono and scaled to a peak amplitude of 0.95 Pa. Stimuli were presented using E-Prime 1.1.4.1 on a PC. Participants wore headphones and read computer-presented instructions.

## 2.2. Measures

### 2.2.1. Toronto-Alexithymia Scale

A validated French translation of the Toronto-Alexithymia Scale (TAS-20) (Loas et al., 1997) was used to measure the level of alexithymia of the participants. The TAS-20 is the most widely used measure of the alexithymia construct (Bagby et al., 1994a, 1994b). It comprises 20 items rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The items load on three factors – Difficulty Identifying Emotions (e.g., “I am often confused about what emotion I am feeling”), Difficulty Describing Emotions (e.g., “It is difficult for me to find the right words for my feelings”) and Externally Oriented Thinking (e.g., “I prefer talking to people about their daily activities rather than their feelings”). The French version has good reliability and validity with an internal consistency of 0.73 for the total score (Loas et al., 1996). Total scores range from 20 to 100 points.

### 2.2.2. Positive Affectivity Negative Affectivity Schedule

In order to assess the participants' mood, we used a French version of the Positive Affectivity Negative Affectivity Schedule (PANAS) (Gaudreau et al., 2006), as it is the most widely used scale for the assessment of current affective states. The PANAS is a 20-item scale which assesses the level of positive and negative affective states that the participants feel at a particular moment (Watson et al., 1988). It consists of 10 positive (e.g., interested) and 10 negative (e.g., guilty) affective states rated on a 5-point Likert-type scale ranging from 1 (not at all) to 5 (extremely). Possible scores range from 10 to 50 for each scale (Positive Affect: PA and Negative Affect: NA).

## 2.3. Procedure

Each stimulus was displayed once in random order through headphones. Following the procedure used by Sauter et al. (2010), participants were asked to categorize each of the 100 emotional sounds by pressing one of 10 number keys (0–9), corresponding to the 10 emotion labels of achievement, amusement, anger, contentment, disgust, fear, sensual pleasure, relief, sadness, and surprise (translated respectively as réussite, joie, colère, satisfaction, dégoût, peur, plaisir, soulagement, tristesse and surprise) that were displayed on the screen until a response was given. A sheet of paper was provided next to the computer, which gave an example of a situation illustrating each emotion label (e.g., Disgust: “You put your hands in vomit”). Participants were asked to answer as fast and accurately as possible. After the categorization task, all the participants completed the TAS-20 and PANAS questionnaires.

## 2.4. Statistical data analyses

The data from the complete set of participants ( $N=57$ ) were analyzed in SPSS version 19.0 (Armonk, NY: IBM Corp.). We first examined whether participants were able to accurately categorize the vocalizations compared to the chance level (10%). The mean accuracy rate was of 75.1% and one sample tests showed that the accuracy rates for the 10 categories of vocalizations were all higher than the chance level of 10% (all:  $p_s < 0.001$ ). As can be seen in Table 1, the mean accuracy rates per emotion category varied substantially between 0.37 and 0.94. Although participants from this study were non-clinical volunteers or students, the distribution of alexithymia scores did not differ from a Gaussian distribution ( $KS(57)=0.11$ ;  $p > 0.05$ ) and were broad as shown by the range of scores for the TAS-20 total score (25–74) with a mean score of 45.89 (S.D.=11.07). The positive affectivity subscale (PA) did not differ from a Gaussian distribution ( $KS(57)=0.09$ ;  $p > 0.05$ ), with a mean score of 29.92 (S.D.=8.62), whereas the negative affectivity subscale (NA) was right-skewed (Skew=0.78;  $SE=0.31$ ) with a mean score of 17.84 (S.D.=7.53), consistent with the literature (Watson et al., 1988). Since we consider these independent variables as continuous we performed correlational analyses with the NEV recognition accuracy scores. In order to deal with the non-normality of most of the accuracy scores per emotion category ( $KS(57)$ :  $p_s < 0.05$ ), we performed nonparametric Spearman rank-order correlations (i.e., nonparametric measure of associations based on the rank of the data value rather than on the observed data) between all variables. Furthermore, because mood states are related to alexithymia (Vermeulen et al., 2007), we performed Spearman partial rank-order correlations between the TAS scores and accuracy rates, controlling for the mood states of the participants (i.e., PA, NA). In order to investigate possible interactions between alexithymia and mood states in NEV processing, we looked at the Spearman correlations between state affects and the accuracy scores by splitting the results into two groups, based on the alexithymia level of the participants. The

median value of 44 was used to separate the low alexithymia group ( $N=29$ ;  $M=36.93$ ; S.D.=5.41) from the high alexithymia group ( $N=28$ ;  $M=55.18$ ; S.D.=6.94). For all results, two-tailed tests were used.

## 3. Results

### 3.1. Alexithymia and mood

The correlational analyses showed several links between the levels of alexithymia, negative and positive affectivity, and the ability to accurately categorize emotional non-verbal vocalizations. Regarding the association between alexithymia and mood states, the Spearman correlations showed that the TAS-20 total score was negatively correlated to the Positive Affectivity score (PA) ( $r_s = -0.32$ ;  $p < 0.05$ ), and that the DIF alexithymia factor (i.e., difficulty identifying feelings (DIF)) was positively correlated to the Negative Affectivity score (NA) ( $r_s = 0.32$ ;  $p < 0.05$ ), consistent with previous observations (De Gucht et al., 2004; Parker et al., 2005; Vermeulen et al., 2007).

### 3.2. Alexithymia and accuracy rates

Concerning relations between alexithymia and accuracy rates (see Table 2), the Spearman correlations demonstrated that the TAS-20 alexithymia total score still negatively correlated with the ability to identify contentment and negative vocalizations (a composite score from disgust, anger, fear, and sadness), respectively,  $r_s = -0.27$  ( $p < 0.05$ ) and  $r_s = -0.28$  ( $p < 0.05$ ), even after controlling for the positive and negative affective states of the participants. Furthermore, the DDF alexithymia factor (i.e., difficulty describing feelings (DDF)) still correlated negatively with the capacity to identify sadness,  $r_s = -0.30$  ( $p < 0.05$ ) and contentment marginally,  $r_s = -0.26$  ( $p = 0.05$ ).

### 3.3. Mood and accuracy rates

As for relations between mood and accuracy rates (see Table 3), the Spearman correlations performed on the complete set of the participants showed that NA negatively correlated with the capacity to categorize negative NEV but also NEV in general, respectively  $r_s = -0.36$  ( $p < 0.01$ ) and  $r_s = -0.30$  ( $p < 0.05$ ). Looking at the discrete emotion categories, NA negatively correlated with the recognition rates of surprise ( $r_s = -0.28$ ;  $p < 0.05$ ), disgust ( $r_s = -0.26$ ;  $p < 0.05$ ), anger ( $r_s = -0.27$ ;  $p < 0.05$ ) and particularly sadness ( $r_s = -0.44$ ;  $p < 0.01$ ). When looking at PA, no significant correlations with accuracy rates were observed.

**Table 1**

Means and standard deviations of accuracy rates for each emotional category for the overall sample.

	M	S.D.
Achievement	0.59	0.27
Amusement	0.81	0.22
Contentment	0.37	0.19
Relief	0.93	0.09
Pleasure	0.59	0.23
Surprise	0.79	0.13
Disgust	0.94	0.07
Anger	0.85	0.13
Sadness	0.74	0.14
Fear	0.88	0.16
Positive emotions	0.66	0.11
Negative emotions	0.85	0.07
All emotions	0.75	0.06

### 3.4. Alexithymia, mood and accuracy rates

After splitting the data by the alexithymia level, significant associations between state affects and accuracy rates were found in the high alexithymia group only. More precisely, in this group, NA negatively correlated with the capacity to categorize negative NEV ( $r_s = -0.44$ ;  $p < 0.05$ ), and more particularly sad NEV ( $r_s = -0.42$ ;  $p < 0.05$ ), anger marginally ( $r_s = -0.36$ ;  $p = 0.05$ ), as well as NEV expressing surprise ( $r_s = -0.49$ ;  $p < 0.01$ ). Finally, in the high alexithymia group as well, only the ability to accurately categorize NEV expressing contentment was significantly correlated to PA ( $r_s = -0.40$ ;  $p < 0.05$ ).

These correlational analyses clearly support the hypothesis of a link between mood and alexithymia in emotion processing, even though it does not allow any conclusion toward a causal relation.

## 4. Discussion

The main aim of the present study was to investigate whether the capacity to accurately identify non-verbal vocalizations of emotions may vary along with the level of alexithymia and measured mood states. Most importantly, the results showed that mood had an impact on performance, but was impeding only for individuals who scored high in alexithymia.

As alexithymic individuals are typically impaired in the recognition of emotions from visual and auditory material, we hypothesized that alexithymic features would be associated with a reduced capacity to accurately categorize emotions from nonverbal vocalizations. In line with the idea that alexithymia is related to particular difficulties with negative or unpleasant emotions (Berthoz et al., 2002; Kugel et al., 2008; Parker et al., 2005; Pollatos and Gramann, 2011; Prkachin et al., 2009), we found that a high total score on the alexithymia scale was associated with a poorer accuracy rate for the recognition of negative nonverbal vocalizations (taken as a composite mean score from disgust, anger, fear, and sadness), even after controlling for the role of the participants' mood states. More specifically, high scores on the TAS factor "difficulty describing feelings" were associated with greater difficulties in recognizing sadness. These results are consistent with the neurophysiological evidence of a decreased

attention to negative emotions in HA (Van der Velde et al., 2013). Unexpectedly however, we observed a significant negative correlation between the TAS total score and the capacity to recognize NEV expressing contentment. Nevertheless, neuroimaging studies on alexithymia have reported a deficit in positive emotion awareness in HA (Van der Velde et al., 2013). Overall, our findings are clearly in line with the literature on alexithymia, supporting the idea that high alexithymia scorers have a disability, a deficit or a deficiency in emotional processing (Heaton et al., 2012; Lumley et al., 2007). Furthermore our findings lend to the idea that this deficit may occur across different sensory modalities. Our exploratory results on NEV categorization support the implementation of

**Table 3**

Bivariate Spearman correlations between mood states and accuracy rates for each emotional category, for the overall sample and by alexithymia groups (low scorers and high scorers).

	All participants		LA		HA	
	PA	NA	PA	NA	PA	NA
Achievement	-0.10	-0.04	-0.11	-0.05	-0.12	-0.08
Amusement	0.11	0.05	-0.11	-0.02	0.08	0.05
Contentment	-0.08	-0.19	-0.00	-0.25	<b>-0.40*</b>	0.04
Relief	<b>0.24†</b>	0.08	0.23	0.01	0.23	0.23
Pleasure	0.03	-0.08	-0.21	0.03	0.15	-0.09
Surprise	-0.14	<b>-0.28*</b>	-0.15	-0.20	-0.12	<b>-0.49**</b>
Disgust	-0.17	<b>-0.26*</b>	-0.23	-0.30	-0.27	-0.15
Anger	-0.07	<b>-0.27*</b>	-0.22	-0.12	-0.09	<b>-0.36*</b>
Sadness	-0.02	<b>-0.44**</b>	-0.14	-0.26	-0.06	<b>-0.42*</b>
Fear	0.19	0.13	-0.15	0.09	0.14	0.26
Pos. emo.	-0.00	-0.10	-0.07	-0.09	-0.07	0.00
Neg. emo.	-0.04	<b>-0.36**</b>	-0.22	-0.15	-0.13	<b>-0.44*</b>
All emo.	-0.06	<b>-0.30*</b>	-0.17	-0.21	-0.16	-0.28

Note: LA=low alexithymia scorers ( $M$  TAS-tot > 44); HA=high alexithymia scorers ( $M$  TAS-tot  $\leq$  44). PA=positive affectivity score; NA=negative affectivity score. Pos. emo.=composite score of accuracy rates for achievement amusement, contentment, relief and pleasure. Neg. emo.=composite score of accuracy rates for disgust, anger, sadness and fear. All emo.=composite score of accuracy rates for all emotional categories.

†  $p < 0.1$ .  
 †\*  $p = 0.05$ .  
 \*  $p < 0.05$ .  
 \*\*  $p < 0.01$ .

**Table 2**

Bivariate and partial (control by PA and NA scores) Spearman correlations between alexithymia scores and accuracy rates for each emotional category.

	Bivariate $r_s$				Partial $r_s$ (by PA and NA)			
	DIF	DDF	EOT	TAS-tot	DIF	DDF	EOT	TAS-tot
Achievement	-0.03	0.06	-0.07	-0.01	-0.05	0.04	-0.09	-0.04
Amusement	-0.07	-0.04	0.03	-0.06	-0.06	-0.02	0.05	-0.04
Contentment	-0.19	<b>-0.25†*</b>	<b>-0.22†</b>	<b>-0.27*</b>	-0.16	<b>-0.26†*</b>	-0.21	<b>-0.27*</b>
Relief	-0.05	-0.12	-0.14	-0.14	-0.00	-0.06	-0.10	-0.08
Pleasure	-0.17	-0.02	-0.06	-0.10	-0.14	0.00	-0.03	-0.07
Surprise	-0.12	0.00	-0.02	-0.06	-0.06	0.00	0.00	-0.01
Disgust	-0.16	-0.08	-0.11	-0.17	-0.13	-0.09	-0.11	-0.17
Anger	<b>-0.28*</b>	-0.08	-0.06	-0.22	-0.22	-0.06	-0.01	-0.17
Sadness	<b>-0.25†*</b>	<b>-0.32*</b>	-0.19	<b>-0.32*</b>	-0.10	<b>-0.30*</b>	-0.10	-0.22
Fear	-0.12	-0.02	0.04	-0.10	-0.13	0.01	0.07	-0.08
Pos. emo.	-0.18	-0.09	-0.17	-0.18	-0.16	-0.08	-0.15	-0.17
Neg. emo.	<b>-0.33*</b>	<b>-0.23†</b>	-0.15	<b>-0.35**</b>	<b>-0.24†</b>	-0.21	-0.08	<b>-0.28*</b>
All emo.	<b>-0.30*</b>	-0.17	-0.18	<b>-0.28*</b>	<b>-0.23†</b>	-0.15	-0.14	<b>-0.23†</b>

Note: DIF=difficulty identifying feelings (TAS-20 factor 1); DDF=difficulty describing feelings (TAS-20 factor 2); EOT=externally oriented thinking (TAS-20 factor 3); TAS-tot=total score on the TAS-20 alexithymia scale. Pos. emo.=composite score of accuracy rates for achievement, amusement, contentment, relief and pleasure. Neg. emo.=composite score of accuracy rates for disgust, anger, sadness and fear. All emo.=composite score of accuracy rates for all emotional categories.

†  $p < 0.1$ .  
 †\*  $p = 0.05$ .  
 \*  $p < 0.05$ .  
 \*\*  $p < 0.01$ .

further cross-modal experiments (Goerlich et al., 2012, 2011; Vermeulen et al., 2010) to better understand the emotional “handicap” experienced in alexithymia within natural contexts.

Regarding our findings on mood states and NEV categorization performances, this study fits well with the existing literature but also yields novel suggestions. Among both psychopathological or healthy populations, mood effects on affective cognition are well established (for a review, see Elliott et al., 2011). Nonetheless, the negative relation we found between negative affectivity and the capacity to accurately categorize all NEV is facing two opposite results in the literature. Among the two studies with a similar categorization task (with EFE), one also found a general impeding effect of sad mood (induced by music and the reading of a script) (Chepenik et al., 2007) whereas the other did not find any effect of mood (induced by a sad or happy movie scene) (Schmid et al., 2011). These discrepancies may be due to differences in the mood induction method, which may have been unequal in efficacy and illustrate the need to measure the actual mood states of the participants in order to ensure the validity of associations we observe between emotion recognition performance and mood.

We also found an effect of negative affectivity on the recognition rates of negative NEV, more specifically sadness. Substantially, these findings bring new insights into the literature on the mood-congruency effect. Whereas findings support the fact that mood-congruent information is processed faster (Herr et al., 2012), longer (Niedenthal et al., 2000) and stronger (Lim et al., 2012), we found that mood-congruent emotional stimuli were more poorly processed at a qualitative level (i.e., analytical, higher order cognition, such as in a categorization task). Despite the fact that other studies found a facilitating effect of mood (e.g., in a lexical decision task) (see Niedenthal et al., 1997), we argue that a difference in the origin of the mood occurrence might allow for a reconciliation of both types of findings. Specifically, we suggest that when a negative mood state is occurring naturally (vs. induced by an experimental manipulation in the lab), the encountered negative emotional stimulations might be seen as threatening for the already impeded psychological state (vs. simply instigate enhanced attentional focus due to a negativity bias). Consequently, these undesired stimulations are cognitively avoided and therefore processed less thoroughly. In other words, when someone is in a bad mood, information from the environment that conveys negative feelings might be blocked from consciousness, in order to improve one's affective state. Such a mechanism would generally be protective and should be considered as a healthy regulatory process, however deleterious for congruent information processing. Nevertheless, this hypothetical “mood-interference effect” on emotion perception needs further empirical support.

Interestingly, our results showed an interaction between alexithymia and mood states in NEV identification. Indeed, our observations are in line with our expectations and bring new insights into the body of research on the emotion processing deficit in alexithymia. When looking at the associations between mood and task performances as a function of the level of alexithymia we found that HA, but not LA, show a pattern of correlation between their ability to accurately categorize NEV and their level of NA (for surprise, sadness and anger marginally) or PA (for contentment). In our view, these results on NA suggest that the negative mood-interference effect (i.e., avoidance of undesired, negative feelings), as mentioned above, might be stronger among HA, owing to a lack of emotional competence (e.g., affect (dys-) regulation) in comparison to LA (Taylor et al., 1997). This is consistent with a study of adolescents which found a moderate positive correlation between the level of alexithymia and the tendency to use an avoidance strategy to cope with negative experiences (e.g., emotions) (Venta et al., 2013). In the present

study, where most participants were women, we could hypothesize the role of the avoiding strategy as an underlying mechanism in the emotion processing deficit among HA with a relatively high NA. Indeed, since alexithymic women show a particularly high emotional arousability (Vorst and Bermond, 2001), very disturbing and aversive emotions (e.g., sadness, anger, and surprise) might be blocked from awareness in order to protect their psychological balance. All the more so if their psychological balance is already weakened by negative affectivity. Regarding the association between the level of PA and the capacity to identify NEV expressing contentment, we propose an explanation via another mechanism. As has been found with emotional faces (Hills et al., 2011), we argue that positive mood leads to less elaborate processing of emotional vocalizations. Consequently, particularly complex emotional states, such as contentment, might be more frequently misidentified as other similar emotional categories (e.g., amusement and pleasure) following a less analytical process. Furthermore, we suggest that it would occur in HA only, because of their subjective affect hyperarousal tendency (Connelly and Denney, 2007) and their associated lack of affect regulation competence (Pandey et al., 2011).

Overall, these results indicate a combined effect of alexithymia and mood in emotion processing through the auditory channel (e.g., of nonverbal vocalizations). HA, but not LA, were hampered by their current mood in task performances. Moreover, our findings suggest the importance of mood regulation competencies in the occurrence of emotion processing deficits among the alexithymic population. However, further empirical support would be needed to support this proposal.

Several considerations must be taken into account when interpreting our results. Regarding the sample, two particular enhancements could be made in future studies. Firstly, in order to investigate the role of alexithymia and mood in a more generalizable manner, the proportions of male and female participants should be equated. Indeed, given our sample, the results of our study should be interpreted as specific to the female population rather than as generalizable to the general population. Secondly, the relatively small size of our sample (i.e.,  $N=57$ ) might have impeded the power of our statistical analyses and calls for replication attempts within larger samples. Furthermore, one particular limit should be kept in mind while interpreting our results. Indeed, considering the fact that the correlations we observed were not very strong and that we did not apply a correction to their  $p$ -value (i.e., Bonferroni correction for the number of relations tested), interpretations of the results must be considered with relative caution. Even so however, this study brings novel and interesting findings, as it is the first to investigate NEV processing in alexithymia with a large range of emotions (i.e., positive as well as negative). Finally, since this study has been conducted with a non-clinical sample, it would be very interesting to see how the results come out within psychopathological populations, particularly with diagnoses known to be intrinsically related to mood disorders (Stringaris et al., 2012) and emotional deficits (Kring, 2010), such as the alexithymia construct.

To conclude, this exploratory correlational study contributed in enriching the existing literature on the role of mood and alexithymia in emotion perception. Importantly, our results provide directions for future research, such as the use of multi-modal emotional stimuli, but also point to issues of potential clinical interest.

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