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I Can Take My Eyes Off You: Effect of Alexithymia and Perceptual Load on Processing Emotional Faces

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Abstract
Alexithymic individuals have difficulties processing emotional stimuli, including faces, and may require more resources to process such stimuli. Alexithymia may interact with task characteristics, like perceptual load, which modulates the processing capacity allocated to task-relevant, versus task-irrelevant stimuli. We examined effects of load and distractor type (face, object) and valence (threatening, neutral), and alexithymia on performing a letter-search task. We assessed reaction time, accuracy, and heart rate to index arousal and cognitive effort. Perceptual load, distractor presence, type and valence showed expected effects. Alexithymia did not meaningfully affect reaction time, but was associated with decreased accuracy when distractors were threatening, under low perceptual load. HR did not suggest changes in resources mobilized depending on alexithymia level. Results suggest that alexithymic individuals perceived emotional stimuli and were able to maintain intact reaction time, though this came with a cost in accuracy. Absence of HR effects suggests that no additional resources were recruited to remedy this difficulty. Overall, results suggest that emotional stimuli are perceived in alexithymia at early stages, but resources are not appropriately allocated to prevent performance impairment.

Keywords alexithymia, perceptual load, heart rate, emotion, face, load theory

Emotional faces convey critical information for social behavior and mental health (Öhman, 1986; Marsh, Kozak & Ambady, 2007). Threatening faces signal rejection by group members, which, evolutionarily, could place one at risk (Öhman, 2009; Öhman, Juth, & Lundqvist, 2010; Bradley et al, 1997). Because of their motivational significance, faces may be processed preferentially (Ro, Friggel, & Lavie, 2007). Yet, individual differences exist in how emotional faces are processed.

Alexithymia, a trait found on a continuum in the general population, describes difficulties in identifying and describing emotions (Lane et al., 1996; Taylor, Bagby, & Parker, 1997; Taylor et al., 2016) and broad dysfunctions in processing emotional information (Luminet, Nielson & Ridout, 2021). Preece, Becerra, Allan, Robinson, & Dandy (2017) conceptualize alexithymia as involving ability deficits in emotion processing, combined with attempts to regulate emotion by avoidance, when faced by increased distress. In terms of observed deficits, alexithymia is associated with blunted physiological reactivity to (Constantinou, Panayiotou & Theodorou, 2014; Panayiotou, Panteli & Vleminx, 2018; Peasley-Miklus, Panayiotou, & Vrana, 2016), and reduced recovery from, affective stimulation (Panayiotou & Constantinou, 2017; Neumann et al., 2004). In the cognitive domain, deficits are found in early and sustained attention, memory, and language, for affective information, including faces, as summarized in a review by Luminet, Nielson & Ridout, (2021).

Specific difficulties in processing emotional faces (see Donges & Suslow, 2017 for a review) include poor memory for them (Prkachin, Casey, & Prkachin, 2009), reduced attention and early perception as indicated by P1, N2b and P3a ERPs (Pfabigan, et al., 2014; Vermeulen, Luminet, De Sousa, & Campanella, 2008), and low activation of brain regions involved in perception, suggesting less automatic encoding (Duan, Dai, Gong, & Chen, 2010; Reker et al., 2010; Kügel et

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al., 2008). Alexithymia also reduces priming of negative words by angry faces (Vermeulen, Luminet, & Corneille, 2006), and, in autistic individuals, eye fixations to the eye region (Bird, Press, & Richardson, 2011), consistent with early processing limitations.

However, other evidence indicates that it is not performance on tasks involving faces and other emotional content that suffers in alexithymia, but that more resources are required to execute such tasks. This view remains compatible with the deficits account by Preece et al. (2017), but suggests that processing difficulties may be identified by studying brain and physiological indices of mental effort, even if observed performance appears intact. For example, Mériau et al. (2006) found no performance reduction in alexithymia during a gender-labelling task while viewing faces, but increased activation in the dorsal anterior cingulate cortex (ACC), which they interpreted as the need for more elaborate processing. Heinzel et al. (2010a) found no alexithymia effects during passive viewing of emotional faces but greater dorsal ACC activation, which they interpreted as alexithymic individuals requiring more cognitive effort to suppress the emotional arousal induced by affective stimuli (see also Heinzel et al., 2010b). Grynberg et al. (2012), in their systematic review of face processing in alexithymia, postulated deficits in early face processing and decoding, which are worse when stimuli are brief or degraded, and interpreted this to imply that more effort or information is required.

Individual differences, like alexithymia, may also interact with task parameters to affect the way emotional information, including faces, is processed. One such parameter is perceptual load (Van Dillen, Heslenfeld, & Koole, 2009), which modulates the degree to which task-relevant and irrelevant stimuli are perceived (Carmel, Fairnie, & Lavie, 2012; Jenkins, Lavie & Driver, 2005; Palermo & Rhodes, 2007; Yang, Wang, Jin, & Li, 2015). According to Load Theory (Lavie, 1995; 2005), merely instructing participants to ignore task-irrelevant stimuli does not guarantee that they will effectively do so, as it is assumed that attentional capacity is not fully under voluntary control. When attentional capacity is not exhausted by the main task (i.e. low perceptual load tasks, Lavie, 2005), excess capacity is automatically and involuntarily allocated to processing task-irrelevant stimuli (Lavie et al., 2004). Processing of task-irrelevant information can only be prevented when a task exhausts available capacity (Maylor & Lavie, 1998; Lavie & Cox, 1997).

Typically, emotional distractors, like any other task-irrelevant information, will be processed more fully when the task is of low perceptual load. However, this may not be the case for individuals with difficulties in the early processing of emotional information, or those for whom the emotional stimuli hold specific relevance. Such individual differences may relate to the ability to exert control over the allocation of attention (Berggren & Derakshan, 2013) to primary and peripheral stimuli, or may predispose them to attention biases towards specific distractors such as threat. These effects may interact with the automatic distribution of attention, modulated by perceptual load. For those with deficits in perceiving emotional distractors, these stimuli may not be processed adequately, even under low load, and therefore will not affect performance on the primary task. In the case of depression, which is strongly related alexithymia, it was found that perceptual load effects on a task with neutral distractors were reduced (Weldon, Liu, Heller, & Buetti, 2020), presumably due to a narrower attention window, or reduced attention to distractors. In the case of biased attention toward personally significant peripheral stimuli, they may be partially or fully perceived and affect performance, even in high load conditions. For example, Soares et al. (2015), in a letter search task, found slower RT and decreased accuracy, interpreted as greater distraction, for socially anxious participants, in the high load condition, when distractors were angry faces, a highly relevant threat for these participants. Such findings indicate that some individual traits may override typical perceptual load effects. The evidence is not conclusive, however, with other studies supporting that perceptual load effects hold, irrespective of individual traits (Bishop, Jenkins, & Lawrence, 2006; Fox, Yates & Ashwin, 2012).

Given that alexithymia has been found to involve deficits in early attention to and perception of emotional information (Luminet et al., 2021), including faces (Grynberg et al., 2012), one might expect that perception of peripheral emotional stimuli will be more difficult, and therefore less distraction from the main task may occur, even under low load conditions. On the other hand, alexithymia has been related to poor attentional control (Correro et al., 2021; Vermeulen et al., 2018), which does not necessarily translate into more distraction by task-irrelevant stimuli, but may be observed as a less adaptive distribution of attention between the main task and potentially threatening peripheral stimuli.

In addition to typical perceptual load effects and individual differences, characteristics of the peripheral stimuli may also modulate the attention allocated to them, versus the main task. Biologically significant distractors, including faces, may override perceptual load effects, and receive preferential processing, even when resources are occupied by the primary task (i.e. high load). For example, Lavie, Ro and Russell (2003) found that faces distract from target processing regardless of load, obligatorily attracting and holding attention (Ro, et al., 2007; Vuilleumier, Armony, Driver & Dolan, 2001). However, the majority of findings are consistent with the general premises of load theory, showing distraction by faces only in low load conditions (Lim, Padmala, & Pessoa, 2008; Pessoa, Padmala, & Morland, 2005; Yates, Ashwin, & Fox, 2010). Examining how perceptual load and characteristics of the presented stimuli affect performance in alexithymia is a useful avenue for uncovering how perceptual resources are distributed and controlled in relation to this trait, and can increase our understanding of how motivationally significant information, and faces in particular are processed, which may play a part in the mental health and interpersonal difficulties often observed in association with alexithymia.

Current study

This study examines how alexithymia interacts with stimulus characteristics (valence: threatening/neutral; type: face/object) and task perceptual load (low/high) to preferentially process, or filter out, task-irrelevant information, when this is emotional and of motivational significance. Participants high, medium, and low in alexithymia were compared on reaction time (RT) and response accuracy to a letter search task of either low or high perceptual load (Beck & Lavie, 2005). To examine if alexithymia affects the processing of faces, versus any emotional stimuli, we included both faces and objects (threatening guns and neutral chairs) as distractors, in a balanced design.

To check our manipulations, based on Load Theory, we expected typical perceptual load effects across participants (e.g. Forster & Lavie, 2008), i.e. more distraction by task irrelevant stimuli under low load compared to high load. We further expected emotional distractors, especially threatening faces, to produce more distraction (slower RT and less accuracy on the search task). Because the latter findings are not relevant to the main study hypotheses, results on overall performance on the whole sample, per condition, are described in Supplementary Table 1.

Our main hypotheses pertain to the effects of alexithymia. We expected that higher levels of this trait, would be associated with poor perception of the emotional distractors, given the empirical evidence that alexithymia is related to poor early processing of emotional information (see review by Luminet et al., 2021). Consequently, participants higher in alexithymia would show less distraction by emotional stimuli, especially under low perceptual load, than low alexithymic participants, and better performance on the letter search task. Given the broad emotional deficits associated with alexithymia across many types of emotional stimuli and situations, we could not predict a priori if alexithymia effects would be specific to faces, or generalize to emotional objects.

In addition to RT and accuracy, we also measured heart rate (HR) as an index of arousal and cognitive effort, to evaluate the hypothesis that alexithymia affects the resources required to complete emotional tasks. Based on Grynberg et al.'s (2012) findings, we would expect that higher levels of alexithymia will be related to greater changes in HR during blocks involving emotional/face distractors. Because HR, simultaneously indexes arousal (i.e. higher HR reflecting greater emotional intensity), but also concentration on a task (i.e. HR deceleration indicating more attention), we could not set a priori predictions as to whether emotional vs cognitive effects would dominate, but in either direction, more HR change in higher alexithymia would indicate greater engagement with distractors. The study was approved by the National Bioethics Committee and participants provided informed consent.

Method

Participants

Participants were 74 undergraduates who completed the Toronto Alexithymia Scale (TAS-20; Bagby, Parker, & Taylor, 1994) as part of standard screening, and agreed to take part in the experiment. They were split into three groups: high and low alexithymia based on the top and bottom 30% (N=24, Mean TAS-20=58.74, SD=5.62 and N=27, Mean TAS-20=34.26, SD=4.60 respectively) of the distribution of total scores on the TAS-20, and medium alexithymia including all remaining participants (N=24, Mean TAS-20=45.46, SD=3.15). Groups significantly differed from each other in total TAS-20 total score, $F(1, 739)=179.31$, $p<.001$. Groups also significantly different in all 3 subscales of the TAS-20, Difficulty Identifying Feelings, $F(2, 71)= 73.37$, $p<.001$; Difficulty Describing Feelings, $F(2, 71)= 60.39$, $p<.001$; Externally Oriented Thinking $F(2, 71)= 5.09$, $p=.009$. When running post-hoc, Bonferroni corrected, pairwise comparisons, the three groups significantly differed among them for the first two dimensions, but for Externally Oriented Thinking, only the low and high groups differed significantly.

Apparatus

The experiment was controlled by the Cogent Toolbox (http://www.vislab.ucl.ac.uk/cogent.php) for Matlab (MathWorks, Inc.) on a Microsoft Windows 7 PC with 19" monitor (60 Hz refresh rate; resolution 800 × 600). A chin rest ensured a constant 60cm distance from the screen.

Stimuli

Sixty-four pictures were used in the experiment (16 X categories). Faces (50% female; 16 threatening/angry, 16 neutral) were selected from the Karolinska Directed Emotional Faces1 (Lundqvist, Flykt, & Öhman, 1998), and cropped to exclude extra-facial information (hair and background) using Adobe Photoshop (Adobe systems, Incorporated, San Jose, CA; www.abode.com). Handguns (threatening objects) were selected from the UCSD Vision and Memory lab database (Konkle, Brady, Alvarez, & Oliva, 2010). Chairs (neutral objects) were created at the National Institute of Mental Health (Zachariou, Safiullah, & Ungerleider, 2015). All stimuli, converted to grayscale, were pre-rated by an independent college sample (N=55), on valence and arousal (Theodorou, Panayiotou, & Konstantinou, 2016). Psychophysiological data were recorded at 1000 Hz with BIOPAC MP150 (BIOPAC Systems, Inc., Goleta, CA), and reduced in AcqKnowledge 3.9.0. Electrocardiogram (ECG) was recorded via two Ag/AgCl electrodes on the inner forearms, amplified by a BIOPAC ECG100C bioamplifier. HR was averaged for each block and all inter-trial intervals (baselines). Two participants with poor signals were excluded from analyses.

Procedure

Participants arrived at the lab and sat in a sound-attenuated room. Following informed consent and instructions, they were fitted with HR monitors. A 10-minute adjustment period preceded the experiment to stabilize physiological signals. For the main task, participants completed a letter-search task during which they had to identify a target-letter (X or Z; subtending 0.6° × 0.4°) appearing in a circular array around fixation (Figure 1). Each trial began with a fixation cross at the center of the screen followed by eight equally sized target letters. Displays were presented for 100 ms to avoid eye-movements that could contaminate results (Kramer, Irwin, Theeuwes, & Hahn, 1999). Letters were arranged in a circle of 2° radius centered at fixation. Perceptual load was manipulated by varying the set size of the target stimuli. In the low load condition Os replaced seven of the letters, making the target easier to detect. In the high load condition, seven angular letters similar in structure to the target were presented (K, F, V, T, L, N, H). On 50% of the trials, a distractor picture was presented in the center of the circle simultaneously with the letter display. Participants had to search for the target letter in each trial, and respond as quickly and accurately as possible, while ignoring task-irrelevant pictures. They had to press "1" or "2" on the keyboard with their index (1 for "X") or middle fingers (2 for "Z" – counterbalanced between target letters) when they identified the target, which was equally likely to appear in any of the eight positions.

Distractors were either faces or objects, half neutral and half threatening. Thus, a load (high, low) x type (face, object) x valence (neutral, threatening) x distractor presence (present, absent) within-subjects design was used, with group (alexithymia; 3 levels) as the between-subjects factor. Each cell represented by the load x type x valence matrix was presented in a separate block to allow adequate time for physiological measurement. Blocks lasted 4 minutes with 1-minute intervals between them. Each participant completed 8 blocks of 64 trials each, 32 of which contained distractors. Block order was counterbalanced across participants. Before the experiment, a high and a low load practice block of 16 trials each were administered.

After the letter search task, distractors were presented again, in a counterbalanced order, so that participants could rate their affective response, i.e. how they felt when viewing each stimulus, on valence (1=very unpleasant, 9=very pleasant) and arousal (1=very relaxed, 9=very tense), using digital scales 1-9 analogous to the Self-Assessment Manikin (SAM; Lang, Bradley, & Cuthbert, 2005).

Data Reduction and Analysis

Dependent variables were RT, accuracy (% correct) and mean HR. RTs deviating +/- 2.5SDs were considered outliers and excluded from analyses (Ratcliff, 1993). For RT, only trials with correct responses on the search task were included in analyses, as errors may come from diverse sources and introduce significant error variance (Forster & Lavie, 2005). For RT and accuracy, a mixed design ANOVA was used, with perceptual load (high, low) x distractor presence (present, absent) x distractor type (face, object) x distractor valence (threatening, neutral) as within-subjects variables and alexithymia group (3 levels) as the between-subjects variable. First, manipulation checks pertaining to perceptual load effects, are briefly presented. Next, main and interactive effects of alexithymia, the main focus or the present hypotheses, are reported. Main and interactive effects of the additional within-subjects variables, which are not directly relevant to the hypotheses, are reported in Supplementary Table 1.

Results

Manipulation Checks

Performance. For RT, the repeated measures ANOVA showed an effect of load, $F(1, 71)=485.08$, $p<.001$, $\eta 2=.87$, with slower RTs in the high load condition, indicating that the task was harder at high load, as expected. There was also an effect of distractor

Table 1. Marginal Means and SE across whole sample for perceptual load x distractor presence interaction

		Mean	SE
High Load	Present	747.49	16.14
	Absent	738.49	15.12
Low Load	Present	546.34	13.43
	Absent	519.77	12.74

Note. On the whole sample the load x distractor presence interaction, $F(1, 71)=14.24$, $p<.001$, $\eta2=.17$

presence, with trials including distractors having slower RTs than trials without distractors, $F(1, 71)=47.05$, $p<.001$, $\eta2=.40$. A load x distractor presence interaction, $F(1, 71)=14.24$, $p<.001$, $\eta2=.17$, showed the expected effect that distractor present trials (vs absent) resulted in slower RTs in the low load condition $F(1, 71)=95.20$, $p<.001$ $\eta2=.57$, compared to high load, $F(1, 71)=4.80$, $p=.032$ $\eta2=.06$, consistent with load theory (Table 1). For Accuracy, the repeated measures ANOVA on percentage of correct trials showed a significant effect of load, $F(1, 71)=528.05$, $p<.001$, $\eta2=.88$, with better performance in the low than in the high load condition (95% accuracy on trials in low load blocks, vs 70% on trials in high load blocks). There was also a significant effect of distractor presence, $F(1, 71)=35.16$, $p<.001$, $\eta2=.33$, with better accuracy on trials without distractors compared to trials with distractors, modified by a load x distractor presence interaction, $F(1, 71)=7.68$, $p=.007$, $\eta2=.10$, so that performance was more uniform in low load $F(1, 71)=16.82$, $p<.001$, $\eta2=.19$ (about 95% accuracy) irrespective of presence of distractors, but in the high load condition, performance was somewhat better in the absence of distractors, $F(1, 71)=22.36$, $p<.001$, $\eta2=.24$. Overall, effects indicate that load and distractor presence were appropriately manipulated, with high load and distractor presence uniquely and interactively making the letter search task more difficult. See Supplementary Table 1 for effects of other within-subjects variables on performance.

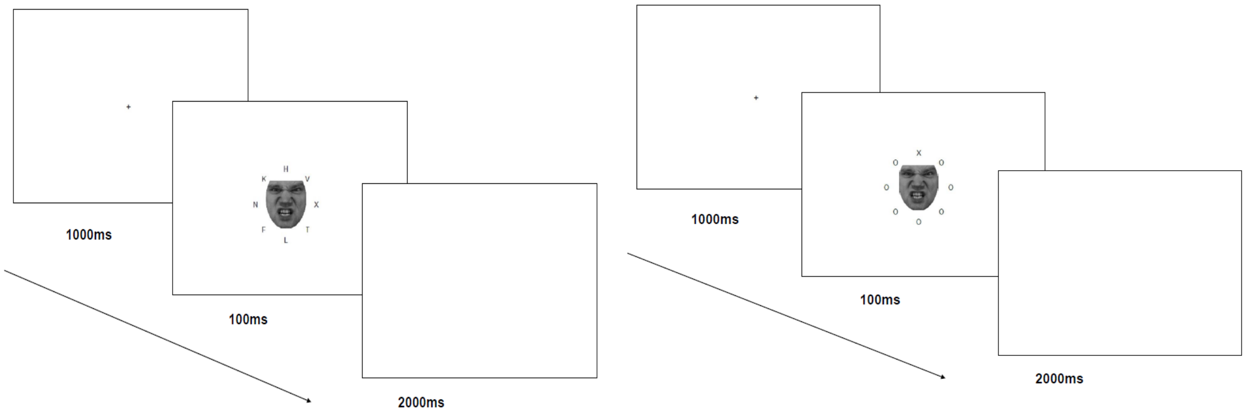
Heart Rate. The repeated measures ANOVA with 4 within-subjects variables, phase (baseline vs task), load, type and valence resulted in the following: There was a significant effect of phase, with HR decreasing during task blocks compared to their respective baselines, $F(1, 68)=121.30$, $p<.001$, $\eta2=.64$, consistent with deceleration associated with increased orienting and perceptual input (Graham, 1979). The effect of distractor type was also significant $F(1, 68)=4.66$, $p=.034$, $\eta2=.06$, with lower HR during blocks with objects than faces. Valence was significant, $F(1, 68)=4.86$, $p=.031$, $\eta2=.067$, with lower HR on blocks with threatening than neutral distractors, and a type x valence interaction, $F(1, 68)=5.42$, $p=.023$, $\eta2=.074$, such that for blocks with object distractors HR did not change as a function of valence (mean BPM, 81.78 vs 81.83), whereas for blocks with face distractors, HR was lower when these were threatening than neutral, $F(1, 68)=9.75$, $p=.003$, $\eta2=.125$ (mean BPM, 81.74 vs 82.81).

Subjective ratings. The repeated measures ANOVA on valence ratings that took place after the experiment (i.e. how positive participants felt when looking at each stimulus) showed a significant effect of distractor type, $F(1, 70)=29.70$, $p<.001$, $\eta2=.30$, so that objects were rated as more positive than faces. There was also a main effect of valence, $F(1, 70)=157.81$, $p<.001$, $\eta2=.69$, with threatening distractors rated as less positive than neutral, and a type x valence interaction, $F(1, 70)=62.50$, $p<.001$, $\eta2=.47$, such that neutral objects were rated as the most positive of all distractors. For arousal ratings, there were significant main effects of distractor type and valence, $F(1, 70)=21.03$, $p<.001$, $\eta2=.23$, and $F(1, 70)=140.67$, $p<.001$, $\eta2=.67$ respectively, and a type x valence interaction, $F(1, 70)=63.28$, $p<.001$, $\eta2=.48$. Faces were rated as more arousing than objects, and threatening distractors as more arousing than neutral, with neutral objects rated as the least arousing.

Effects of Alexithymia

RT. There was no significant main effect of alexithymia on RT ($p=.67$), but significant interactions demonstrated that alexithymia modulated the effects of within-subject variables. Importantly for our hypotheses, the load x distractor presence x group interaction was significant, $F(1, 71)=4.65$, $p=.013$, $\eta2=.12$, and further modified by a load x distractor presence x valence x group interaction $F(2, 71)=5.83$, $p=.005$, $\eta2=.14$. Decomposing these interactions by examining each alexithymia group separately found that: The load x presence x valence effect, $F(1, 26)=7.61$, $p=.010$, $\eta2=.23$, was only significant for the lowest alexithymia group (i.e. slower RT for blocks with neutral distractors, when these were present than absent, during high load conditions), while the effect did not reach significance for the medium alexithymia group ($p=.07$) and was non-significant for high alexithymia ($p=.47$; Figure 2).

Figure 1. Structure of a trial: In the left panel High Load with distractor present (threatening face); in the right panel, Low Load with distractor present (threatening face).



Accuracy. Although for accuracy too the main effect of alexithymia did not reach significance (p=.07), the load x distractor presence x valence x group interaction $F(2, 71)=10.108$, $p<.001$, $\eta^2=.22$ was significant. Decomposing this by examining the effects separately for each alexithymia group showed that the load x distractor presence x valence interaction was significant only for the highest alexithymia group, $F(1, 22)=17.23$, $p<.001$, $\eta^2=.44$. Probing further into this interaction showed that for the high alexithymia group, in high load blocks and on trials with distractors absent, accuracy was non-significantly better when these were neutral, $F(1, 22)=3.23$, $p=.086$, $\eta^2=.13$. In the low load condition, this group had significantly higher accuracy on distractor present trials when these were neutral, $F(1, 22)=9.94$, $p=.005$, $\eta^2=.36$ (Figure 3).

Heart rate. Alexithymia group did not show significant main or interactive effects with regards to HR.

Subjective Ratings. There were no significant main or interactive effects of alexithymia on valence ratings. With regards to arousal ratings, alexithymia significantly interacted with distractor type $F(2, 70)=5.43$, $p=.006$, $\eta^2=.13$. Breaking this down by alexithymia group showed that the effect of distractor type (i.e. higher arousal ratings when viewing faces than objects) was significant for both low, $F(1, 25)=21.91$, $p<.001$, $\eta^2=.47$ and medium alexithymia, $F(1, 23)=28.45$, $p<.001$, $\eta^2=.55$, but not the high alexithymia group, $F(1, 22)=.003$, $p=.96$, $\eta^2=.00$, who rated faces and objects as equally arousing (Figure 4).

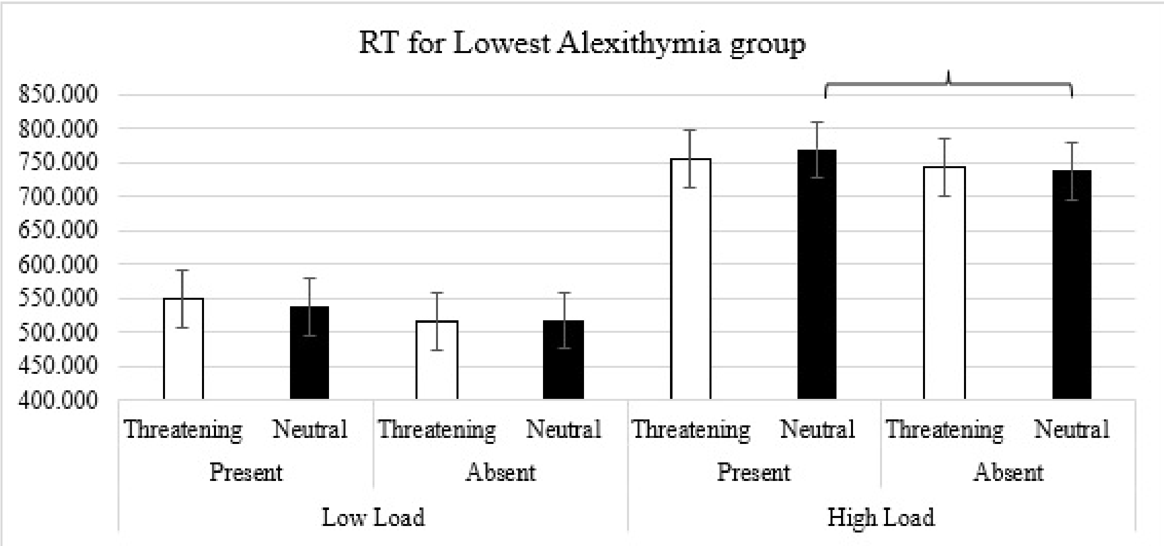
Discussion

This study examined the perception of emotional stimuli, especially faces, in alexithymia, when these are presented within tasks varying in perceptual load, which allowed us to manipulate the ease of attention allocation to peripheral emotional stimuli. We aim to contribute to understanding how motivationally significant stimuli are processed in alexithymia, which may relate to the emotional deficits linked to this trait, that create vulnerability for psychopathology, health problems, and relationship difficulties (Porcelli & Taylor, 2018; Grynberg, Berthoz & Bird, 2018).
Expected results were obtained for load and distractor presence on task performance, lending support to our manipulations, and in line with findings on similar tasks (Forster & Lavie, 2008a; 2008b), on the basis of Load Theory (Lavie, 2005), such that more distraction was apparent in low than high load conditions.

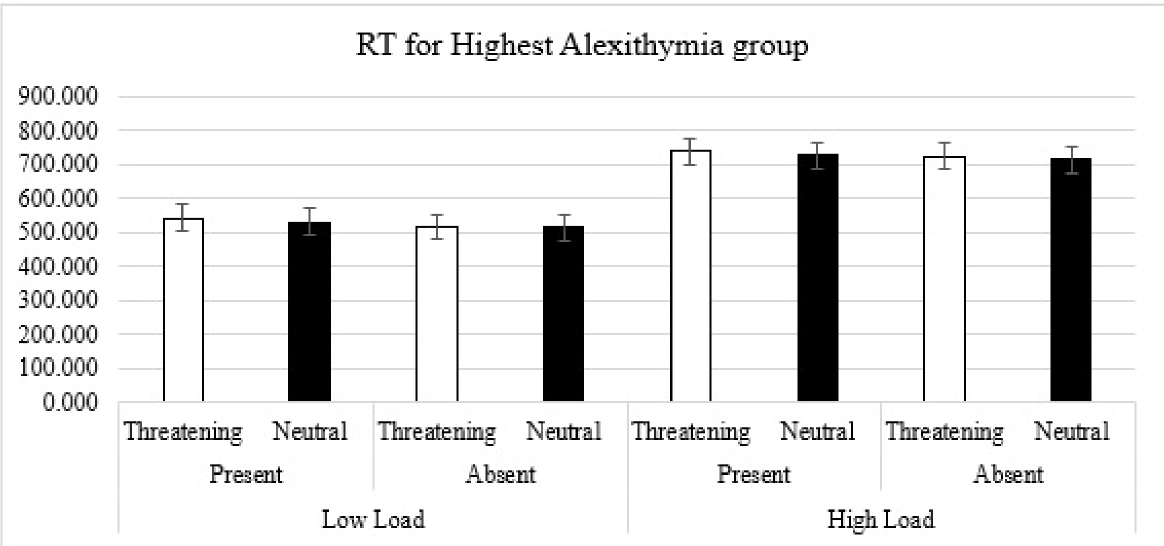
The main focus of this study was on the interactive effects between alexithymia and the within-subjects variables. Overall, alexithymia affected accuracy more than speed of response. Alexithymia significantly modulated accuracy on the letter search task, in interaction with task and distractor characteristics. The load x distractor presence x valence interaction was significant only for the high alexithymia group. On high load blocks and on trials with distractors absent, accuracy was better when distractors were neutral, suggesting perception of the valence of distractor stimuli, and inability to stop distraction by threatening information. A similar effect was stronger in the low load condition, during which the high alexithymia group had higher accuracy on distractor present trials when distractors where neutral, showing distraction by motivationally significant stimuli, in the load condition that allows distraction to occur. These effects indicate that emotional aspects of the distractors were actually perceived by alexithymic individuals, and in fact interfered with their ability to complete the task

Figure 2.

(a)



(b)

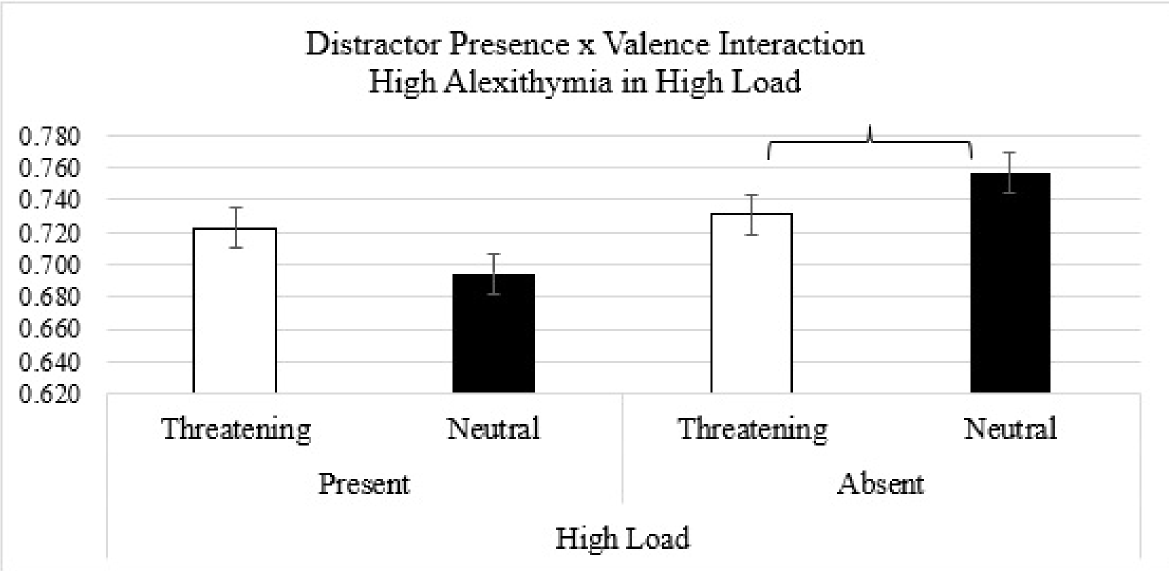


Note. Bracket in panel (a) indicates marginally significant comparison after Holms-Bonferroni correction (with p set at .006), p=.004. Panel (b) shows that Load x Presence x Valence effect was not significant for high alexithymia group, p=.47.

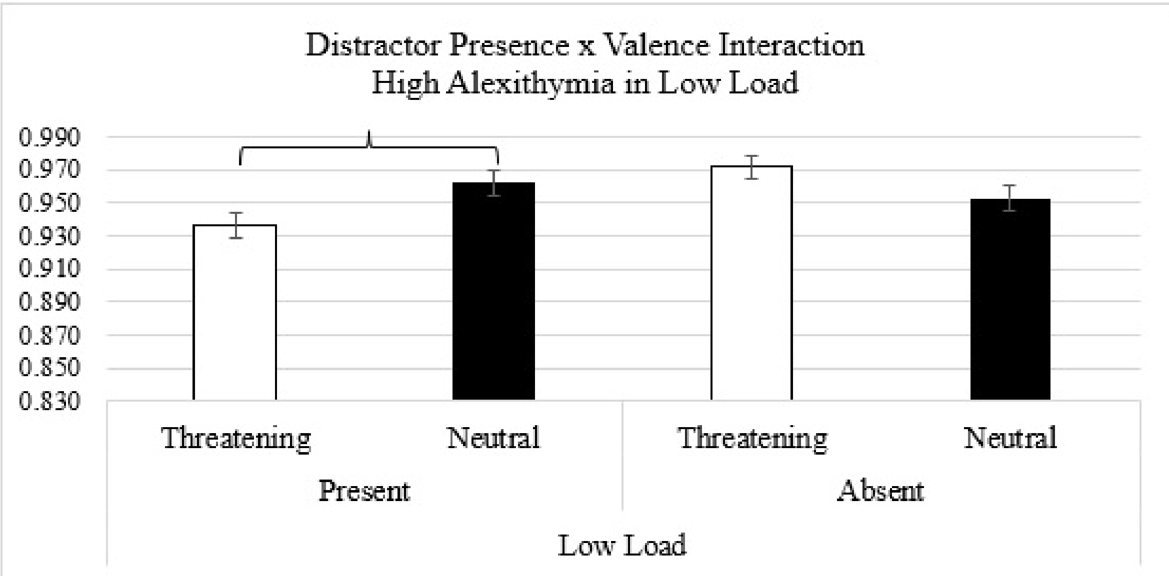
efficiently, especially under low load, despite the task being easy, something that did not occur at lower alexithymia levels. These effects are compatible with an "over-responding" to emotional situations account of alexithymia (see Luminet et al., 2021 for a discussion), leading to reduced accuracy due to interference by emotional information that was peripheral to the main task. That is, potentially important (i.e. threatening) emotional stimuli were appropriately perceived, but attention was not adaptively regulated in ways to prevent interference. Unlike accuracy, the RT of the higher alexithymia groups was not significantly affected by emotional aspects of the task. In the high load condition only, RT was faster when neutral distractors were absent than present, an effect that was not significant for other types of distractors, only for lower alexithymia participants. It appears that this group was distracted by neutral distractors, perhaps in an attempt to evaluate their relevance. Overall, the minimal effects of alexithymia on the RT measure is in line with studies that did not find impaired performance in alexithymia

Figure 3.

(a)



(b)

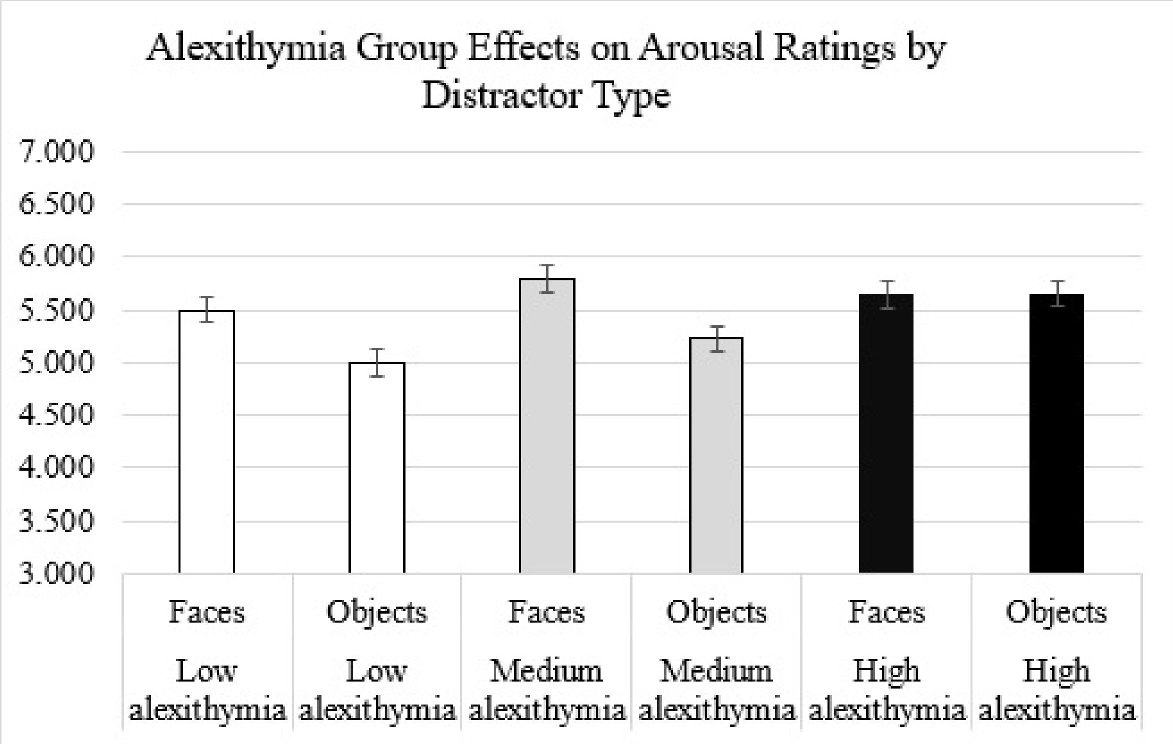


Note. T=Threatening, N=Neutral, P=Present, A=Absent distractors in Low Load Condition. In bracket indicates marginally significant comparison (a) after Holms-Bonferroni correction (with p set at .006), p=.086. In (b) Bracket indicates significant comparison, p=.005.

when emotional faces were involved (Mériau et al., 2006), and inadequate early perception of emotional information (Vermulen et al. 2006; Grynberg et al, 2012). However, intact RTs seemed to occur with trade-off in accuracy when distractors were present and threatening. Findings suggest greater difficulty in regulating perceptual resources in alexithymia in order to perceive but not be distracted by emotional stimuli, something not occurring in people with lower alexithymia. In this way, one aspect of performance, accuracy, on a relatively easy response, and at ceiling levels in the low load condition, was negatively impacted.

The high alexithymia group, however, did not show any differences in HR when distractors were threatening compared to neutral, to parallel these

Figure 4.



Note: Differential arousal ratings for F=faces and O=objects for the three alexithymia groups low, medium and high, showing absence of stimulus type effect in the high alexithymia group.

performance effects. In fact, no alexithymia effects occurred on HR, a measure that indicates perceptual intake and orienting towards the environment (Bradley, 2009). The absence of HR moderation by alexithymia speaks against the hypothesis that alexithymia is associated with greater mobilization of resources to maintain normal levels of performance.

There were also no alexithymia effects on valence ratings, consistent with previous assertions from studies that carefully manipulated valence and arousal separately in their emotion induction stimuli, that it is the arousal aspect of emotion that is not appropriately processed in alexithymia (Constantinou et al., 2014; Roedema & Simons, 1999). Arousal ratings were affected by alexithymia, such that distractor type effects (i.e. higher arousal ratings when viewing faces than objects) were absent for the high alexithymia group, showing less granulation between emotional contexts of different emotional intensity (Aaron et al., 2018; Luminet et al., 2021), which may lead to reduced reports of emotional intensity, in accord with deficit accounts of alexithymia. This finding is in line with prior evidence that it is the processing of arousal aspects of emotional stimuli that suffers in alexithymia (Peasley-Miklus et al, 2015). This conclusion is in partial contradiction with the conclusion of Luminet et al. (2021), that alexithymic individuals display decreased appraisals of negative valence. The contradiction may be reconciled by the fact that many of the studies reviewed by Luminet et al. report appraisals of valence, but not arousal, for presented stimuli, which however may have differed on both dimensions. The studies therefore did not systematically distinguish between valence and arousal evaluations, which we did in this study. At least when it comes specifically to face stimuli, our findings also indicate that, at a conscious subjective level, faces do not hold greater motivational significance for high alexithymic individuals that objects, something that may be reflected in the interpersonal difficulties they face. These findings are also in line with conceptualizations that alexithymia entails strategic avoidance of emotions, as these become conscious (Panayiotou et al., 2015), because they are experienced as diffuse, ambiguous and unpleasant (Luminet et al., 2021).

Both the design and results of this study are compatible with current conceptualizations in personality psychology that emphasize the interaction between person and context, and identify that stability in personality reflects tendencies to behave consistently, across specific types of contexts and over time, that activate and update, relevant mental representations (Shoda & Mischel, 2000). Alexithymia, conceived as a personality trait, remains poorly understood in terms of its core emotional and cognitive mechanisms. The present study demonstrates that the ability to regulate attention may reflect a critical skill for the regulation of emotion and behavior (Mischel & Shoda, 1998). Quirin et al. (2020) and others (e.g., Robinson et al., 2019) advocate for the use of well-controlled cognitive and behavioral tasks, as done in this study, to model processes such as attention, perception, appraisals, and cognitive control to specific types of stimuli, in order to study stable personality traits. Future research in alexithymia could examine whether problems with adaptive attention distribution between primary and biologically relevant secondary tasks predicts a broader difficulty in fully processing important emotional information. This may relate to a tonic state of vigilance or arousal, but poor awareness of one's emotional state (Panayiotou, Panteli & Vlemincx, 2021), hindering initiation of adaptive coping, which in turn may be involved in the association between alexithymia and mental and physical illness.

This study comes with some limitations. The participants were healthy, educated, young college students, at a selective university, calling for further replication in more diverse community samples. The sample was relatively small, leading to some concerns regarding power for the between-group comparisons, even though the mainly within-subjects design, and large number of observations per condition for each participant greatly increases confidence in our findings. The small sample size also precluded us from running facet-level analyses, something highly recommended for alexithymia research. In fact, in contrast to Luminet et al., (2021) who suggest that the externally oriented thinking (EOT) facet is most related to attentional effects in alexithymia, our group comparisons on TAS-20 facets suggested that their primary differences were on difficulty identifying and difficulty describing feelings facets, which likely drove attentional effects in our current study. In a previous study using eye-tracking methodology, findings were indeed aligned with the hypothesis that EOT holds a central role in attentional difficulties in alexithymia (Leonidou, Constantinou, Panteli, & Panayiotou, 2022). This may not have been the case in the present study, where high, medium and low alexithymia groups did not significantly differ in EOT, because participants were educated and more psychologically minded (mostly psychology students), characteristics that may reduce the concrete, non-insightful thinking associated with the EOT dimension.

As another limitation, the blocked design may have also led participants to develop unintended strategies during each block to deal with the task demands, which may also be associated with the small effects observed on distractor absent trials. In defense of this choice, due to the short duration of each trial, a more random design would have precluded the reliable measurement of physiological indices. Another important omission was the non-inclusion of positive emotional facial expressions among the distractor stimuli, a comparison condition that would elucidate the role of valence in alexithymic difficulties. This was done to reduce the number of within-subjects independent variables, but does not allow for separate examination of arousal and valence effects. Future studies could incorporate a greater range of facial expressions, and more direct, neuroimaging measures of attention and perception to track perceptual processes for briefly presented emotional stimuli.

In spite of these limitations, the study, through a balanced design and the inclusion of multiple measures, provides novel evidence regarding the processing of emotion information in participants with increasing levels of alexithymia. It showed that alexithymic individuals are indeed affected by emotional information, even at early stages of processing, but may be less able to modulate their perceptual resources and initiate appropriate responses, relevant to the task and situation. At more conscious levels of processing, and in self-reports, we instead observed the more typical finding of low emotional intensity reported by high alexithymic individuals. Effects indicate that both time allowed for emotional processing (i.e. early vs late/conscious perception), and the resources available that may depend on task perceptual load, modulate the emotional difficulties associated with this trait and may need to be taken into consideration when interpreting findings on emotional difficulties in alexithymia. It is noteworthy that the three alexithymia groups differed more substantially in the difficulties identifying and describing emotion factors, which likely drove the observed alexithymia effects.

In sum, emotional aspects of stimuli do seem to be perceived in alexithymia, and are not easily ignored to protect performance on competing tasks. Not being able to adapt to the emotional and cognitive requirements of the context, allocating attention appropriately to both main task and potentially significant peripheral stimuli, may be a central feature of the pervasive emotional and physiological dysregulation seen in alexithymia, and may pave the way to various psychological symptoms associated with this trait.

Footnotes

[1]AF01ANS, AF07ANS, AF16ANS, AF20ANS, AF21ANS, AF23ANS, AF25ANS, AF31ANS, AM03ANS, AM05ANS, AM07ANS, AM08ANS, AM10ANS, AM14ANS, AM17ANS, AM29ANS, AF01NES, AF07NES, AF16NES, AF20NES, AF21NES, AF23NES, AF25NES, AF31NES, AM03NES, AM05NES, AM07NES, AM08NES, AM10NES, AM14NES, AM17NES, AM29NES

Additional Information

Supplementary Materials
https://osf.io/9zhrk/?view_only=071c4b7848ff48348581056d7125a041

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Conflict of Interest
The authors have no known conflict of interest to disclose.

Ethical Approval
Aproved by the Cyprus National Bioethics Committee. Protocol number: ΕΕΒΚ/ΕΠ/2014/31

Data Availability
The authors can make the data available for purposes of use by other researchers upon specific request, in collaboration with the research team to secure protection of participants' personal data. The data are not openly available due to absence of specific consent by the participants for this purpose.

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