

Original

## Interoception moderates the association between alexithymia and anxiety symptoms

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## ARTICLE INFO

*Article history:*

Received 13 September 2023

Accepted 8 April 2024

*Keywords:*Interoception  
Alexithymia  
Emotion regulation  
Anxiety symptoms  
Anxiety disorder*Palabras clave:*Interocepción  
Alexitimia  
Regulación emocional  
Síntomas de ansiedad  
Trastorno de ansiedad

## A B S T R A C T

In 2019, 301 million people were living with an anxiety disorder. Recently, alexithymia and interoception has been considered to play a key role to understand anxiety symptoms. Both constructs are related to each other and together interfere with emotional regulation; however, its relationship has been much debated. A recent two-stage model proposed interoception as a moderator in the relation between alexithymia and anxiety symptoms. Therefore, the aim of the present research was to study how this model could explain the anxiety symptoms. Two hundred forty-one healthy participants completed the General Health Questionnaire, the Toronto Alexithymia Scale and the Multidimensional Assessment of Interoceptive Awareness. Results verified that interoception moderates the association between alexithymia and anxiety symptoms, showing that, for alexithymia to be positively associated with the magnitude of these symptoms, at least a medium level of interoception is necessary.

### La interocepción modera la asociación entre la alexitimia y los síntomas de ansiedad

## R E S U M E N

En 2019, se estimaba que 301 millones de personas vivían con un trastorno de ansiedad. Recientemente, se ha considerado que tanto la alexitimia como la interocepción desempeñan un papel clave en la comprensión de los síntomas de ansiedad. Ambos constructos están relacionados entre sí y juntos interfieren en la regulación emocional; sin embargo, su relación ha sido objeto de mucho debate. Recientemente, un nuevo modelo de dos etapas propuso la interocepción como moderador en la relación entre la alexitimia y los síntomas de ansiedad. El objetivo de la presente investigación es estudiar cómo este modelo podría explicar los síntomas de ansiedad. 241 participantes sanos completaron el Cuestionario de Salud General, la Escala de Alexitimia de Toronto y la Evaluación Multidimensional de la Conciencia Interoceptiva. Los resultados verificaron que la interocepción modera la asociación entre la alexitimia y los síntomas de ansiedad, mostrando que, para que la alexitimia esté positivamente relacionada con la magnitud de estos síntomas, es necesario al menos un nivel medio de interocepción.

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## Introduction

In 2019, 301 million people were living with an anxiety disorder (WHO, 2019). Additionally, during the initial year of the COVID-19 pandemic, the worldwide prevalence of anxiety and depression increased by 25% (WHO, 2022). Consequently, it is now more crucial than ever to understand the origin of these pathologies in order to treat them and slow down their development. An essential concept in comprehending internalizing disorders, such as anxiety, is emotion regulation. This involves both internal and external processes dedicated to monitoring, evaluating, and modifying individuals' emotional states (Liang et al., 2022). Its interconnection with alexithymia and interoception is noteworthy, as these constructs actively engage in the emotion regulation process (Ben Hassen et al., 2023). Furthermore, they have been identified as significant risk factors for the development of anxiety symptoms (Palser et al., 2018).

On one hand, alexithymia is a personality trait characterized by difficulties in identifying, describing, and regulating one's emotions (Lloyd et al., 2021; Shah et al., 2016). Individuals with high levels of alexithymia face persistent challenges in processing their emotions at a cognitive level and regulating them, making them susceptible to developing psychiatric conditions marked by affective dysregulation, such as anxiety disorders (Leweke et al., 2011). However, recent studies indicate that alexithymia does not play a single role in the development of clinical symptoms. In alexithymia, internal experience is believed to be minimized, and attention is directed outward, an effect that some authors have attributed to impaired interoception (Lloyd et al., 2021). Interoception is the ability to detect and process subtle internal bodily sensations triggered by stimuli related to an emotional experience (Zamariola et al., 2018). Alterations in interoceptive circuitry have been also proposed as a possible etiopathogenesis of anxiety (Paulus & Stein, 2010). Indeed, anxiety is often considered the prototypical disorder of interoception, as physiological symptoms and their interpretation constitute an essential part of its diagnostic (Khalsa et al., 2018). Thus, several studies have found a relationship between heightened interoception and anxiety symptoms (Dunn et al., 2010; Pollatos et al., 2007; Khalsa et al., 2018; Zamariola et al., 2018). More specifically, anxiety could arise from altered interoceptive states as a consequence of amplified interoceptive predictive belief states (Paulus & Stein, 2010). In other words, bodily signals may be sensed with intensity, but their processing and interpretation are not performed correctly. Consequently, alexithymia and interoception are interconnected and jointly interfere with emotional regulation (Nicholson et al., 2019). In fact, although it was initially thought alexithymia and interoception could be two sides of the same coin (Shah et al., 2016), contemporary studies argue that they are independent constructs which may influence each other (Manzoor et al., 2021; Palser et al., 2018; Shah et al., 2016). Moreover, some authors suggest interoceptive problems could be the root of alexithymia (Ben Hassen et al., 2023). Palser et al. (2018) explains the relation between alexithymia and interoception through the *Alexithymia Hypothesis*, suggesting that difficulties in emotional processing arise because individuals may be aware of their bodily sensations and states, but alexithymia makes it challenging to identify and understand them; thus, alexithymia would enhance the subject's negative experience, leading to catastrophizing interpretations (Palser et al., 2018).

This explanation would transform interoception into a moderator between alexithymia and anxiety symptoms. Therefore, in order to develop a higher risk of anxiety, individuals should bring together both factors: elevated alexithymia along with elevated interoception. These results were found in Palser et al. (2018),

however, rather than using a moderation analysis, it was used a multiple regression with age, sex, interoceptive sensibility and alexithymia as predictors of anxiety scores. From the perspective of decision-making, interoception have also been considered a moderator. According to Manzoor et al. (2021)'s *two-stage model*, alexithymia predicts decision making, but only if there is first a high level of interoception. Thus, if one is not able to pre-capture one's bodily signals (interoception), it become irrelevant to know or not identify them (alexithymia) (Manzoor et al., 2021).

Therefore, the aim of this study is to test whether the two-stage model proposed by Manzoor et al. (2021) also predicts the extent to which anxiety symptoms are experienced. We hypothesize that interoception will moderate the association between alexithymia and anxiety symptoms, demonstrating that, for alexithymia to be positively associated with the magnitude of these symptoms, a high level of interoception will first be necessary.

## Method

### Participants

241 young and healthy participants (women: N =200; age: M =24.44, SD =7.073) completed the questionnaires. All participants shared socioeconomic status (medium-high level) and educational level (university studies). They all met the exclusion criteria as follows: no presence of physical, neurological or psychiatric diseases; not consuming 10 or more cigarettes a day; no regular use of drugs; no drug consumption the 24 hours preceding the experimental session; and no intake of stimulant drinks in the 2 hours before the experimental session.

### Procedure

All participants provided the informed consent and were briefed about the study without disclosing the precise purpose and variables involved. They were emphatically informed that they retain the freedom to withdraw their consent at any point in the study. Through a questionnaire, all participants furnished information on their socioeconomic variables (age, sex, sociodemographic status, and educational level). The administration of the questionnaires occurred remotely, with participants being instructed on the conditions necessary to ensure the standardization of the measures. The study received approval from the Research Ethics Committee of the Universitat de València in accordance with the ethical standards of the 1969 Declaration of Helsinki.

### Instruments

#### Anxiety Symptoms

The General Health Questionnaire (GHQ-12) was employed to assess participants' anxiety symptoms. Developed by Goldberg & Williams (1988), GHQ-12 is the most widely used self-administered screening instrument for common mental disorders, serving as a comprehensive measure of psychiatric well-being. Scores are typically recorded using a bimodal scale (0-0-1-1) and a 4-point Likert-type scale (0-1-2-3). In this study, we specifically utilized the anxiety subscale (cognitive dimension), encompassing items 1, 2, 5 and 7 (González & Ibáñez, 2001). The internal consistency for the anxiety factor, as measured by Cronbach's alpha in our study, was 0.707.

**Table 1**  
Descriptive statistics (N = 241)

	M			SD		
	Male	Female	Total	Male	Female	Total
GHQ_anxiety	2.60	2.80	2.77	0.66	0.67	0.67
Alexithymia (TAS-20)	45.05	44.33	44.45	10.90	11.67	11.52
Interoception (MAIA-2)	23.52	22.95	23.04	4.84	5.25	5.17

Note. M = mean; SD = standard deviation; GHQ\_anxiety (ranging between 0 and 4), the higher the score, the greater the degree of anxiety symptomatology; interoception (ranging between 0 and 185), sum 37 items of MAIA-2; alexithymia (ranging between 20 and 100), sum 20 items of TAS-20.

## Alexithymia

The latest version of the *Toronto Alexithymia Scale*, TAS-20 (Bagby et al., 1994), served as the primary self-report tool to assess the alexithymia construct. Comprising 20 items on a 5-point Likert scale, the total score ranges from 20 to 100, with higher scores indicating increased alexithymia (a score above 71 suggests clinical-level alexithymia). The Spanish version of TAS-20 (Sánchez, 1996) was employed in our study, yielding a Cronbach's alpha of 0.768 for our sample.

## Interoception

The *Multidimensional Assessment of Interoceptive Awareness Version 2* (MAIA-2) is an 8-scale state-trait questionnaire featuring 37 items designed to measure various dimensions of interoception through self-report. Its eight scales correspond to its 8-factor structure, labeled as Noticing, Not-Distracting, Not-Worrying, Attention Regulation, Emotional Awareness, Self-Regulation, Body Listening, and Trust (Mehling et al., 2018). While there is no well-defined objective measure for the dimensions of interoceptive bodily awareness (Mehling et al., 2018), we calculated an overall score with all sub-factors in this study. The internal consistency for our sample, as measured by Cronbach's alpha, was 0.856.

## Statistical analyses

First, we checked for outliers and assessed variable normality using Kolmogorov-Smirnov normality test. Secondly, t-tests were conducted to check if there were gender differences. To investigate whether interoception, alexithymia, and their interaction could predict anxiety symptoms, we conducted a general linear model while controlling gender differences. Once the significant interaction between alexithymia and interoception was confirmed, we proceeded with the Johnson-Neyman procedure using the PROCESS macro for SPSS (Hayes, 2017). The Johnson-Neyman method identifies important transition or critical points (JN) where the effect of the moderator variable (in this case, interoception), on Y (effect of alexithymia on the anxiety symptoms), shifts from being significant to non-significant, or vice versa. All analyses were performed using IBM SPSS Statistics 25, with the significance level ( $\alpha$ ) set at 0.05. The partial eta square ( $\eta^2p$ ) indicates the effect size, while  $\beta-1$  (power) represents statistical power.

## Results

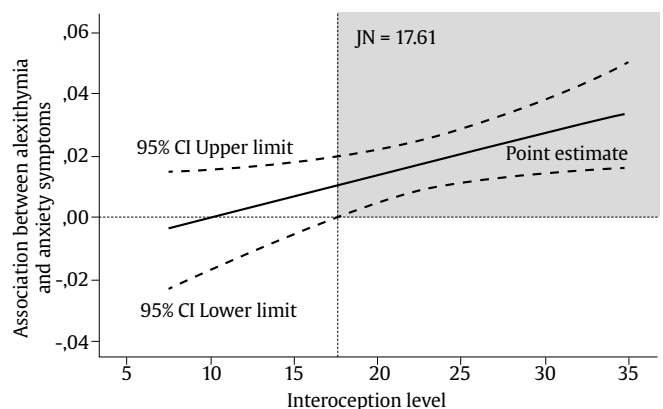
### Descriptive statistics

In the Table 1, descriptive characteristics of variables are presented.

No significant gender differences were found in any of the questionnaire scores using the independent samples t-test.

### Anxiety, alexithymia and interoception

We employed a general linear model to examine the predictive impact of interoception, alexithymia and their interaction on anxiety symptoms. Our findings revealed a significant main effect of interoception ( $B = -.063$ ,  $SE = .028$ ,  $t = -2.269$ ,  $p = .024$ ,  $\eta^2p = .021$ ), indicating a positive correlation with anxiety symptoms. Conversely, there was no significant main effect of alexithymia ( $B = -.015$ ,  $SE = .014$ ,  $t = -1.053$ ,  $p = .293$ ,  $\eta^2p = .005$ ), suggesting that alexithymia alone does not predict anxiety symptoms. Notably, we identified a significant interaction term, Interoception\*Alexithymia ( $B = .001$ ,  $SE = .001$ ,  $t = 2.264$ ,  $p = .024$ ,  $\eta^2p = .021$ ), signifying that interoception moderates the effects of alexithymia on anxiety symptoms. The overall model was significant,  $F(3, 237) = 8.29$ ,  $p < .001$ , and explained 9.51% of the variance. Further exploration using the Johnson-Neyman procedure indicated a critical point at an interoception score of 17.61 (refer to Figure 1). Scores below this threshold showed no significant associations between alexithymia and anxiety symptoms, unlike higher scores, which demonstrated a positive association between alexithymia and anxiety symptoms. In essence, alexithymia is significantly linked to anxiety symptoms only when interoception levels are intermediate or high.



**Figure 1.** Johnson-Neyman graph. Graph of the conditional association between alexithymia and the anxiety symptoms, as a linear function of Interoception including the Johnson-Neyman transition point (JN). The JN point is where the confidence interval around the condition effect intersects zero on the y-axis. Thus, the shaded quadrant is the region of significance, i.e. those values of interoception for which the association between alexithymia and the anxiety symptoms was significant.

The analysis of expected quadratic means indicated no statistically significant gender differences ( $\text{Var}(\text{Sex}) = 67.757$ ,  $\text{Var}(\text{Error}) = 1.000$ ), so gender did not explained variance.

## Discussion

In this study, our focus was on investigating the potential influence of interoception and alexithymia on anxiety symptoms, testing a recent *two-stage model* (Manzoor et al., 2021) and considering the role of gender. Given the limited research exploring these variables within the same experimental design, our primary objective was to delve into these relationships and contribute further evidence to this field.

We hypothesized that interoception would serve as a moderator in the association between anxiety symptoms and alexithymia. Our results supported this hypothesis: only interoception and the interaction between alexithymia and interoception were predictive of anxiety symptoms, with alexithymia itself not independently predicting anxiety symptoms. Specifically, we observed a positive association between alexithymia and anxiety when interoception levels were moderate to high.

These findings align with existing research that underscores the relationship between interoception and anxiety. Importantly, our results suggest that this relationship persists even when accounting for the influence of alexithymia. Numerous studies have highlighted the independence of these constructs, emphasizing that the capacity to perceive and process internal body signals (interoception) is inherently linked to the experience and manifestation of anxiety, irrespective of individuals' levels of alexithymia. Noteworthy contributions to this understanding come from Khalsa et al. (2018), which explores the neurobiological connections between interoception and anxiety, and studies by Zamariola et al. (2018), suggesting that alterations in interoception may independently contribute to the development and maintenance of anxious symptoms. Further support for the significant role of interoception in anxiety, regardless of alexithymia levels, is found in the works of Pollatos et al. (2007) and Dunn et al. (2010).

Given the intricate connection between body signals and emotion, it is not surprising that several psychiatric disorders, such as anxiety disorders, are associated with altered physical sensations. While some authors have linked alexithymia with the development and maintenance of anxiety (Leweke et al., 2011; Lloyd et al., 2021), emerging perspectives suggest understanding alexithymia as a condition inherently associated with high interoception, establishing a link with anxiety symptoms (Manzoor et al., 2021). This stems from the understanding that anxiety symptoms originate from our emotional system, implying that the ability or inability to detect, process, and regulate our bodily sensations and emotions can impact these symptoms (Manzoor et al., 2021). Our results substantiate this proposition, revealing that participants with a greater presence of anxiety symptoms exhibited higher interoception. In contrast, alexithymia alone did not exhibit a significant association with such symptoms. Moreover, neuropsychological research has identified a relationship between these two constructs, with impairment seemingly attributed to damage in the anterior insula. The anterior insula, a critical brain area where interoceptive signals are integrated, provides information about body state, and its lesions can lead to deficits in body awareness and difficulties in recognizing emotions (Zamariola et al., 2018).

Hence, our findings suggest that to effectively discriminate between various physiological and emotion-related bodily states, it is important to possess somatosensory capacity enabling the sensing of internal bodily occurrences (Khalsa et al., 2018; Lloyd et al., 2021). In essence, for alexithymia to exert a significant influence on anxiety levels, awareness of sensations emanating from the body is a prerequisite.

## Limitations

Despite the findings, it is crucial to acknowledge limitations in this study. The primary constraint stems from the use of a cross-sectional design, which inherently lacks the capacity to establish evidence of causality. Additionally, while the role of gender was controlled in all analyses and yielded non-significant results, it is important to note that the sample may not be representative due to an unbalanced gender distribution, with women constituting 83%. Therefore, caution should be exercised in interpreting our results, as gender differences have been observed in previous studies. For instance, Palsler et al. (2018) found a higher prevalence of alexithymia in men, while women scored higher on anxiety and interoception. Future research should adopt a longitudinal design that accounts for gender differences. Furthermore, the reliance on self-reports (GHQ, TAS-20, and MAIA-2) through an online questionnaire introduces potential issues of subjectivity and reliability (Lyvers et al., 2022). Lastly, it is important to consider that the data were collected after the COVID-19 pandemic, which had corresponding negative impacts on the mental health of the population.

## Conclusion

In conclusion, our study revealed an association between alexithymia, interoception, and anxiety symptoms, highlighting the role of interoception as a moderator between alexithymia and anxiety. This underscores the necessity for intervention programs incorporating interoception training for individuals with anxiety. A comprehensive understanding of one's bodily reactions, coupled with accurate emotion attribution and regulation, can facilitate the modulation of the emotional system contributing to anxiety. Techniques like biofeedback or mindfulness may enhance the comprehension of bodily reactions (interoception) and the regulation of emotions, promoting greater acceptance, improved communication of bodily feelings, and self-control of physiological processes (Manzoor et al., 2021), thereby contributing to a reduction in anxious symptomatology.

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