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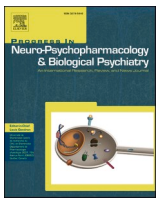

Bodily maps of emotion in psychiatry: A preregistered systematic review

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ABSTRACT

Difficulties in emotional processing are common across a wide range of psychiatric disorders. Interoception, defined as the sensing, integration, and interpretation of internal bodily signals, is thought to contribute to the subjective bodily sensations that accompany affective states. However, despite the well-established role of emotion in psychopathology, current understanding remains incomplete regarding how emotion-related bodily sensations are represented and experienced in psychiatric populations. Bodily maps of emotions make it possible to visualize where individuals feel bodily changes during discrete emotions, offering a direct window into the interoceptive phenomenology of emotional experience. This paradigm therefore provides a promising approach for examining how altered interoceptive experience may contribute to emotional disturbances across psychiatric conditions. Following PRISMA guidelines, this systematic review synthesizes research using bodily maps to assess interoceptive emotional experiences in psychiatric populations. We identified altered interoceptive phenomenology related to emotions and highlighted underexplored areas in this field.

We found altered interoceptive experiences of emotions are common across a large range of psychiatric states, including depression, schizophrenia, autism, and alcohol use disorder. Future studies should establish the mechanisms by which interoceptive experiences may contribute to difficulties in different emotional processes across its subcomponents. We hence propose new directions for the use of bodily maps to foster a more theoretically grounded and comprehensive analysis of interoceptive experiences in psychiatry.

1. Introduction

Psychiatric disorders are frequently associated with deficits in emotional processing (Gross & Jazaieri, 2014a), which underlie many of their characteristic symptoms (Phillips et al., 2003b). Emotions are proposed to result from the perception of internal bodily changes, a process called interoception, reflecting the complex interactions between the brain and the body (Critchley and Garfinkel, 2017). Within this framework, contemporary perspectives on emotion emphasize that these interactions are not limited to the transmission of bodily signals to the brain, but also involve predictive processes through which the brain interprets and organizes this information according to the environment and prior experience, such that emotions are viewed as context-dependent predictions that the brain constructs to guide action and maintain bodily well-being (Barrett et al., 2025). One promising approach to investigating the bodily dimension of emotions is the assessment of perceived bodily sensations (Bechara and Naqvi, 2004), capturing how individuals experience and interpret physiological changes across musculoskeletal, neuroendocrine, and autonomic systems involved in emotional states (Nummenmaa et al., 2014). Although this approach has provided valuable insights into the bodily basis of emotional experiences in healthy populations, its relevance for understanding emotional dysfunctions associated with mental disorders has received comparatively little attention. This systematic review investigates the use of bodily maps of emotions within psychiatric populations to study the characteristics of their emotional interoceptive phenomenology, which could provide partial explanation of deficits in emotional processing.

Recognizing and regulating emotions plays an essential role in mental health, as it contributes to cognitive functioning and well-being (Gross, 1998). Emotional deficits are often considered a central feature of psychiatric disorders (e.g., anxiety disorders, mood disorders, autism,

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schizophrenia, Kret and Ploeger, 2015). These deficits hinder the generation and use of complex affective states, feelings and behaviors in response to an internal or external emotional stimulus (Phillips et al., 2003a) which are then reflected in a range of affective difficulties in psychiatric disorders (Gross & Jazaieri, 2014). Although the role of emotions in psychiatric disorders is well recognized, current understanding of their underlying mechanisms remains incomplete, particularly regarding how subjective bodily sensations associated with emotions are represented and experienced in psychiatric populations.

While current models of emotion regulation include both cognitive and bodily aspects of emotional responding (Gross, 2015), recent advances have highlighted a more central role for interoception, the processing of internal bodily states, in shaping emotional experience and psychological well-being (Khalsa et al., 2018; Brewer et al., 2021). Importantly, interoception is increasingly recognized as a multidimensional construct rather than a unitary process, comprising distinct but related dimensions. To cite only a few examples, interoceptive accuracy refers to objective performance in detecting internal bodily signals, whereas attention capture how bodily signals are attended to (Desmedt et al., 2024; Garfinkel et al., 2015; Khalsa et al., 2018). Accounting for this multidimensionality is critical when interpreting the role of interoception in emotional experience and psychopathology. The perception and evaluation of affective bodily reactions (e.g., their intensity, valence, and localization) may contribute to shaping emotional experiences, recognizing emotional states, and guiding adaptive regulatory responses (Bechara and Naqvi, 2004). This relationship appears to be bidirectional, with bodily signals contributing to emotional experience, while emotions, expectations, and prior experiences influence how these signals are perceived and interpreted (Barrett, 2016).

On the other hand, altered interoception may also contribute to various psychiatric disorders (Khalsa et al., 2018). For example, lower performance on tasks supposed to assess interoceptive accuracy is sometimes observed in various disorders, including depression (Harshaw, 2015), schizophrenia (Ardizzi et al., 2016), and addiction (Verdejo-Garcia et al., 2012). In contrast, increased performance is sometimes observed among anxiety and panic disorder patients (Paulus and Stein, 2006). However, several meta-analyses have reported weak or non-significant associations between performance-based measures of interoception and mental health indicators (Jenkinson et al., 2024; Desmedt et al., 2022; Adams et al., 2022). This may be due to the limited construct validity of these tasks (Desmedt et al., 2023), highlighting the need for methods that more effectively capture how interoceptive processes contribute to the development and maintenance of psychiatric disorders.

Interoceptive processes are deeply intertwined with emotional mechanisms, providing one pathway through which interoception contributes to psychiatric phenomena (Medford et al., 2024). Alterations in self-reported interoceptive processes (e.g., interoceptive sensibility) may be associated with the self-reported capacity to identify and describe emotions, as illustrated in alexithymia (Hobson et al., 2018; Van Bael et al., 2024), potentially preventing adaptive emotional regulation. Indeed, individual differences in the ability to attend to and interpret internal bodily signals are also associated with emotional resilience (Wallman-Jones et al., 2021; Barca, 2025). Hence, lower ability to detect and interpret stress-related bodily signals, such as increased heart rate, muscle tension, or changes in breathing, may prevent earlier identification of negative emotional states and adaptive regulation. These difficulties may then contribute to the emotional disturbances observed across psychiatric disorders (Gross & Jazaieri, 2014). Together, these findings indicate that the interoception between emotion and interoception cannot be understood without directly examining the bodily sensations through which affective states are perceived. This raises the need for approaches that can characterize not only interoceptive ability, but also the subjective bodily sensations associated with emotional experience.

Yet current methods leave precisely this dimension uncharted. Self-report scales (e.g., MAIA; Mehling et al., 2018) beliefs about one's interoceptive abilities, whereas behavioral paradigms (e.g., Heartbeat Detection Task; Wiens et al., 2000) assess the capacity to detect internal bodily signals. Both approaches have been widely criticized: self-report scales require metacognitive and introspective abilities that may themselves be impaired in psychiatric disorders, while behavioral paradigms present low psychometric properties and fail to validly measure interoceptive accuracy (Desmedt et al., 2023; 2024; Garfinkel et al., 2015). More fundamentally, neither approach provides insight into the qualitative landscape of bodily sensations that accompanies affective states, the very layer at which interoception and emotion meet. To advance theory and intervention, the field now requires instruments that directly map how people experience emotions in the body, bridging subjective feeling, physiological change, and clinical symptomatology.

Bodily mapping methods offer one way to address this gap. The emBODY tool, developed by Nummenmaa et al. (2014), emerged as an innovative approach to assessing self-reported representations of bodily sensations associated with emotional experiences through visual body maps. This method involves participants coloring human bodies to reflect the sensations they experience in various areas of the body during an emotion, indicating where sensations are felt and their intensity (i.e., activation or deactivation). Although flexible in its implementation, this tool typically assesses 14 emotions, including six basic emotions (anger, fear, disgust, happiness, sadness, and surprise), seven secondary emotions (love, contempt, depression, anxiety, pride, shame, and envy), and one neutral state, showing cross-cultural consistency and reliability across multiple studies (Volynets et al., 2020). This tool reliably reveals varying patterns across emotions, such as intense upper limb sensations during approach-oriented emotions like anger and happiness, reduced limb activity in sadness, and strong digestive and throat sensations linked to disgust (Fig. 1). It offers a significant advantage over other methods by allowing the study of self-reported emotional interoceptive experiences without the need for participants to explicitly describe their feelings, making emBODY an accessible, cost-effective, and adaptable approach to emotional assessment (García-Magariño et al., 2018). Yet, caution is needed given that emBODY has been criticized for its measurement imprecision (Desmedt et al., under review) and its self-report nature implies that responses may be the result of many factors such as interoceptive processes, autonomic reactivity, recall bias, and conceptual knowledge or stereotypes of emotions. Out of this tool, different analytical procedures provide measures of, e.g., discriminability and similarity of bodily sensations across emotions (for definition see Box 1).

While the role of bodily sensations in emotions is recognized for long, empirical research on emotional deficits in psychiatric populations has paid more attention to cognitive processes underlying emotional experience and regulation (Khalsa et al., 2018; Brewer et al., 2021). Using bodily mapping could bridge this gap, enhancing our understanding of the subjective bodily underpinnings of emotional processes in psychiatric populations and potentially offering new perspectives at theoretical (i.e., conceptualization of the role played by bodily sensations in psychopathological disorders), empirical (i.e., reliable exploration of subjective bodily sensations and their links with cognitive/emotional processes) and clinical (i.e., developing new therapeutic avenues to develop body awareness among patients) levels. The objective of this systematic review is to examine whether individuals with psychiatric disorders exhibit altered emotional bodily sensations compared to healthy populations. By synthesizing current research, this review will shed light on the potential of the Bodily Maps of Emotions as an effective tool for the study of emotional processing, providing valuable insights for researchers and clinicians in the field of mental health.

2. Methods

2.1. Eligibility criteria (Table 1)

The methodology for this systematic review was preregistered on

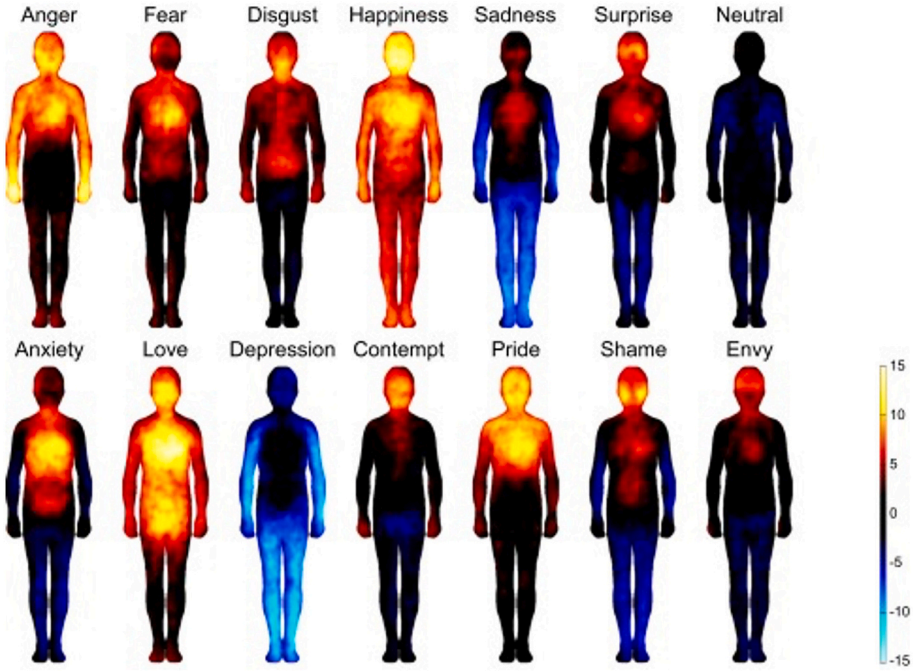

Fig. 1. Example of Bodily Maps of Emotions, extracted from Nummenmaa et al. (2014).

Box 1
Common analytical approaches for Bodily Maps of Emotions.

Discriminant Analysis:
The discriminability of bodily sensations between emotions is measured by within-participants' analyses to determine whether their bodily sensations allow to statistically distinguish one emotion from all others (one-vs-all), or to classify multiple emotion categories simultaneously (all-vs-all). This classification accuracy of bodily sensation maps is assessed using a machine learning algorithm trained to recognize specific patterns of bodily sensations corresponding to each emotion and to compare these classifications with participants' self-reported responses. This is often achieved using Linear Discriminant Analysis (LDA), conducted on bodily mapping data after having performed a principal component analysis (PCA) to simplify their dimensionality (e.g., Torregrossa et al., 2019, 2023; Lee et al., 2022; Lyons et al., 2021).

Similarity Analysis:
Similarity analysis allows quantifying how strongly bodily patterns overlap between different emotional categories or across groups. Within-participants' comparisons are often examined using pairwise correlations computed between the maps of different emotions, whereas *t*-tests or factorial designs allow between-group comparisons (Nummenmaa et al., 2018; e.g., Torregrossa et al., 2019).

Hierarchical Clustering:
Hierarchical clustering generates a structure of emotion categories based on bodily sensations. This method produces a dendrogram by treating each emotion as a node and grouping them iteratively based on their similarity (e.g., Nummenmaa et al., 2014; Nummenmaa et al., 2018).

Extent and Intensity of bodily sensations:
To quantify the extent and intensity of reported bodily sensations, researchers count the number or percentage of colored pixels representing activation (i.e., increased or intensified activity) and deactivation (i.e., decreased or weakened activity) for each emotion. Methodological approaches vary, with some studies focusing on the proportion of pixels activated to assess the spatial extent of bodily sensations, and others counting the frequency with which each pixel is selected to measure the sensation intensity (e.g., Lyons et al., 2021; Lloyd et al., 2021; Herman et al., 2024; Torregrossa et al., 2023).

Clarity:
Clarity refers to the computation of the number of pixels where both activation and deactivation sensations were simultaneously reported for the same emotion. This measure helps assess the level of overlap between opposing bodily sensations (i.e., activation and deactivation) within the same body region, thus providing insights into the coherence and distinctiveness of emotional interoceptive experiences. A high degree of such overlap indicates conflicting or ambiguous bodily representations, and thus a lower clarity of emotional interoceptive experience. Note, however, that this index should be interpreted with caution given that alternative interpretations (e.g., drawing imprecision) exist (e.g., Torregrossa et al., 2019; Lee et al., 2022).

Interindividual Variability:
Interindividual variability refers to the diversity of emotional bodily maps between participants within the same group. This variability serves as an indicator of how bodily sensations associated with emotions may differ across individuals. Greater variability suggests that emotions are perceived in a less uniform manner across the body among individuals in a group, which could indicate differences in the perception or experience of emotions. In contrast, lower variability indicates greater consistency in how emotions are embodied across the group (e.g., Torregrossa et al., 2019; Herman et al., 2024).

Subjective Visualization:
Subjective visualization refers to the researcher's interpretation of the images generated from bodily maps. It allows for the visual examination of patterns of bodily sensations associated with each emotion, helping to identify general trends and potential differences or similarities between emotions or participant groups (e.g., Lyons et al., 2021; Thomas et al., 2021; Herman et al., 2024).

Open Science Framework (doi:10.17605/OSF.IO/GBVCK). In order to determine papers' inclusion criteria, we followed the PECOS procedure (Population, Exposure, Comparator, Outcome, and Study design; (Morgan et al., 2018) as follows: (1) Regarding the Population, we included studies that examined at least one group of human participants with a psychiatric disorder, encompassing both clinically diagnosed conditions and subclinical populations; (2) Regarding the Exposure, the review was limited to studies assessing psychiatric disorders based on standardized diagnostic criteria (DSM/ICD) or subclinical traits identified through validated assessment tools with clinically established cut-off scores indicating the presence of significant psychiatric symptoms, even if diagnostic criteria for a specific disorder are not fully met; (3)

Table 1
Inclusion criteria for the selected studies.

	Inclusion criteria
1.	Articles must be in English, French or Spanish
2.	Articles must be empirical, peer-reviewed studies (i.e., presenting original data)
3.	Articles must be human studies
4.	Participants must have a diagnosed psychiatric disorder or reliably measured psychiatric symptoms.
5.	Articles must use bodily maps to assess bodily sensations related to emotions

Regarding the Comparator, we considered studies that compared at least two distinct groups (mental health vs control) as well as studies using within-group designs, such as correlational analyses assessing the relationship between bodily sensations and emotional processes within a clinical sample; (4) Regarding the Outcome, we selected studies that used bodily maps (i.e., visual representations of bodily sensations) to assess bodily sensations related to emotions. Specifically, we selected studies describing the location, intensity, frequency and/or valence of the perceived bodily sensations associated with emotions in psychiatric populations; (5) Regarding the Study Design, we included empirical research studies, covering both experimental and observational designs, while excluding case reports. Systematic reviews, meta-analyses, commentaries, editorials, and letters were not considered in our analysis. To mitigate publication bias, we also included studies reporting null results.

2.2. *Literature search (Fig. 2)*

This systematic review follows the PRISMA guidelines for systematic reviews (Moher et al., 2009). We focused on peer-reviewed articles published in English, French, or Spanish with no restriction on publication date, up to April 24, 2025, and included in at least one of the three following databases: PubMed, Scopus, and PsycINFO. In addition, we screened the peer-reviewed articles that cited studies on bodily maps of emotions by Nummenmaa et al. (2014), and the studies included in this review to maximize exhaustivity. After having conducted the preregistered search phase, we noticed that our search formula could be optimized, which led us to conduct a second search phase with this modified formula, aiming to increase the precision of the retrieved results and to ensure the comprehensiveness of the systematic review. The final search phase combined terms related to bodily maps of emotions and psychiatric disorders: ("body map" OR "body maps" OR "bodily map" OR "bodily maps" OR "body mapping" OR "bodily mapping" OR "bodily-mapping" OR "body-mapping" OR "emBODY" OR "somatosensory map" OR "somatosensory maps" OR "sensation mapping" OR "affective mapping" OR "topographical mapping") AND (Emotion* OR Affect*) AND ("Psychiatric disorder*" OR "health disorder*" OR "mental health" OR "psychological disorder*" OR "psychopathology" OR depress* OR autism OR anxiety OR "schizophrenia" OR "bipolar disorder" OR obsession* OR compulsion* OR trauma* OR stress OR "dissociative disorders" OR "somatic symptom*" OR anorexia OR obesity OR "eating disorders" OR "elimination disorders" OR insomnia OR "sexual dysfunction" OR "gender dysphoria" OR "disruptive behavior disorders" OR addicti* OR "neurocognitive disorders" OR "personality disorders" OR "paraphilic disorders" OR "Alexithymia" OR "Psychosis"). Two authors (AT and NS), working independently, selected articles by using Rayyan systematic review software (Ouzzani et al., 2016). Titles and abstracts were screened independently by both authors (AT and NS), followed by independent full-text assessments

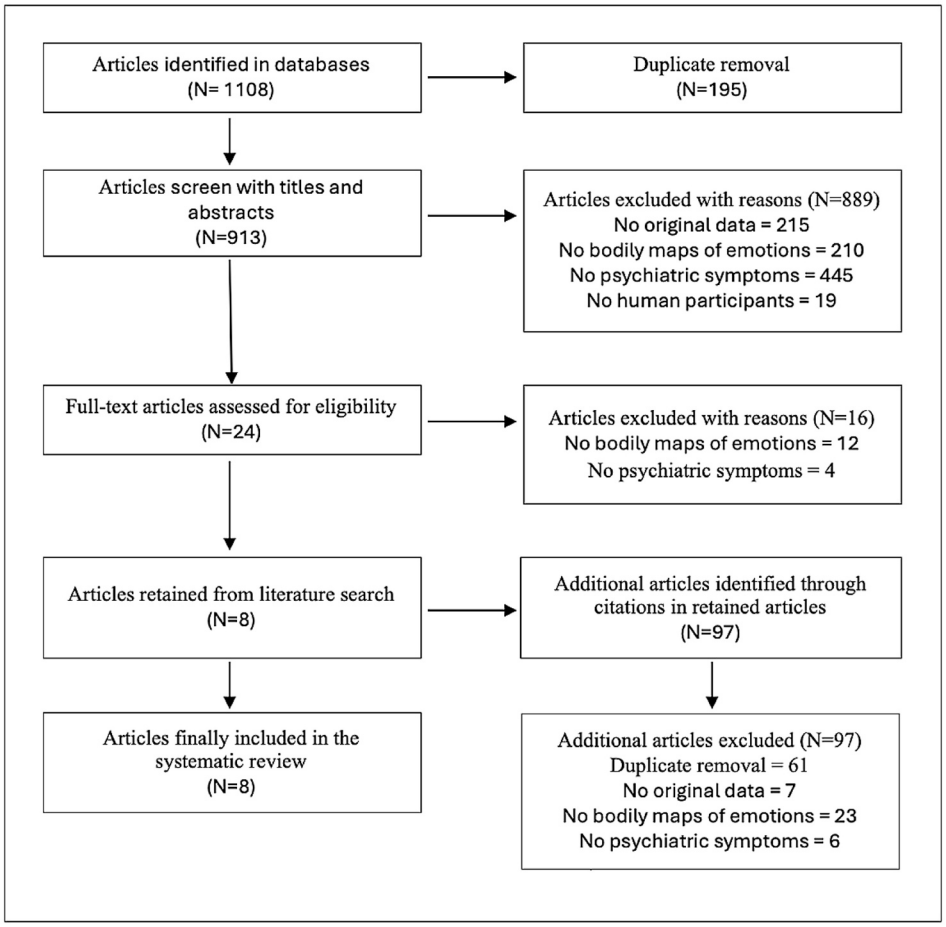

Fig. 2. Flow diagram presenting the selection of the papers reviewed.

for eligibility. Disagreements were resolved through discussion and consensus.

The initial search led to identifying 1108 papers (100 in Pubmed, 302 in Scopus, 143 in PsycINFO, 563 through citation tracking on the key studies on bodily maps). The selection of the papers included was then conducted through four main steps (Fig. 2). First, duplicates were removed, leading to the identification of 913 unique papers. Second, titles and abstracts were screened to remove papers based on the following exclusion criteria: (1) No psychiatric or subclinical population (445 papers excluded); (2) No tools involving bodily maps of emotions to assess emotion-related bodily sensations (210 papers excluded); (3) No human sample (i.e., animal studies; 19 papers excluded); (4) No experimental data presented (i.e., Systematic reviews, meta-analyses, commentaries, editorials, and letters; 215 papers excluded). In total, 889 papers were excluded using this procedure. Third, full-text versions of the 24 remaining papers were examined, leading to the selection of eight studies for the final review (see Fig. 2). Finally, citation tracking was conducted on key studies on bodily maps of emotions, as well as on the included articles. This additional step led to the identification of 97 further papers, which were screened following the same eligibility criteria. However, none of these met the inclusion criteria after full-text assessment. As a result, eight studies were included in the final review.

2.3. Methodological quality assessment and risk of bias analysis

To assess the methodological quality and risk of bias of the included studies, we employed two complementary appraisal tools: a modified version of the Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies developed by the National Heart, Lung, and Blood Institute (NHLBI, 2014), and the JBI Critical Appraisal Checklist for Analytical Cross-Sectional Studies (Barker et al., 2026). These tools were selected because the studies included in this review were primarily analytical cross-sectional studies investigating associations between psychiatric or psychological characteristics and bodily mapping outcomes.

For the NHLBI assessment, five items from the original checklist were removed,[1] resulting in nine binary (Yes/No) items. Scores ranged from 0 to 9 and were converted to percentages. Studies were classified as poor ($<$50%), fair (50–69%), good (70–79%), or strong ($\geq$80%), following Black et al. (2017). The tool assessed study objectives, population definition, exposure and outcome measurement, sample-size justification, assessor blinding, and control of confounding.

The JBI checklist assessed selection, measurement, confounding, and statistical conclusion bias, as well as the completeness of methodological reporting. Its eight items covered inclusion criteria, study setting and participants, exposure and outcome measurement, confounding, and statistical analyses. Items were rated Yes, No, Unclear, or Not Applicable. One point was assigned for each Yes response; No and Unclear received zero points, and Not Applicable items were excluded when relevant. Total scores ranged from 0 to 8, with higher scores indicating lower risk of bias and better methodological quality.

Supplementary Material Tables S1 and S2 present the detailed methodological quality and risk of bias ratings for each included study, including individual item scores, overall quality assessments, and total methodological quality scores obtained using the adapted NHLBI and JBI appraisal tools.

[1] Excluded items: “Was the participation rate of eligible persons at least 50%?”; “For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured?”; “Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed?”; “Was loss to follow-up after baseline 20% or less?”; “Was the exposure(s) assessed more than once over time?”.

2.4. Data extraction and synthesis

A systematic data extraction procedure was used to individually identify the key characteristics of each article, focusing on five categories of variables (adapted to the PECOS framework): (1) Population (sample size, age, and gender ratio); (2) Exposure (specification of the disorder or the subclinical classification, the severity measure used and the mean score); (3) Comparator (presence and size of the control group); (4) Experimental design (specification of the tool used, number of emotions studied, type of emotion, data collection setting (laboratory or online), and statistical analysis); (5) Outcomes (key findings and reported limitations). A comprehensive synthesis of the data extracted from each study is presented in Table 2.

First, the main results related to the assessment of study quality are presented. Second, a brief overview of the key characteristics of the selected studies is provided. Finally, we review the primary findings from the included studies concerning bodily perceptions reported by psychiatric and subclinical populations. For the sake of clarity, the results are organized according to psychiatric diagnoses, beginning with clinically diagnosed disorders and followed by subclinical traits. We adhered to the terminology defined in Box 1, although a strict correspondence between nomenclature and specific statistical analyses across studies was not always present. Grouping similar concepts and measures under a common framework facilitates the extrapolation and comparison of findings across different studies.

3. Results

3.1. Characteristics of the studies

Concerning the geographical distribution of the eight papers selected (i.e., laboratory of the first author), five of the selected studies were conducted in North America (four in the United States, one in Canada), and three in Europe (one in the United Kingdom, one in Germany, and one in Poland).

Publication years suggest a clear increase in studies in recent years. Among the included papers, only one study was published before 2020 (in 2018), while seven were published from 2020 onward (including four in 2021 alone), reflecting a growing interest in this topic during the past five years.

The selected studies investigated a variety of psychiatric conditions, including major depressive disorder, schizophrenia (two studies), schizotypy, and autism spectrum disorder. Several selected studies also examined subclinical traits assessed using validated tools with clinically established cut-off scores, indicating the presence of significant psychiatric symptoms such as alexithymia, alcohol use, and hallucinations. Five studies included participants with a formal psychiatric diagnosis, while three focused on individuals with subclinical symptoms or without a confirmed diagnosis. Most of the studies compared psychiatric groups with healthy control participants; however, one study (Torregrossa et al., 2023) examined a single group with schizotypal traits. While most participants were adults, one study (Palser et al., 2021) specifically examined children with autism.

Regarding the bodily maps tool, while most studies used the online version of emBODY, one study initially applied a pen-and-paper format, with data later digitized for analyses (Palser et al., 2021). The number of emotions assessed varied notably across studies, ranging from 6 to 17. The most investigated emotions included anger, fear, disgust, sadness, happiness, and a neutral condition. In addition to these core emotions, several studies explored a broader spectrum, including anxiety, love, depression, pride, shame, jealousy, and additional specific affective states, including feeling numb, frozen, empty, or lonely.

3.2. Main findings

Across the eight included studies, bodily maps were used to

Table 2
Description and main results of bodily maps of emotions in psychiatric population.

Reference	Population			Exposure			Comparator		Outcomes					
	N	Age (mean and SD)	Sex (M/F)	Disorder type	Disease severity measure	Mean Score + SD	Control group (N)	Tool used	Number of emotions	Type of emotion	Data collection setting	Statistical analysis	Key findings	Reported limitations
Herman et al. (2024)	91	22.67 (3.30)	9/82	Alcohol consumption	AUDIT[10] (≥ 7)	10.53 (3.59)	90	emBODY	11	anger, fear, disgust, sadness, happiness, surprise, anxiety, hope, contempt, confusion and neutral condition	Online	Emotion discriminability, Similarity, Extent of bodily sensation, Interindividual Variability	Hazardous drinkers showed more widespread but less discriminable bodily sensations than low-risk drinkers. Higher extent of bodily activations. Lower interindividual variability: emotional sensations mainly localized in head and chest regions.	Online format with no time limit. University student sample, predominantly female. No additional health information collected, such as substance use history or mental health status. Lack of data on recent or end-of-study alcohol consumption; acute intoxication or withdrawal could have affected emBODY task performance.
Lee et al. (2022)	26 Korea	46.35 (9.88)	9/17	Schizophrenia	DSM-5	NR	26	emBODY	14	anger, fear, disgust, sadness, happiness, anxiety, love, depression, pride, shame, jealousy, loneliness, stress and neutral condition	Laboratory	Emotion discriminability, Extent of bodily sensation, Clarity	Participants with schizophrenia showed overall reduced bodily sensations compared to controls, especially for low-arousal emotions. less clear and less discriminable bodily sensations in schizophrenia. Similar patterns of emotional discernibility found across both cultural groups.	Interoceptive accuracy or awareness was not independently assessed. Medication use was not controlled.
	26 USA	44.85 (8.16)	12/14			NR	26							
Lloyd et al. (2021)	46	36.13 (8.67)	17/30	Alexithymia	TAS-20[3]	58.19 (6.55)	51	emBODY	17	anger, fear, disgust, sadness, happiness, surprise, anxiety, love, depression, contempt, pride, shame, jealousy, numb, frozen, empty and	Online	Extent of bodily sensation	Alexithymic group showed more widespread extent of activation and deactivation but less intense and less discriminable bodily sensation. Reported fewer activating sensations for happiness and	Online format may have introduced self-selection bias affecting the results. Limitations of the TAS-20 may have influenced findings. Comorbid conditions associated with alexithymia symptoms were not controlled for in this study.

(*continued on next page*)

Table 2 (*continued*)

Reference	Population			Exposure			Comparator		Outcomes					
	N	Age (mean and SD)	Sex (M/F)	Disorder type	Disease severity measure	Mean Score + SD	Control group (N)	Tool used	Number of emotions	Type of emotion	Data collection setting	Statistical analysis	Key findings	Reported limitations
										neutral condition			jealousy, and fewer deactivating sensations for fear.	
Lyons et al. (2021)	30 with medication	43.6 (11.7)	14/16	Major depressive disorder	SCID-I[1], BDI II [2]	NR	30	emBODY	6	anger, fear, disgust, sadness, happiness and neutral condition	Laboratory	Emotion discriminability, Extent of bodily sensation, Subjective Visualization	In MDDnm group, extent of bodily sensation was generally lower than healthy control (Clearer divergences for fear and sadness). Emotion discriminability was largely similar between the MDDnm and control groups, except for sadness. Antidepressant treatment further dampens the embodied experience of emotions.	Potential bias due to selection of mildly intense images focused on social situations. Possible non-comparability of groups due to differences in depressive history despite equal current symptom severity. Concurrent use of multiple antidepressants among some participants.
	30 without medication	45.0 (14.2)	13/17		SCID-I[1], BDI II [2]	NR								
Palser et al. (2021)	45	13.27 (2.75)	35/9	Autism (children)	l'ADOS-2[8], SCQ[9]	ADOS-2: 6.61 (2.40) SCQ: 21.92 (6.74)	55 children 134 adults	emBODY (pen-and-paper version)	7	anger, fear, disgust, sadness, happiness, sadness, surprise and a neutral condition which was termed "calm."	Laboratory	Emotion discriminability	Autistic children had less discriminability in bodily sensations across emotions, particularly in areas such as the head, heart, and hands. Reduced bodily differentiation is region-specific, not generalized across the whole body.	A larger number of male than female participants.
Thomas et al. (2021)	8	NR	NR	Hallucination	MUSEQ[7]	NR	10	emBODY	14	anger, fear, disgust, sadness, happiness, axiety, love, depression, contempt, pride, shame, jealousy,	Laboratory	Emotion discriminability, Extent of bodily sensation, Subjective Visualization	Subtle but consistent patterns: low proneness associated with more activation, high proneness with more	Small sample size. Demographic variables could not be included in the models to assess their contribution to explained variance.

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Table 2 (*continued*)

Reference	Population			Exposure			Comparator		Outcomes					
	N	Age (mean and SD)	Sex (M/F)	Disorder type	Disease severity measure	Mean Score + SD	Control group (N)	Tool used	Number of emotions	Type of emotion	Data collection setting	Statistical analysis	Key findings	Reported limitations
										loneliness, stress and neutral condition			deactivation across emotions.	
Torregrossa et al. (2019)	26	46.35 (9.88)	9/17	Schizophrenia	DSM-5, BPRS[4]	BPRS: 17.31 (7.58)	26	emBODY	14	anger, fear, disgust, sadness, happiness, surprise, anxiety, love, depression, contempt, pride, shame, jealousy and neutral condition	Laboratory	Emotion discriminability, Similarity, Extent of bodily sensation, Clarity, Interindividual Variability, Subjective Visualization	participants diagnosed with schizophrenia exhibited less discriminable bodily maps. No significant difference in overall intensity of sensations between groups but less precision in the localization of their emotional bodily sensations. Report more simultaneous sensations of activation and deactivation in the same body regions. more deactivation for high-arousal emotions.	Small sample size. Participants were medicated, but medication dosage was not correlated with emotional embodiment measures. Prior exposure to computer technologies was not controlled No physiological data were collected during the emBODY task. Interoceptive accuracy was not independently assessed.
Torregrossa (2023)	419	19.50 (1.22)	107/312	Schizotypy	SPQ[5], SPQ-B[6]	NR	No group control	emBODY	12	anger, fear, disgust, sadness, happiness, anxiety, love, depression, pride, shame, jealousy and neutral condition	Laboratory	Emotion discriminability, Extent of bodily sensation, Clarity	High negative schizotypy linked to more intense but less clear bodily sensations. Incongruent patterns observed: deactivation during high-arousal emotions and activation during low-arousal emotions.	Student sample may have led to underrepresentation of high schizotypy scores. Dimensional approach to schizotypy limits the ability to draw conclusions about emotional interoceptive experiences in individuals with high schizotypy versus those with diagnosed schizophrenia.

List of abbreviations: NA = Not Applicable; NR = Not Reported.
[1]Structured Clinical Interview for DSM-IV (SCID-I; Münster, 1999)), [2]Beck Depression Inventory II (BDI II; Wideman et al., 2013), [3]Toronto Alexithymia Scale (TAS; Bagby et al., 1994), [4]Brief Psychiatric Rating Scale (BPRS; Overall and Gorham, 1962), [5]Schizotypal Personality Questionnaire (SPQ; Raine, 1991), [6]Schizotypal Personality Questionnaire-Brief (SPQ-B; Raine and Benishay, 1995), [7]Multi-Modality Unusual Sensory Experiences Questionnaire (MUSEQ; Mitchell et al., 2017), [8]Autistim Diagnostic Observation Schedule - 2 (ADOS-2; Lord et al., 2012), [9]Social Communication Questionnaire (SCQ; Rutter et al., 2003), [10]Alcohol Use Disorder Identification Test (AUDIT; Klimkiewicz et al., 2021).

characterize the sensations that participants associate with discrete emotions, and to compare these representations between psychiatric and control groups. Results are organized according to psychiatric diagnoses, beginning with clinically diagnosed disorders and followed by subclinical traits.

3.2.1. Psychiatric disorders

3.2.1.1. Major depressive disorder. Only one study applied bodily maps of emotions in the context of major depressive disorder (MDD). Lyons et al. (2021) used images to elicit emotions with the emBODY task, asking participants to indicate on a body outline where they feel specific sensations when experiencing these emotions. The aim was to examine bodily sensations associated with these emotions in individuals with MDD (diagnosed using the German version of the Structured Clinical Interview for DSM-IV, SCID-I), comparing two clinical groups, respectively taking (MDDm) or not taking (MDDnm) antidepressant medication, to a healthy control group.

In the unmedicated group (MDDnm), emotion discriminability was largely similar between the MDDnm and control groups (HC: M = 36%; MDDnm: M = 34%), except for sadness (20.16%), an emotion for which MDDnm patients exhibited less distinct bodily experiences compared to other emotions. This may indicate that sadness is characterized by less differentiated bodily sensations in unmedicated MDD patients. While emotion discriminability remained largely comparable, notable differences emerged in the extent of bodily sensations during emotional experience, which was generally lower than in healthy controls; they painted only 63% as many pixels as those of healthy controls overall. This attenuation might reflect reduced emotional reactivity, differences in the reporting of bodily sensations, or reduced motivation particularly prominent in these participants. Additionally, the authors visualized the aggregated body maps of each group and concluded that maps were quite similar between groups for disgust, happiness and neutral emotional states, but more dissimilar for fear and sadness. Individuals in the MDDnm (vs. control) group, showed lower activation in the legs in response to fear, as well as reduced activation in the chest and stomach in response to sadness.

In the medicated group (MDDm), emotion discriminability remained relatively high for disgust (41.50%), happiness (52.60%), fear (32.25%), and neutral emotional states (95.42%). However, in this group, sadness was more frequently misclassified as happiness (35.6%) rather than correctly identified as sadness (32.9%), suggesting that sadness may lack distinctiveness in depression. This may be due to the reduced experience of happiness in these individuals, leading them to report bodily sensations associated with sadness instead. Additionally, when compared to the unmedicated (MDDnm) and control groups, the extent of activation was lower throughout the body, except in the heart, stomach, and head areas. These findings may suggest that antidepressant treatment further dampens the embodied experience of emotions, although this may simply be due to greater depression severity rather than the treatment itself. However, in this study, the authors suggested that the social focus of the selected images may have influenced the results, because images depicting social interactions could elicit more moderate or more specific emotional responses compared to non-social images. A different choice of stimuli could yield different results.

3.2.1.2. Autism spectrum disorder. Only one study applied bodily maps of emotions in the context of autism spectrum disorder. Palser et al. (2021) used a pen-and-paper version of the emBODY task, in which participants were asked to indicate on a body silhouette where they feel specific sensations when experiencing a given emotion. The aim was to assess emotion-related bodily differentiation in children with autism (based on the Diagnostic and Statistical Manual of Mental Disorders, DSM-IV-TR) compared to a healthy control group.

Results showed that children with autism exhibit less discriminability in bodily sensations across emotions, particularly in areas such as the head ($F(10, 84) = 3.728$, $p < .001$, adjusted $R^2 = 0.225$, predicted $R^2 = 0.124$), heart ($F(10, 84) = 2.847$, $p = .004$, adjusted $R^2 = 0.164$, predicted $R^2 = 0.044$), and hands ($F(10, 84) = 2.163$, $p = .028$, adjusted $R^2 = 0.110$, predicted $R^2 = -0.035$), which are typically associated with distinct emotional experiences. However, no differences were observed in the gut region. These findings suggest that the reduced differentiation in bodily emotional responses is specific to certain areas of the body, rather than reflecting a general difference in emotional reactivity across the entire body.

3.2.1.3. Schizophrenia. Two studies applied bodily maps of emotions in the context of schizophrenia by asking participants to mark on a body silhouette where they feel specific sensations when they experience a given emotion.

Torregrossa et al. (2019) examined how individuals diagnosed with schizophrenia (based on DSM-5 criteria) experience bodily sensations associated with emotions compared to a healthy control group. In this study, participants diagnosed with schizophrenia exhibited less discriminable bodily maps (HC: 10.82%, $p < .01$; SZ: 8.71%, $p > .05$) compared to healthy controls, suggesting a reduced perception of bodily sensations across emotions. Additionally, a low similarity score (assessed using Spearman correlations) for deactivation maps of low-arousal emotions between individuals with schizophrenia and healthy controls (i.e., sadness $r = -0.010$, $p = .11$; depression $r = -0.084$, $p < .001$) indicates that individuals with schizophrenia showed specific alterations in the subjective interoceptive experience of low-arousal emotions. However, despite these differences in discriminability and similarity, the overall extent of reported bodily sensations did not significantly differ between the two groups. This suggests that although individuals with schizophrenia exhibit altered perception and differentiation of emotion-related bodily sensations, the total of bodily sensations they experience remains comparable to that of healthy individuals. Additionally, for each emotion, they were more likely to report simultaneous sensations of activation and deactivation in the same body regions ($M = 12{,}043.35$, $SD = 18{,}547.08$) compared to the control group ($M = 9098.846$, $SD = 20{,}467.74$) (U = 225.5, $p = .037$, $r = 0.29$), suggesting a reduced clarity in the distinction of bodily sensations. Greater interindividual variability in emotional bodily maps was also observed in this group, with less concordance in how emotions were experienced. Moreover, subjective visualization of the difference maps (activation minus deactivation) showed that individuals with schizophrenia experienced more deactivation for high-arousal emotions (i.e., fear, anger, happiness, pride), contrasting with the expected bodily responses in the general population, where high-arousal emotions are usually characterized by bodily activation, whereas low-arousal emotions (i.e., depression) are associated with deactivation.

Lee et al. (2022) extended this line of research by comparing bodily maps of emotions in schizophrenia across two cultural contexts (South Korea and the United States; diagnosed according to DSM-5 criteria), comparing each clinical group to their respective healthy control groups. Regardless of culture, participants with schizophrenia reported overall reduced extent of bodily sensations compared to controls, especially in response to low-arousal emotions. Supporting the finding of Torregrossa et al. (2019), participants with schizophrenia reported less discriminable bodily sensations across emotions (Korean–HC: 9.59%, $p < 0.05$; USA-HC: 11.06%, $p < 0.01$; Korean-SZ: 8.47%, $p > 0.05$; USA-SZ: 8.15%, $p > 0.05$). Furthermore, the emotional discriminability pattern was similar between the participants with schizophrenia from South Korea and the USA. These results suggest that alterations in emotional interoceptive experiences in individuals with schizophrenia may be stable at a cross-cultural level.

3.2.2. Subclinical traits

3.2.2.1. Traits associated with the schizophrenia spectrum. Two studies applied bodily maps of emotions in the context of subclinical populations exhibiting traits associated with the schizophrenia spectrum: schizotypal traits (Torregrossa et al., 2023) and hallucination proneness (Thomas et al., 2021). In both studies, participants were asked to indicate on a body silhouette where they feel specific sensations when they experience a given emotion.

Torregrossa et al. (2023) employed a within-group approach to assess emotion-related bodily differentiation. Although they did not find significant results for positive and disorganized schizotypy traits, they found that individuals with high levels of negative schizotypy reported more intense bodily sensations overall (r (417) = 0.16, p = .003), with similar results observed for both low-arousal emotions (depression and sadness) (r (417) = 0.19, p = .0002) and high-arousal emotions (happiness, love, pride, anger and fear) (r (417) = 0.13, p = .03). In other words, the higher the negative schizotypy score, the more intense the bodily sensations reported, suggesting an amplification of subjective bodily experience. However, such increased subjective bodily experience does not necessarily imply better or more adaptive interoceptive accuracy. Given the nature of the bodily mapping paradigm, this finding may reflect a variety of underlying processes and should therefore be interpreted cautiously. However, none of the schizotypy traits were significantly associated with the extent of bodily sensations (negative: r (417) = 0.02, p = .11; positive: r(417) = −0.007, p = .88; disorganized: r (417) = −0.02, p = .74). On the other hand, participants with high negative schizotypy also exhibited atypical patterns, such as deactivation during high-arousal emotions (joy, love, pride, anger, fear; r(417) = 0.13, p = .02) and activation during low-arousal emotions (r(417) = 0.12, p = .05), reflecting ambiguous bodily representations and altered interoceptive processing across different emotional states.

Similarly, Thomas et al. (2021) focused on emotional interoceptive experiences in relation to hallucination proneness (assessed using The Multi-Modality Unusual Sensory Experiences Questionnaire, MUSEQ), aiming to assess emotion-related bodily differentiation compared to a healthy control group. This measure is particularly relevant in the context of schizophrenia, as similarities have been established between hallucinatory experiences and the clinical manifestations of schizophrenia spectrum disorders (Ford et al., 2014; Peters et al., 2016). Although no major group differences were observed in the extent of bodily maps between high and low proneness groups, the authors noted subtle but consistent variations in the subjective visualization of bodily maps. Specifically, individuals with low hallucination proneness reported more bodily activation, whereas those with higher proneness exhibited more deactivation across emotional states. This could indicate that individuals with lower hallucination proneness experience greater bodily activation, whereas those with higher proneness tend to exhibit more pronounced bodily deactivation.

3.2.2.2. Alexithymia. Only one study applied bodily maps of emotions in the context of alexithymia. Lloyd et al. (2021) used the emBODY task, asking participants to indicate on a body outline where they feel specific sensations when experiencing particular emotions. The aim was to investigate the distribution of emotion-related bodily sensations in adults who had experienced early maltreatment or neglect, comparing those with probable alexithymia (assessed using the Toronto Alexithymia Scale, TAS-20) to a healthy control group. The study focused on examining whether there were significant differences in the intensity and specificity of bodily sensations associated with various emotions between these two groups.

The results revealed that, compared to the non-alexithymic group, sensations were suggested to be less discriminable across particular emotional states, although no statistical results were provided to support this claim. This could imply a reduced ability to clearly differentiate bodily sensations linked to distinct emotions in individuals with probable alexithymia. Participants with probable alexithymia also exhibited a more widespread extent of activation and deactivation sensations across the body, indicating that sensations were reported over larger body areas for both activation and deactivation across emotions, although these sensations were generally less intense. Note that, as with discriminability, no statistical comparisons were reported for these measures. Moreover, they reported significantly fewer activating sensations for happiness ($\chi^2(1) = 7.8$, p = .005) and jealousy ($\chi^2(1) = 4.4$, p = .04), as well as fewer deactivating sensations for fear ($\chi^2(1) = 10.1$, p = .002). The authors suggest that this might indicate a more muted or blunted emotional experience in the alexithymia group.

3.2.2.3. Alcohol consumption. Only one study applied bodily maps of emotions in the context of alcohol consumption. Herman et al. (2024) used the emBODY task, asking participants to indicate on a body outline where they feel specific sensations when experiencing particular emotions. The aim was to assess emotion-related bodily differentiation in hazardous drinkers (based on AUDIT >7) compared to a healthy control group.

Hazardous drinkers showed less discriminable bodily sensations across all emotions compared to low-risk drinkers (F(1,1998) = 441.16, p < .001), suggesting a reduced ability to differentiate bodily sensations between emotions. In addition, they exhibited a more widespread pattern of bodily sensations, although the authors did not report statistical analyses to confirm this observation. Consistent with this, hazardous drinkers also reported a higher extent of bodily activations (F (1,179) = 6.15, p = .014, η^2 = 0.008). Furthermore, their emotional maps showed overall lower interindividual variability, indicating greater consistency in how emotions are embodied within this group. Specifically, hazardous drinkers tended to localize emotional sensations in similar body areas, primarily in the head and chest regions.

4. Discussion

4.1. Altered subjective perception of emotional bodily signals in psychiatric populations

Across the eight studies included in this review, a consistent pattern emerges when examining bodily maps of emotions in psychiatric populations. Individuals with psychiatric disorders or psychiatric symptoms tend to show altered self-reported emotional bodily sensations compared to healthy controls. This pattern was observed across a range of psychiatric states, including major depressive disorder, schizophrenia, alexithymia, autism, and problematic alcohol use.

Overall, we observe a reduction in the intensity of bodily sensations associated with emotions in several disorders, including depression, alexithymia, and schizophrenia (Lyons et al., 2021; Lloyd et al., 2021; Torregrossa et al., 2019; Lee et al., 2022). In contrast, an overall increase in the intensity was observed in individuals with problematic alcohol consumption, although this activation was less discriminable across emotions (Herman et al., 2024). A similar pattern was observed in individuals exhibiting negative schizotypy traits (Torregrossa et al., 2023), contradicting findings of blunted bodily responsiveness found in schizophrenia (Torregrossa et al., 2019; Lee et al., 2022). This contradiction may reflect variable interoceptive profiles depending on the severity or type of symptoms.

More generally, in all disorders studied, a reduction in emotional discriminability of bodily sensations was observed, varying across emotions and psychiatric disorders. In individuals with depression, sadness was often less clearly differentiated in bodily sensations (Lyons et al., 2021), while in schizophrenia, participants reported lower clarity in bodily sensations across all emotions (Torregrossa et al., 2019). These findings highlight the variability in emotional discriminability across psychiatric disorders, suggesting that emotional processing difficulties

may be both disorder-specific and emotion-dependent. In terms of spatial localization, several studies highlighted a reduced activation of specific body regions: for example, a decrease in activation in the legs (in response to fear) and in the chest/stomach (in response to sadness) in individuals with depression (Lyons et al., 2021), reduced differentiation in the head, heart, and hands in children with autism (Palser et al., 2021), and a concentration of sensations in the head and chest in heavy drinkers (Herman et al., 2024). Regarding intra-individual variability, a greater variability was observed in schizophrenia (Torregrossa et al., 2019), while a lower variability was observed in hazardous drinkers (Herman et al., 2024). Additionally, some disorder-specific findings emerged. For example, sadness was frequently confused with happiness in depressive disorders, alexithymia, and schizophrenia (Lyons et al., 2021; Lloyd et al., 2021; Torregrossa et al., 2019). Similarly, in schizophrenia, participants individually reported simultaneous sensations of activation and deactivation in the same body regions for the same emotion (Torregrossa et al., 2019; Torregrossa et al., 2023). In individuals with autism, the reduction in bodily differentiation appeared to be localized to certain specific body areas, suggesting that it is not a generalized alteration of emotional reactivity (Palser et al., 2021).

Taken together, these findings indicate that bodily maps provide complementary measures of the subjective representation of bodily experiences, such as overall intensity, regional specificity, and emotion confusion, that can reveal both inter-group and intra-individual differences in the bodily representation of emotion across psychiatric disorders. However, these representations should not be interpreted as direct measures of interoceptive signals, but rather as subjective reconstructions of bodily experiences that may be influenced by multiple factors, including interoceptive processes, memory, conceptual knowledge, emotional beliefs, and culturally shared representations of emotions. Across disorders, several recurring patterns nevertheless emerge, including reduced discriminability of bodily sensations across emotions, changes in the reported intensity or extent of bodily sensations, and atypical bodily representations of particular emotional states (Lyons et al., 2021; Lloyd et al., 2021; Torregrossa et al., 2019, 2023; Lee et al., 2022; Palser et al., 2021; Herman et al., 2024). These observations highlight the potential value of bodily mapping paradigms for investigating transdiagnostic variations in the subjective bodily experience of emotions. However, given the self-report nature of bodily mapping tasks, such patterns should not be interpreted as direct evidence of shared underlying interoceptive mechanisms.

4.2. Incomplete coverage of psychiatric disorders in bodily mapping research

An important gap emerging from this systematic review concerns the limited range of psychiatric conditions investigated using bodily mapping paradigms. While the included studies focused on disorders such as depression, schizophrenia, autism, and problematic alcohol use, several major psychiatric conditions remain absent or underrepresented, reflecting the limited implementation of bodily mapping tools (e.g., emBODY) across a broader spectrum of clinical populations. This is particularly noteworthy given that several underrepresented conditions, including anxiety disorders, eating disorders, and somatic symptom disorders, are characterized by well-documented alterations in interoceptive processing and body-related representations (Paulus & Stein, 2010; Khalsa et al., 2018; Brewer et al., 2021). Anxiety disorders have consistently been associated with several alterations in self-reported interoceptive processing, including greater negative attention to bodily signals, increased sensitivity to bodily sensations, more frequent monitoring of internal states, and difficulties describing these sensations (Clemente et al., 2024). Similarly, eating disorders have been associated with alterations in body representation and atypical processing of bodily signals, including differences in the perception of hunger, satiety, and emotional arousal (Khalsa et al., 2015). Notably, body-mapping approaches have already shown promise in anorexia nervosa (Ralph-Nearman et al., 2021). For example, Somatomap measures of body image disturbance were significantly associated with eating disorder severity. Although this paradigm focused on body image representations rather than emotion-related bodily sensations and was therefore not included in the present review, these findings suggest that emotion-focused bodily mapping paradigms may also prove valuable in this population. Somatic symptom disorders also involve atypical interpretation of bodily sensations, frequently leading to increased symptom reporting and distress despite the absence of clear medical explanations (Van den Bergh et al., 2017). Given these potential alterations, these conditions represent particularly relevant targets for bodily mapping paradigms. This could help determine whether these conditions are characterized by heightened, blunted, or poorly differentiated bodily representations of emotions, and whether these patterns vary across emotional categories.

4.3. Limitations and future directions

4.3.1. Exploration of other emotional components

Within a triadic model of emotional processing comprising identification, response, and regulation (Phillips et al., 2003a), the studies in this systematic review predominantly addressed the emotional response component, since they mostly asked participants to report the somatomotor expressions of the emotions they felt or recalled. Yet, it is important to note that when participants are requested to report the bodily sensations felt in response to emotional stimuli, this may also partially involve the capacity to identify the emotional significance of the stimuli (i.e., the identification component), but also processes related to the generation and regulation of emotional responses.

Importantly, most studies relied on retrospective designs without real-time emotion induction. Consequently, bodily maps may reflect participants' capacity to recall or infer bodily sensations associated with emotions rather than immediate interoceptive experiences. This process may rely partly on semantic knowledge or culturally learned stereotypes (e.g., 'joy feels like warmth in the chest') rather than actual interoceptive experience, such that observed alterations could reflect impairments in semantic recall rather than pure online interoceptive experience. Furthermore, no study has directly investigated how bodily sensations interact with the identification and regulation components. Examining these processes from a bodily perspective may nevertheless extend current evidence on emotional processing beyond neural mechanisms alone.

Building on the triadic distinction outlined above, we believe that a more nuanced investigation into how bodily sensations support or participate in each emotional subcomponent could provide a richer and better-structured understanding of emotional processes in psychiatric populations. Starting with emotional identification, one possible approach could be to combine bodily maps of emotions with basic emotion identification tasks within the same experimental paradigm, using the same emotional stimuli (e.g., facial expressions, body postures, or vocal cues). Such a design would make it possible to examine whether the characteristics of subjective bodily representations (e.g., intensity, discriminability, or localization of sensations) are associated with participants' ability to correctly identify emotions. Indeed, such methodologies have proven sensitive to emotion identification deficits in psychiatric (i.e. Garrido-Vásquez et al., 2011; Martini et al., 2025). This could be assessed across different modalities such as facial expressions, body postures, and vocal cues for both basic emotions (e.g., fear, happiness) and self-conscious emotions (e.g., shame, pride), which involve additional social and evaluative components (Tracy and Robins, 2004), providing additional insights into the interplay between bodily sensations and the emotion identification process in psychiatric populations. Beyond correlating bodily sensations with emotion identification performance, future research could also manipulate actual levels of physiological arousal to examine how bodily sensations impact the ability to identify emotional stimuli. Experimental studies have already

adopted such mechanistic approaches, demonstrating that modulating internal bodily signals can causally influence emotional perception and identification (e.g., Pezzulo et al., 2018; Yu et al., 2021; Kever et al., 2015). Building on this work, bodily mapping could be integrated into these paradigms to visualize and quantify how induced physiological changes shape the spatial distribution and intensity of perceived bodily sensations, thereby providing a direct link between physiological states and emotional identification performance. This approach would inform about the role of bodily sensations in the capacity to identify the emotional valence and motivational salience of a stimulus.

Regarding emotional response, bodily mapping can be used to explore how individuals perceive and represent the somatic components of emotions as they are experienced. Most studies included in this systematic review have employed bodily maps in a retrospective format, where participants are presented with emotion words and asked to recall and localize the corresponding bodily sensations (Lloyd et al., 2021; Torregrossa et al., 2018, 2023; Lee et al., 2022; Herman et al., 2024; Palser et al., 2021; Thomas et al., 2021). Only Lyons et al. (2021) used emotionally evocative images to examine associated bodily sensations in patients diagnosed with major depressive disorder. The induction of affective states using emotionally charged videos and images (see Uhrig et al. (2016) for a perspective on methodology selection) would allow studying how bodily sensations map onto objective (e.g., behavioral performance, physiological measures such as ECG or skin conductance) and subjective (self-report) measures of emotional response, excluding the biasing influence of memory recall present in previous studies. In the context of psychiatric populations, this would allow disentangling the role of bodily sensations in impaired emotional response and determining whether classical measures of emotional response align with the bodily sensations mapped by participants.

Finally, regarding emotional regulation, one promising direction could be to combine bodily mapping with self-report measures of emotion regulation abilities, and experimentally examine their interplay in generating adaptive or maladaptive responses to stress (i.e. Trier Social Stress Test, Emotional regulation Task, Cognitive Reappraisal Experimental Task). The integration of bodily mapping in stress or emotional induction paradigms could thus improve our understanding of the often-overlooked bodily dimension of emotional regulation. Regulating emotions may not only involve changing one's thoughts or appraisals but also reducing the associated bodily activation. Given that previous research has shown that self-perceived sensory sensitivity is associated with greater emotional dysregulation (Merwin et al., 2013), this may extend to sensitivity to interoceptive signals, this approach could help determine whether emotion dysregulation is linked to alterations in the ability to regulate bodily sensations.

4.3.2. Methodological improvement

In parallel with expanding the scope of emotional components studied, future research would benefit from methodological refinements to enhance the reliability, validity, and interpretability of findings. First and foremost, all included studies relied on emBODY, which has notable limitations (Desmedt et al., preprint). Most importantly, valence is not captured, precluding analyses of how the subjective tone of emotional experiences differs across clinical states. The recently developed InteroMap (Desmedt et al., under review) addresses this gap, and future studies using it will be needed to reassess the robustness of previous conclusions.

A second limitation is the absence of clear guidelines for the statistical analyses applied to bodily maps. The included studies employed a variety of approaches (see Box 1), and although most focused on discriminability and the extent of bodily sensations, they relied on heterogeneous methods to do so. This heterogeneity, which applies to both analytical procedures and their interpretation, complicates direct comparisons across studies and likely contributes to inconsistent findings. Standardized analytical pipelines and reporting conventions are therefore needed to support interpretability and reproducibility in this emerging literature.

A third challenge concerns interindividual variability in how emotions are conceptualised and labelled, which may itself hinder map comparability. Some studies have addressed this by providing participants with reference definitions of the emotional terms used in the task (Torregrossa et al., 2019; Lee et al., 2022), an approach that helps standardise interpretation. The delivery format raises further considerations, particularly in patient populations where familiarity with computerized tools may be lower.

Finally, bodily maps on their own cannot reveal the mechanisms underlying individual differences in emotional bodily sensations. Because the task relies on retrospective self-report, atypical maps may reflect alterations at any stage of a sequence that includes the identification of the emotional stimulus, the physiological reaction, its perception, the ability to recall it, and the ability to report it onto bodily maps. Rather than reflecting a single aspect of interoception (e.g., interoceptive phenomenology), bodily mapping outcomes likely emerge from the combined contribution of multiple dimensions distributed across the hierarchy of interoceptive processing, including the sensing, attention, integration, interpretation, and explicit reporting of bodily signals (Khalsa et al., 2018; Suksasilp & Garfinkel, 2023; Desmedt et al., 2025). Consequently, individual or group differences in bodily maps may arise from alterations in one or several of these dimensions, as well as non-interoceptive factors such as conceptual knowledge (e.g., love is represented by the heart). For instance, individuals may report heightened attention to bodily sensations while exhibiting low objective accuracy in detecting internal signals (Garfinkel et al., 2015). Moreover, because bodily mapping paradigms rely on self-report, they necessarily involve higher-order cognitive processes related to the monitoring, interpretation, and explicit representation of bodily experiences, meaning that atypical maps may reflect not only alterations in primary interoceptive processing but also difficulties in accessing, interpreting, or explicitly representing these experiences. These broader higher-order processes should not be equated with the more specific construct of interoceptive awareness defined by Garfinkel et al. (2015) as metacognitive insight into interoceptive accuracy. Rather, bodily maps likely reflect the combined influence of multiple interoceptive dimensions together with broader cognitive processes involved in retrospective self-report. This distinction is particularly relevant in psychiatric populations such as alexithymia or schizophrenia, where the bodily signal itself may remain partially intact while the ability to identify, monitor, and map these sensations is impaired. Combining bodily mapping with physiological measures and multidimensional interoceptive assessments would help disentangle which stages and which dimensions are affected in each psychiatric condition.

4.3.3. Clinical and psychopathological applications of bodily mapping

Beyond emotional processes, bodily mapping methods may also help investigate a broader range of clinically relevant subjective states beyond basic emotions. For instance, Herman et al. (2024) incorporated alcohol-related subjective states such as “tipsy” and “hangover,” demonstrating the adaptability of bodily mapping paradigms to clinically meaningful bodily experiences. Similarly, Billaux et al. (2025) showed that patients with severe alcohol use disorder experienced craving-related bodily sensations as strongly aversive, whereas control drinkers sometimes perceived the same sensations as pleasant or appetitive. Leganes-Fonteneau et al. (2025) further demonstrated that the extent of bodily sensations induced by acute alcohol administration tracked alcohol-related heart rate changes and contributed to the subjective feeling of intoxication, effects that may signal increased vulnerability to alcohol use disorder.

Such approaches may also hold important clinical potential. Bodily maps constitute relatively accessible tools that can be implemented repeatedly throughout therapeutic follow-up, either on paper or computerized platforms, to monitor changes in subjective bodily experiences over time. This longitudinal perspective may help clinicians

better characterize symptom evolution and personalize interventions targeting bodily experiences associated with psychiatric symptoms. For example, repeatedly reported chest tension associated with anxiety could guide the integration of relaxation or breathing-based interventions into treatment. More broadly, bodily mapping may provide fine-grained and patient-specific markers relevant for risk assessment, symptom monitoring, and intervention planning, particularly in disorders involving strong somatic or interoceptive components.

Finally, integrating bodily mapping approaches into ecological momentary assessment paradigms may further improve the understanding of interoceptive processes in everyday life and contribute to more personalized diagnostic and treatment strategies (Epskamp et al., 2018; Wright & Woods, 2020). Future research should therefore continue expanding bodily mapping beyond basic emotion research by investigating a wider range of clinically relevant subjective states and examining how these somatic representations relate to both emotional and non-emotional psychopathological processes.

5. Conclusion

This preregistered systematic review identified growing evidence of altered subjective bodily representations of emotional experiences in psychiatric populations using the bodily maps tool. Bodily maps constitute a promising method for studying emotional processes, offering novel perspectives not only in clinical contexts but also for early detection of emotional disturbances in subclinical populations. However, none of the studies to date have explicitly investigated the distinct subcomponents of emotional processing (i.e., identification, response, and regulation). We argue that a more systematic exploration of how bodily sensations contribute to each of these subcomponents could yield valuable insights into the mechanisms underlying emotional dysfunctions. In this context, we propose new directions for the use of bodily maps, aimed at fostering a more theoretically grounded and comprehensive analysis of interoceptive experiences in psychiatric disorders.

CRediT authorship contribution statement

Annelise Theis: Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Natascha Steiger:** Methodology, Investigation, Formal analysis. **Olivier Desmedt:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Pierre Maurage:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Mateo Leganes-Fonteneau:** Writing – review & editing, Supervision, Project administration, Methodology, Conceptualization.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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