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Noemi Micheli

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THÈSE PRÉSENTÉE

POUR OBTENIR LE GRADE DE

**DOCTEURE DE
L'UNIVERSITÉ DE BORDEAUX**

ÉCOLE DOCTORALE SOCIÉTÉS, POLITIQUE ET SANTÉ PUBLIQUE

SPÉCIALITÉ : PSYCHOLOGIE

Par **Noemi MICHELI**

**ÉMOTIONS ET STRATÉGIES DE RÉGULATION DANS LES
PROCESSUS SOMATIQUE ET DE PLEINE CONSCIENCE**

Sous la direction de Cécile DANTZER, Maîtresse de Conférences - HDR
et la codirection de Piero PORCELLI, Professeur des Universités

Soutenue le 7 décembre 2023

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« If you are distressed by anything external, the pain is not due to the thing itself, but to your estimate of it; and this you have the power to revoke at any moment. »

– Marcus Aurelius (AD 121-180),
Meditation VIII, 45

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Émotions et stratégies de régulations dans les processus somatiques et de pleine conscience

Résumé :

Le phénomène de la somatisation a acquis une importance capitale, non seulement en raison de sa prévalence pendant et après la pandémie de la COVID-19, mais aussi en raison des problèmes entourant sa définition déjà problématique. Cette situation aggrave les défis existants liés à l'identification et à la gestion des Symptômes Somatiques (SS), caractérisés par un dualisme somatique/psychiatrique obsolète. Cette division entraîne fréquemment des diagnostics retardés, des renvois médicaux excessifs et des traitements inefficaces ou dangereux. Étant donné le rôle des émotions dans la psychopathologie, réintégrer les SS dans le domaine de la régulation émotionnelle a le potentiel de combler ces fossés, favorisant une approche plus holistique pour prendre soin de ces patients. Les difficultés dans la capacité à évaluer, traiter et réguler les émotions jouent un rôle central dans le développement et la persistance des SS. Cependant, à ce jour, une compréhension exhaustive des processus de régulation émotionnelle dans les SS et ses comorbidités, telles que l'anxiété et la dépression, reste un enjeu important.

Se focalisant sur le contexte de la crise sanitaire, cette thèse a exploré la relation complexe entre les SS et la régulation émotionnelle, évaluant également la pertinence des interventions de régulation émotionnelle basées sur la méditation de pleine conscience pour cette population. L'objectif principal de cette thèse était de mieux comprendre les processus de régulation émotionnelle chez les patients présentant des SS, en tenant compte de la diversité des stratégies et des déficits émotionnels impliqués. Adoptant une approche hybride entre les approches centrées sur les variables et celles centrées sur la personne, nous avons mené cinq études. Cela nous a permis de : 1) examiner l'évolution des symptômes somatiques pendant la COVID-19, évaluant l'impact de l'anxiété liée à la pandémie et de la proximité interpersonnelle perçue sur le SS ; 2) identifier les déterminants de la régulation émotionnelle des SS, comprenant l'effet que peut avoir l'alexithymie sur la régulation émotionnelle; 3) explorer les processus de régulation émotionnelle impliqués dans la comorbidité entre les SS, l'anxiété et la dépression ; et 4) évaluer l'effet de la pleine conscience dispositionnelle et de la pratique intentionnelle de la pleine conscience sur les SS pendant la pandémie de la COVID-19.

Nos résultats mettent en évidence la variabilité inter-individuelle dans les processus de régulation émotionnelle chez les personnes signalant une cooccurrence de SS, d'anxiété et de dépression. Bien que ces conditions soient souvent comorbides, l'influence de périodes de détresse telles que la pandémie de la COVID-19 peut intensifier leur cooccurrence et la gravité des symptômes. Dans l'ensemble, l'alexithymie et les stratégies cognitives de régulation émotionnelle non adaptatives, telles que la rumination et la catastrophisation, se sont révélées être des prédicteurs importants de la symptomatologie somatique. Cependant, l'impact de dimensions moins significatives de l'alexithymie, telles que la pensée orientée vers l'extérieur, a été médié par des voies complexes impliquant l'évaluation et les processus de régulation émotionnelle, plutôt que par des liens directs avec les symptômes somatiques. Ces résultats

apportent une contribution significative aux connaissances existantes sur les processus émotionnels des patients présentant des SS, soulignant l'importance de la variabilité interindividuelle dans les relations entre l'alexithymie et la régulation émotionnelle. Nous proposons également de questionner la pertinence des interventions basées sur la méditation de pleine conscience sur les symptômes somatiques et discutons des orientations futures pour intégrer la flexibilité émotionnelle des SS et la régulation émotionnelle dans la compréhension des effets indésirables liés à la pleine conscience.

Mots clés : symptômes somatiques, régulation émotionnelle, alexithymie, pleine conscience, Covid-19, comorbidité anxiété et dépression.

Emotions and Regulation Strategies in Somatic and Mindfulness Processes

Abstract:

In the aftermath of the global COVID-19 pandemic, the phenomenon of somatization has gained significant importance not only for its prevalence during and after the health-crisis, but also for the problems surrounding its already problematic definition. This situation compounds the existing challenges regarding the identification and management of Somatic Symptoms (SS), characterized by an outdated somatic/psychiatric dualism. This division frequently results in delayed diagnoses, excessive medical referrals, and ineffective or harmful treatments. Given the role of emotions in psychopathology, re-inscribing SS in the domain of emotional regulation has the potential to bridge divisions, fostering a more holistic approach to the care of these patients. Deficits in the ability to appraise, process, and regulate emotions are central in shaping the development and persistence of SS. However, to date, a comprehensive understanding of emotion regulation processes in SS and comorbid conditions, such as anxiety and depression, remains elusive.

Focusing on the context of the COVID-19 pandemic, this thesis explored the intricate relationship between SS and emotional regulation, also assessing the relevance of emotion regulation interventions based on mindfulness meditation for this population. The main objective of this thesis was to better understand the emotional regulation processes in patients presenting SS, taking into account the diversity of strategies and the emotional deficits involved. With a hybrid stance in between variable-focused and person-centered approaches, we conducted five studies in this perspective, allowing us to 1) investigate the evolution of somatic symptoms during COVID-19, assessing the impact of pandemic related anxiety and perceived interpersonal closeness on SS reporting; 2) identify the emotional regulation determinants of SS, understanding the effect that alexithymia can have on antecedent-focused emotion regulation phases; 3) explore the emotion regulation processes involved in the comorbidity between SS, anxiety, and depression; and 4) assess the effect of dispositional mindfulness and intentional mindfulness practice on SS during the Covid-19 pandemic.

Our results highlight the inter-individual variability in emotional regulation processes of people reporting a co-occurrence of SS, anxiety and depression. If these conditions are often comorbid, the influence of a distressing period such as the Covid-19 pandemic can further impact on their co-occurrence and on symptom severity. Overall, alexithymia and maladaptive cognitive emotional regulation strategies, such as rumination and catastrophising, were important predictors of somatic symptomatology. However, the impact of less significant dimensions of alexithymia, such as Externally Oriented Thinking, was mediated through intricate pathways involving appraisal and emotion regulation processes, rather than direct connections with somatic symptoms. These various findings make a significant contribution to existing knowledge about emotional processes of patients presenting SS, emphasising the importance

of inter-individual variability in the relationships between alexithymia and emotional regulation. We also propose to question the relevance of mindfulness meditation-based interventions on somatic symptoms and discuss future directions for integrating SS emotional flexibility and emotional regulation in understanding mindfulness-related adverse effects.

Keywords: somatic symptoms, emotion regulation, alexithymia, mindfulness, Covid-19, anxiety and depression comorbidity

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LIST OF ACRONYMS AND ABBREVIATIONS

ACE	Adverse Childhood Experiences
ANOVA	Analysis of Variance
BDD	Bodily Distress Syndrome
DSM	Diagnostic and Statistical Manual of Mental Disorders
ICD	International Statistical Classification of Diseases and Related Health Problems
M	Mean
MBI	Mindfulness-based interventions
MBP	Mindfulness-based programs
MUS	Medically Unexplained Symptoms
MRAE	Mindfulness-Related Adverse Effects
SS	Somatic Symptoms
SD	Standard deviation
SSD	Somatic Symptom and related Disorders
SSAD	Somatic Symptom, Anxiety and Depression

General Introduction

In 2015, while pursuing my Master's degree in Clinical Psychology, I had the occasion of reading a book entitled “Tra mente e corpo” (between mind and body), in which Luigi Solano, professor of the University La Sapienza of Rome, presented scientific and theoretical advances in psychosomatic medicine (Solano, 2013). The book, discussed about an unitarian body/mind perspective, presenting the psychoanalytical theories of Carla De Toffoli (2014) and the Multiple Code Theory of Wilma Bucci (1997), who conceptualised well-being as dependent on adequate linkages between a non-symbolic system and symbolic systems, all of which are integral components collectively constituting both "mental" and bodily dimensions. In the same book the construct of Alexithymia was presented and conceptualised as a disorder of affective regulation particularly characterised by deficits in the cognitive-experiential facet of emotional response systems and in the interpersonal regulation of emotions (Solano, 2013; G. J. Taylor, 1994, 2004). This book nurtured my profound interest and fascination in the domain of somatisation, evoking numerous questions about the intricate processes of emotion regulation associated with this phenomenon.

Eight years later, the concept of emotional regulation/dysregulation has gained significant prominence in research, capturing growing interest among both researchers and clinicians across the realm of development (Fombouchet et al., 2023) and the domain of adult mental health (Gratz & Tull, 2022; Lenzo et al., 2020; Restubog et al., 2020; Schnabel, Petzke, et al., 2022). Furthermore, recent years have witnessed concerted efforts to more comprehensively integrate the construct of Alexithymia into the broader landscape of emotion regulation (Luminet et al., 2018; Panayiotou et al., 2019; Preece et al., 2020, 2023). This evolving focus on emotional regulation aligns with evidence emphasising its pivotal role in shaping the development, persistence, and exacerbation of somatic symptoms (SS)(Okur Güney et al., 2019; Schnabel, Petzke, et al., 2022; Schnabel, Schulz, et al., 2022), a connection also validated by The Hierarchical Taxonomy of Psychopathology (HiTOP), which posits that SS, anxiety and depression, are distinct yet intricately linked through a common overarching category of emotional regulation dysfunction (Watson et al., 2022).

SS like chest pain, dizziness, fatigue, abdominal discomfort, and musculoskeletal pain are frequent (Hinz et al., 2017). In a representative study, more than 81% of the general

population reported at least one mild SS in the last seven days and 22% reported at least one symptom causing severe impairment (Hiller et al., 2006). The prevalence of SS varies between 6.7 and 17.4% among the general population (Löwe, Levenson, et al., 2022), and it raises up to 45% in primary care and specialised settings, accounting for almost half of the workload of general practitioners (Haller et al., 2015; Löwe, Levenson, et al., 2022; Sirri et al., 2017; Zantinge et al., 2005). However, the landscape surrounding the identification, diagnosis, and treatment of patients presenting SS is complex and further complicated by an outdated and artificial somatic/psychiatric dualism that frequently results in delayed diagnoses, unnecessary diagnostic procedures, numerous and often superfluous referrals and potentially hazardous or ineffective treatments. Indeed, if patients with SS frequently use opioids to silence their symptoms, these drugs can only provide short-term relief, rather than benefit in the long run (Braunstein et al., 2017; Ibeziako et al., 2021; Martell et al., 2007). In light of the recent "Opioids crisis", which has vividly illustrated the risks associated with diminished tolerance to these drugs, it is essential to underscore that SS represents a complex, multidimensional experience encompassing emotional, social and psychological aspects, rather than simply a deficiency of opioids (Rummans et al., 2018). This understanding gains heightened significance in the current era marked by the global COVID-19 pandemic, where enforced social distancing, and heightened anxiety associated with any physical symptoms potentially signalling a SARS-CoV-2 infection, have contributed to an exacerbation of SS reporting (Horn et al., 2020, 2023; C. Willis & Chalder, 2021).

In these circumstances, the importance of investigating emotional regulation processes of somatisation extends beyond clinical observation. It holds the potential to bridge the artificial gap separating somatic and psychiatric settings, thereby promoting a more holistic and collaborative approach to patient care. Indeed, if a connection has been made between SS and emotion regulation disturbances, "the exact role and particular type of crucial emotion regulation alterations and difficulties remain unclear" (Schnabel, Petzke, et al., 2022, p. 19). Therefore, further research is required to understand the role of different regulatory processes in shaping the experiences of individuals suffering from SS. Consequently, the primary objective of this thesis is to shed more light on emotional regulation processes among individuals with SS, while also questioning the pertinence of mindfulness meditation for this population.

Interventions based on mindfulness meditation are increasingly used to target emotion recognition, regulation and expression in those therapies that have been defined as the ‘*third wave*’ (Gregucci et al., 2020; Guendelman et al., 2017; Jahoda et al., 2017). Initial evidence on interventions promoting mindful and non-judgmental attention to emotions have shown improvements not only in emotion regulation and SS (Aktaş et al., 2019; Billones et al., 2020; Hsu et al., 2010; Mazaheri, 2015), but also in alexithymia (Bornemann & Singer, 2017; Norman et al., 2019). However, studies do not always differentiate between mindfulness as state, a trait, and a training and some results show inconsistent or null effects of mindfulness training on SS (Gaylord et al., 2011; Greeson & Chin, 2019; Sollie et al., 2017; Zernicke et al., 2013). Therefore, it remains uncertain whether patients “are afforded pain relief from MBIs (Mindfulness-Based-Interventions), due to low methodological rigour (Hilton et al., 2017), chronicity of pain, and co-morbidity with other mental and physical health conditions” (Greeson & Chin, 2019).

The present thesis is organised into two main parts and comprises a total of 9 chapters, each dedicated to exploring a specific facet of the research topic. Each chapter includes a final key points section that summarise the main aspects discussed. The document ends in a comprehensive general discussion, bringing together the findings of the thesis.

The first part, entitled *somatic symptoms and emotion regulation processes* (p. 7), presents a review of the literature on SS and emotional regulation, and then proposes an integrated emotional regulation framework for the study of somatisation. This integrated framework brings together contemporary theories of emotion regulation, which capture emotions as a continuously changing dynamic process (Aldao et al., 2015; Bonanno & Burton, 2013; Gross, 2015a), with a dynamic-phasic approach to ER, which includes a spectrum of processes characterising adaptive adjustment to the affective environment (Panayiotou et al., 2019). Through the lens of this integrated framework we discuss specific aspects of emotion regulation in SS, looking at the influence of alexithymia and SS comorbidity with anxiety and depression.

This first part is divided in seven chapters:

- Chapter I provides an overview of somatisation, encompassing its history, classification and measurement. At the end of the chapter, based on the

informations discussed, we elucidate our stance regarding the use of the term SS, which we have opted to employ in this thesis. Also, we discuss how we have assessed SS in the studies presented in the thesis.

- Chapter II looks at the multifactorial aetiology of SS. Sociodemographic, physiological and psychological factors are discussed. Moreover, a schematic representation of the risk factors and aetiological mechanisms highlighted in the literature of SS is presented, highlighting the variables that we have assessed in the studies presented in the thesis (p. 24). Within the psychological factors, we discuss the construct of alexithymia, as well as, the relation between SS, anxiety and depression (identified in the thesis as the SSAD triad).
- Chapter III presents some of the most known contemporary frameworks of emotion regulation (Aldao et al., 2015; Bonanno & Burton, 2013; Gross, 2015a), as well as a dynamic-phasic approach to emotion regulation (Panayiotou et al., 2019). Then, an original proposal for an integrated framework of Emotion regulation flexibility is presented. In this chapter we also discuss a framework to integrate the construct of alexithymia in the process of emotion regulation, proposed by Preece et al. (2017).
- Chapter IV synthesises the literature presented in the firsts four chapters, identifying some of the problems and gaps in the existing literature, and delineates the research questions and objectives of the present thesis.
- Chapter V presents two studies (Study I and II), aiming to investigate the relationship between COVID-19-related anxiety and perceived interpersonal closeness during the pandemic, with SS reporting. We try to replicate findings from two studies from the UK and Italy, identifying COVID-19-related anxiety as a distinctive predictor of somatic symptom scores, in a French community sample.
- Chapter VI, building on contemporary emotion regulation theories and on the attention-appraisal model of alexithymia of Preece et al. (2017), delves into the identification of emotion regulation predictors of SS using a variable-centred approach. A sequential mediation model is presented with the objective of

identifying the role of the sub-scale Externally Oriented Thinking (EOT) of alexithymia, on emotion regulation processes related to SS reporting (Study III).

- Chapter VII discussed the importance of taking into account the comorbidity between SS, anxiety and depression in psychosomatic medicine (SSAD). A study (Study IV) is presented, using a person-centred approach to assess differences in emotion regulation and alexithymia between different profiles of SSAD symptom severity.

Shifting attention to mindfulness meditation, the second part of the thesis, entitled “*Questioning the pertinence of mindfulness in somatic symptoms*”, critically assess the relevance of these practices for individuals with SS.

After differentiating mindfulness practice from dispositional mindfulness and investigating the relevance of mindfulness for individuals with SS, we discuss the necessity to continue research on this field, building upon the complexities of the literature on mindfulness-related adverse effects (MRAE). Recognising that mindfulness practitioners can encounter difficulties during their practices, as acknowledged both in contemplative Buddhist teachings and scientific studies, our exploration focuses on emotional, somatic, cognitive and behavioural aspects of these experiences. A study protocol, submitted to the ethical committee in France in 2023, is presented. The study aims to analyse the patterns of emotion flexibility deficits in individuals experiencing MRAE during mindfulness interventions using a person-centred approach. By considering the diverse nature of these adverse experiences and their association with emotion regulation, we aim to contribute valuable insights to the field. This research effort aligns with our commitment to establishing mindfulness as a thoroughly evidence-based therapy and to enhance the understanding that these practices can have for people with SS.

This second part includes three chapters:

- Chapter VIII provides a theoretical exploration of the current clinical approaches for the management of patients presenting SS, explaining the interest of mindfulness interventions and their relationship with emotion regulation.
- Chapter IX presents Study V, published in *Frontiers of Psychology* in 2022, which explores the impact of mindfulness practice on SS (Micheli et al., 2022). The study makes a clear distinction between dispositional mindfulness and intentional

mindfulness practice, thereby shedding light on the nuanced dynamics of their effects.

- In Chapter X, a comprehensive study protocol is introduced, submitted for approval to the ethical committee in France. This research employs a person-centred approach to investigate the challenging experiences that naïve meditation practitioners can encounter within established mindfulness-based interventions, contributing valuable insights to the scientific understanding of mindfulness practices and processes. This study, encompassing the assessment of experiences having a somatic nature, also looks at emotional, cognitive and behavioural adverse effects of meditation practice, looking at emotion regulation processes involved.

Lastly, we conclude with a general discussion, synthesising the insights derived from the thesis and outlining potential future directions for studying emotion regulation processes and mindfulness processes in SS.

PART I

Somatic Symptoms and Emotion Regulation Processes

1. The Evolving Concept and Definition of Somatic Symptoms

The traditional biomedical model holds that physical symptoms are sensory experiences caused by injury or disease, and can therefore be reduced to them. This model typically comprises two phases: the diagnostic phase and the therapeutic phase (Van den Bergh et al., 2017). In the diagnostic phase, physicians rely on medical history, physical examinations, and investigations to identify *signs* of the patient's underlying condition. Once diagnosed, the therapeutic phase commences, aiming to restore the patient's health through appropriate treatment. However, this seemingly straightforward process often proves ineffective, as tests may fail to pinpoint clear signs explaining symptoms, and treatments may fall short in alleviating them (Eriksen & Risør, 2014). In fact, a significant challenge in traditional medical diagnostics and treatment has been the tendency to conflate *symptoms* with *signs*. Symptoms encompass physical sensations like pain, fatigue or gastrointestinal issues, while signs are objective evidences such as blood pressure, skin rushes or dyspnea. Thus, in the section 1.2 we delve into how patients' perceptions of symptoms are not solely shaped by their physical signs but also by the meanings attributed to them.

When “symptoms persist but a disease cause remains elusive, then the patient may be given a diagnosis that simply describes their complaint (e.g., chronic fatigue) or another label that identifies them as suffering from Medically Unexplained Symptoms (MUS)” (Van den Bergh et al., 2017). The term MUS has been used by researchers and health professionals to refer to bodily complaints for which medical examination and investigation do not reveal a clear aetiology or a clear correspondence with the diagnostic criteria of a specific pathology. Most importantly, this term has been widely used as an indicator for somatisation without describing an emotional or stress-related component. Over the years, the use of this term has provoked numerous discussions as it has been considered: 1) not accepted by patients and doctors; 2) based on what symptoms are not, rather than by what they are; 3) based on dualistic thinking of symptoms' origins as either physiological or psychological (Creed et al., 2010). Therefore, psychiatric classification systems and researchers have employed various other general terms, including: “psychosomatic symptoms”, “functional symptoms”, “subjective health complaints”, “somatic symptom distress”, “bodily distress”, and “chronic pain”. To date, a consensus about the term that should replace “medically unexplained symptoms” has not been reached, and there is little agreement on the level of description and analysis needed (i.e., as

symptoms, syndrome, disorder, or disease)(Creed et al., 2010; Kroenke et al., 2007; Rief & Sharpe, 2004; Van den Bergh et al., 2017).

1.1 The concept of somatisation: history and classification

The understanding of somatisation, as well as its classification in the different versions of the Diagnostic and Statistical Manual of Mental Disorders (DSM) and the International Statistical Classification of Diseases and Related Health Problems (ICD), has evolved over time. The idea of the existence of a disorder in which people could present physical symptoms in the absence of demonstrable organic pathology dates back to the Egyptian civilisation (C. V. Ford & Folks, 1985). Early hypotheses explaining somatisation focused on the disturbance of bodily organs, in particular the uterus, which is the organ from which the term “hysteria” originated in the Greek era of Hippocrates' collection. Still in the ninth century, the medical school of Salerno thought that hysteria was a physical disorder (Tomasson et al., 1991). However, as early as the end of 1600, psychoneurological factors began to be considered as the root of unexplained organic symptoms (Turiaco et al., 2022). In 1667, the neurologist Thomas Willis wrote that “the passions vulgarly called hysterical do not always proceed from the womb, but often from the head’s being affected” (T. Willis, 1980). At the end of the 17th century, the physician Thomas Sydenham declared that “[in hysteria] the mind sickens more than the body” (Sydenham, 1848) and Giorgio Baglivi, Chair of Medical Theory at the Collegio della Sapienza in Rome, encouraged doctors to enquire about the patient's mental state (Sharpe, 2001). The turning point was finally marked by the publication in 1850 by Pierre Briquet of the “*Traité clinique et thérapeutique de l'hystérie*” (Clinical and therapeutic treatise on hysteria), which linked the symptomatology to a “neurosis of the portion of the brain destined to receive affective impressions and emotions”, implicating neurological and psychological factors at the origins of the syndrome (Tomasson et al., 1991).

During the 20th century, the idea of a functional disturbance of the central nervous system was discarded in favour of the concept of “psychogenesis” (Sharpe, 2001). Freud distinguished two different phenomena characterised by the presence of SS: conversion hysteria and neurasthenia (Freud, 1916). According to his theorisation, the conversion hysteria originated from the psyche (i.e., symptoms are the symbolic expression of infantile sexual conflicts), and neurasthenia had somatic origins (i.e., symptoms are a direct consequence of unresolved sexual tension in the present) (De Gucht & Fischler, 2002). The term “somatisation”, was finally

introduced in 1924 by Wilhelm Stekel who characterised it as a profound neurosis stemming from psychological origins but surfacing as physical disorders (De Gucht & Fischler, 2002). On the other hand, the concept of hysteria was further developed by Purtell (Purtell et al., 1951), and operationalised as the presence of multiple somatic complaints associated with anxiety and depressive symptoms (Perley & Guze, 1962). The criteria included the early onset before age 35, the involvement of diverse organ systems, the dramatic descriptions of symptoms and an excessive use of medical care (Garfield & Guze, 1962).

Influential authors like Alexander (1950) and Dunbar (1947), drawing from Freudian concepts and embracing the predominant psychoanalytic principles in the USA during the mid-20th century, developed a fundamental hypothesis regarding the genesis of SS: unconscious conflicts lead to chronic emotional activation, which can either directly cause somatic disorders (hysterical conversion model) or indirectly affect the autonomic nervous system, potentially resulting in actual pathological changes in tissues and organs (somatic equivalents model). The general prospective was that intrapsychic conflicts were at the core of psychosomatic disorders (Porcelli, 2022). Depending on the nature of the conflict and the related defence mechanisms, seven psychosomatic pathologies were identified. These classic psychosomatic diseases comprised peptic ulcers, ulcerative colitis, bronchial asthma, essential hypertension, certain thyroid disorders, neurodermatitis, and rheumatoid arthritis (*ibidem*).

Psychosomatic medicine has witnessed substantial transformations since the 1970s. The once-dominant idea of psychogenesis as the sole cause of illness has been firmly abandoned, replaced by more intricate, circular models of causality. Additionally, the original psychoanalytic paradigm in medicine, focused on conflicts, has given way to a paradigm centred on developmental deficits and theoretical models aligned with cognitive psychology, such as attachment and alexithymia. Two pivotal concepts have played a central role in reshaping the field of psychosomatic medicine and the understanding of SS: George Engel's biopsychosocial model (George & Engel, 1980) and David Kissen's concept of illness heterogeneity (Kissen, 1963). Integrating these two theoretical frameworks, illnesses emerge as intricate outcomes of multifaceted interactions across various levels of human existence, encompassing cellular, tissue, organ, interpersonal, and environmental systems. In essence, the psychosomatic nature of an illness is not inherent in the illness itself but it is influenced by underlying factors that lead certain illnesses to manifest in a psychosomatic manner in specific individuals. This paradigmatic shift redirects our attention from the pursuit of a singular primary

cause to comprehending the nuanced contributions of various elements and systems in shaping the manifestation of psychosomatic symptoms (Porcelli, 2022).

1.1.1 Classification of psychosomatic disorders in the DSM and in the ICD

The evolving diagnostic criteria for psychosomatic disorders found in various editions of the DSM and ICD highlight the challenges inherent in formulating an effective definition for clinically relevant somatisation. Psychosomatic disorders were first introduced in 1980 with their inclusion in the DSM-III under the Somatoform Disorders category. This category also found its way into the ICD-10 (World Health Organization, 1992), encompassing patients who exhibited physical symptoms in the absence of demonstrable organic pathology. In both diagnostic manuals, the use of the "-form" suffix, a common convention in psychiatry to characterise conditions that exhibit similarities or mimic other disorders, signalled that the physical symptom presentation resembled various other medical conditions (Porcelli, 2022). Building on this concept, symptoms are not as they initially seem, and even though they manifest physically, their true origin lies within the mind (*ibidem*). The major difference with the former concept of hysteria was that Somatoform Disorders did not include anxiety and depressive symptoms in the diagnostic criteria (De Gucht & Fischler, 2002). Instead, the DSM-III criteria required a count of 12 physical symptoms for males and 14 for females, later standardised to 13 for both genders in the DSM-III-R.

In following revisions, the DSM-III-R (1987) and DSM-IV (1994), minor changes to the definition of Somatoform Disorders were made. The focus was on symptoms, and diagnoses indicated that the symptoms were "medically unexplained" (Van den Bergh et al., 2017). Nonetheless, with the DSM-III-R, the introduction of the diagnosis "Undifferentiated Somatoform Disorder" created a broader category that allowed for the inclusion of individuals who did not meet the criteria for other specific somatoform categories. For instance, those who did not meet the required number of SS for diagnosis could still find a place within this general group (Mayou et al., 2005).

In the fourth edition (DSM-IV), Somatisation Disorder was defined as "a pattern of recurring, multiple, clinically significant somatic complaints" for which no medical explanation could be found to adequately account for the subject's experience. The criteria for this disorder were very stringent and detailed, including an onset of symptoms before the age of 30 years, a typically chronic course, the presence of pain in at least four body regions, a minimum of two

gastrointestinal symptoms, at least one non-painful sexual symptom, and at least one pseudo-neurological symptom. However, this classification posed significant challenges. Notably, the criteria had been developed in highly selected patient populations and were not supported by substantial empirical evidence, making them difficult to use outside specialised health-care settings (Fink et al., 2005). Thus, in comparison to clinical observations, the prevalence of Somatisation Disorder following this classification remained relatively low, ranging from 0.2 to 2% (Creed & Barsky, 2004; Strassnig et al., 2006). More importantly, the crucial focus of the diagnosis on the medical “unexplainedness” of symptoms and their separation from other psychopathological disorders under Axis-I, encompassing anxiety and depression, left challenges in both diagnosis and treatment unresolved (Creed, Henningsen, et al., 2011; Fink et al., 2005; Kroenke et al., 2007). For example, symptoms related to the cardiovascular system were intentionally omitted in this version to enhance the differentiation between somatisation and anxiety disorders (Rief et al., 1996).

The introduction of the category of Somatic Symptom Disorders (SSD) in the fifth and most recent edition of the DSM, published in 2013, represented an effort to address the evolving understanding of the somatisation and implement necessary changes. In fact, in this version SS do not need to be organically unexplained for the diagnosis. Instead, DSM-5 focuses on the way a patient emotionally, cognitively and behaviourally copes with the physical symptoms (Henningsen, 2018), marking a theoretical transition from emphasising the lack of a medical explanation to highlighting the existence of maladaptive responses to somatic symptomatology. Thus, even when a SS lacks medical explanation, there is still an acknowledgment of a physiopathological process at play (Macina et al., 2021). On the other hand, the presence of a medical diagnosis does not exclude a comorbidity with psychological difficulties. In consequence, the “-form” suffix that characterised the previous denomination has been abolished.

In DSM-5, to fulfil the diagnostic criteria for SSD, the following must be present:

- A- One or more SS that are distressing and/or result in significant disruption in daily life.
- B- One or more excessive thoughts, feelings, and/or behaviours related to the following SS or associated health concerns:
 - (i) disproportionate and persistent thoughts about the seriousness of one’s symptoms;

- (ii) persistently high level of anxiety about health or symptoms;
- (iii) excessive time and energy devoted to these symptoms or health concern.

• C- Although any one symptom may not be continuously present, the state of being symptomatic is persistent and lasts more than 6 months.

The indicator of severity is no longer based on the number of SS, but on the severity of psychological features. The condition is considered to be mild when only one of the psychobehavioural symptoms is fulfilled; moderate, when two or more of these symptoms are fulfilled; and severe, when two or more of the psychobehavioural symptoms are fulfilled, plus when there are multiple somatic complaints (or one very severe somatic symptom). The chronicity of the condition is addressed in the criterion C: typically a duration of symptoms of at least 6 months.

Additionally, SSD consolidates three somatoform disorders from DSM-IV (somatisation disorder, pain disorder, and undifferentiated somatoform disorder, and sometimes hypochondriasis) into a single diagnostic entity. In fact, under the revised framework in DSM-5, the relationship between Illness Anxiety Disorder (formerly known as Hypochondriasis) and SSD has evolved. If an individual exhibits both a preoccupation with acquiring a severe illness and SS, they receive a diagnosis of SSD. Conversely, if they don't have any SS, they are diagnosed with Illness Anxiety Disorder (IAD). This shift means that approximately 20% of individuals who previously met Hypochondriasis criteria, without SS, now receive an Illness Anxiety Disorder diagnosis, while the remaining 80% are diagnosed with SSD (Dimsdale et al., 2013). Moreover, this change has had significant implications for research, as many studies had previously explored somatic symptom using the hypochondriasis construct, which is now split into two distinct disorders.

The change of focus in SSD from the strict criterion of “unexplainedness” in SSD to the way people express and interpret symptoms (e.g., symptom preoccupation, excessive health worry, maladaptive illness behaviour), has largely been welcomed (Henningsen, 2018; Van den Bergh et al., 2017). “However, the potential over-inclusiveness of the “one size fits all” category has raised fears about mislabelling patients with medical illness as having a mental disorder” (Henningsen, 2018). In fact, patients suffering from chronic medical conditions can also receive a SSD diagnosis. Therefore, DSM-5 has faced criticism for grouping together diverse clinical conditions, given the uncertainty surrounding whether medically explained and unexplained SS share similar underlying mechanisms (Rief & Martin, 2014).

Similar to the DSM-5, major changes have been made in the ICD-11, which has replaced the former category of Somatoform Disorder with the category “Bodily Distress Disorder” (BDD)(World Health Organization, 2004). The guidelines for the bodily distress disorders include the presence of persistent bodily symptoms that are distressing to the individual with excessive attention toward the symptoms. The symptoms are not alleviated by clinical examination or investigations and associated with significant impairment in functioning. Therefore, both ICD-11 with BDD and DSM-5 with SSD emphasise the importance of health preoccupation cognitions as the basis for considering the presence of one of these mental disorders. However, in BDD “the term *bodily distress* may better describe the fact that patients indeed suffer from their bodily symptoms, but for some, *distress* implies a difficulty to accept psychological component of this primarily bodily condition” (Henningsen, 2018).

1.1.2 Classifications of psychosomatic disorders in other diagnostic systems

In the past years, questions have been raised regarding the clinical effectiveness of the DSM and the ICD classifications in identifying the psychological factors involved in psychosomatic disorders (Epstein et al., 1999; Fava, 1992; Macneil et al., 2012; Schröder & Fink, 2010). Consequently, alternative approaches have proposed a redefinition of these disorders, shifting focus from what the patient "has" or "has not". It is the case of the Psychodynamic Diagnostic Manual (PDM-2 ; Lingardi & McWilliams, 2017), the Hierarchical Taxonomy of Psychopathology (HiTOP; Kotov et al., 2021) and the Diagnostic Criteria for Psychosomatic Research (DCPR-R; Porcelli et al., 2020; Sirri & Fava, 2013).

In summary, the PDM-2 delves into the organisation of personality in individuals exhibiting psychosomatic symptoms, employing a specific psychodynamic theoretical approach. On the other hand, the HiTOP focuses on understanding the factors shaping personality through an evidence-based hierarchical dimensional structure (Kotov et al., 2021). Meanwhile, the DCPR translates psychosocial variables from psychosomatic research into practical tools, trans-diagnostically evaluating the perception of somatic sensations, the healthcare use, and the origins of symptoms (Porcelli et al., 2000). To achieve this, the DCPR-R assesses 14 psychosomatic factors influencing symptoms, such as allostatic load, hypochondriasis, alexithymia, type A behaviour, irritable mood, demoralisation, disease phobia, thanatophobia, health anxiety, illness denial, functional somatic symptoms secondary

to a psychiatric disorder, persistent somatisation, conversion symptoms, and anniversary reactions (Porcelli et al., 2020).

1.2 Somatic symptoms as a multidimensional experience

Before exploring how a physical sensation evolves into a psychosomatic symptom, it's crucial to examine our concept of health. The World Health Organization's definition of health is "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity" (World Health Organization, 2006). However, this comprehensive view of health is idealistic in practice, as no one achieves such a state of well-being for extended periods of time (Porcelli, 2022). George Canguilhem, a French epistemologist, proposed that health is experienced as the quietude of our bodily organs, emphasising that true health is sensed when our body remain free of signals and we can listen to its silence (Canguilhem, 1966). This definition delves into the core representation of health and disease, underlining that we perceive ourselves as healthy when our bodies remain silent, without any noticeable signals. Instead, this silence is often interrupted by bodily signals and physical sensations. However, these symptoms must reach a critical threshold to prompt us to seek medical consultation. A recent study examined a substantial cohort of 20,187 individuals, revealing that even if 41% reported one new-onset SS within the past week, only a mere 3.1% of these individuals sought consultation with a general practitioner within six weeks of the symptom's onset (Ballering et al., 2023).

Pain plays a significant role in the critical temporal gap between perceiving an interoceptive sensation or a change in bodily functions and deciding to attribute that sensation to a symptom deserving a doctor's attention. In fact, pain serves as homeostatic feeling, providing a dynamic and integrated perspective with other systems like cognition and mood regulation (Mayer, 2000). The International Association for the Study of Pain (IASP) defines pain as "an unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage" (Raja et al., 2020). This definition holds significance because even though the classifications of SSD and BDD encompass symptoms beyond pain-related complaints, other SS, such as fatigue or dizziness, could be still defined as unpleasant sensory and emotional experiences, associated or interpreted as body malfunction or physical homeostatic imbalance. Therefore, for economy of discussion, we employ the term *pain* to indicate any unpleasant sensory and emotional experiences that could be associated or interpreted as potential damage or malfunction in the body. Furthermore, the IASP definition

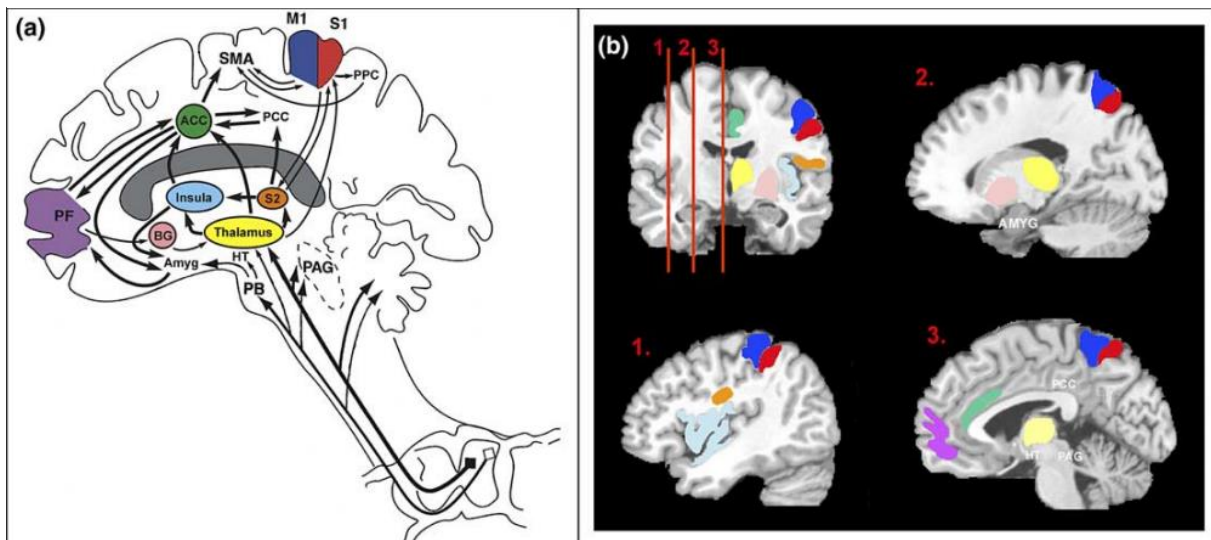
of pain underscores that pain is not solely a sensory experience; it is also an emotional one that cannot be reduced to nociception. This holds true even when considering the neurophysiological appraisal of pain.

The appraisal of pain involves a complex pain processing matrix that comprises excitatory ascending networks and multiple inhibitory descending controls, orchestrated by spinal and supraspinal structures, to modulate the nociceptive message (Apkarian et al., 2005). Peripheral nociceptive stimuli can arise directly from sources like excessive heat or pressure, or indirectly through molecules released during inflammation, such as cytokines, prostaglandins, and neuropeptides. However, unlike sensory processing in other systems, pain processing operates independently and in parallel across six primary supraspinal regions that participate in pain processing and modulation (Figure 1)(Apkarian et al., 2005; Tracey, 2008; Tracey & Mantyh, 2007).

Pain modulation is facilitated through the release of endogenous opioids, which have analgesic effects and play a crucial role in modulating pain perception (Calvino, 2006). Worthy of note is that other regions come into play based on contextual circumstances and the

Figure 1

Cortical and subcortical regions involved in pain perception (Apkarian et al., 2005, p 473).



Note. The six cerebral areas identified by the meta-analysis are the primary and secondary cortices (S1, S2, red and orange), the anterior cingulate cortex (ACC, green), the insula (blue), the thalamus (yellow), and the prefrontal cortex (PFC, violet). Other regions also indicated include the supplementary and primary motor cortices (M1 and SMA), the posterior parietal cortex (PPC), the posterior cingulate cortex (PCC), the basal ganglia (BG, pink), the hypothalamus (HT), the amygdala (AMYG), the parabrachial nucleus (PB), and the periaqueductal gray matter (PAG).

significance of each dimension in the pain matrix. Some of the crucial regions, such as the amygdala and the thalamus, are involved in the affective-emotional experience of pain (Apkarian et al., 2005).

This shows how the processing of nociceptive sensory input is profoundly influenced by affective, cognitive, and cultural contexts. Thus, pain has been defined as a multi-dimensional experience involving four distinct components that interact continuously: sensory-discriminative, affective-emotional, cognitive, and behavioural (Hart et al., 2003; Tracey & Mantyh, 2007). The sensory-discriminative component involves assessing the quality, location, intensity, and duration of the nociceptive information. The affective-emotional component relates to the unpleasant valence associated with the nociceptive perception, which can trigger distressing emotions based on individual interpretations and contextual factors. The cognitive component encompasses mental processes that influence emotional expression and are culturally influenced, including interpretations, anticipations, memories, and attentional focus, leading to emotional suffering such as anxiety or frustration. Finally, the behavioural component comprises verbal (e.g., complaints) and non-verbal (e.g., tense posture) pain-related responses. These four components interact continuously in a hierarchical order to create a subjective and unique SS perception for each individual (Tracey & Mantyh, 2007).

According to Armstrong's Symptom Experience Model (Armstrong, 2003), patients' perception of symptoms is influenced by four crucial factors: frequency, intensity, distress, and meaning. Therefore, beside attributions and interpretations, symptoms' frequency and intensity also play important roles. Physical symptoms such as pain have traditionally been dichotomised as acute and chronic. From a biological point of view, an acute pain has a survival value: it serves as a warning signal for potential harm to the body or in response to environmental threats, and it is followed by an automatic defence mechanism like muscle contraction or withdrawal reflex. However, if a short experience of pain can be protective, chronic and persistent symptom serves no adaptive purpose (Katz et al., 2015). Persistent symptoms are far more than a sensory process and shift the experience into the "suffering", entailing psychological, cognitive and behavioural aspects. The severity of these symptoms is difficult to measure, and their spectrum can go from little functional impairment to severely disabling conditions.

In comparison to the neurophysiological mechanisms governing acute pain, chronic pain is usually characterised by peripheral and central hypersensitivity, along with a deficiency in the modulation carried out by inhibition and excitation mechanisms (Martelli et al., 2004).

These physiological features are generally accompanied by progressive cognitive impairment and psychological distress (Apkarian et al., 2005). Research has revealed that patients with chronic pain exhibit significant reductions in grey matter within specific brain regions, including the dorsolateral prefrontal cortex and the right thalamus, amounting to 5% to 11% compared to control subjects (Apkarian et al., 2004). Remarkably, this magnitude of grey matter loss is comparable to that observed in individuals experiencing 10 to 20 years of normal aging. The atrophy in the dorsolateral prefrontal cortex could potentially hinder its top-down regulatory influence on the orbitofrontal cortex, contributing to a decreased perception of pain intensity (Lorenz et al., 2003). Moreover, endogenous opioids, which play a central role in inhibitory control systems of pain, appear to be affected by chronic symptoms such as fibromyalgia, especially in brain regions known to be involved in the emotional-affective quality of pain (Apkarian et al., 2005; Harris et al., 2007).

1.3 Measuring Somatic Symptoms

In a comprehensive systematic review, 40 scales designed for self-reporting SS were identified (Zijlema et al., 2013). The usage of these numerous questionnaires to assess common SS varies considerably among different studies. Some of the most recommended questionnaire are: the Symptom CheckList-90 Somatization (SCL-90 SOM), the Patient Health Questionnaire-15 (PHQ-15), the Four-Dimensional Symptom Questionnaire (4DSQ), the Bodily Distress Syndrome (BDS) and the Physical Symptom Checklist (PSC-51) (Sitnikova et al., 2017; Zijlema et al., 2013). These questionnaires have distinct focuses, with some aiming at merely detecting symptom presence, while others evaluating also symptom severity. Also, disparities arise from the differences in the number of symptoms they cover and the wide array of symptom categories they encompass. In fact, previous research has indicated that specific types of symptoms tend to co-occur, although this pattern is not universally observed across all studies (Zijlema et al., 2013). Four common clusters of symptoms frequently reported are cardiopulmonary (including autonomic symptoms), gastrointestinal, musculoskeletal, and general symptoms.

Two questionnaires that have emerged as the most suitable choices for large-scale population-based studies, following a thorough evaluation of various criteria, including symptom types, assessment timeframe, response scale, psychometric properties, and patient burden (van Driel et al., 2018; Zijlema et al., 2013):

- The PHQ-15, is a widely employed self-administered questionnaire that covers approximately 90% of commonly reported SS (Creed et al., 2012). It begins with the question, "During the past 4 weeks, how much have you been bothered by any of the following problems?" followed by a series of 15 questions for females and 14 for males, each addressing specific bodily symptoms. Respondents provide ratings for each symptom, selecting from options such as 'not bothered at all' (scored as 0), 'bothered a little' (scored as 1), or 'bothered a lot' (scored as 2) (Kroenke et al., 2002). The total PHQ-15 score ranges from 0 to 30. To evaluate symptom severity, clinical cut-off points are often employed. A score ranging from 0 to 4 is typically considered as minimal severity, indicating the presence of at least three symptoms. Scores falling within the range of 5 to 9 are categorised as low severity, signifying the presence of at least five symptoms. A score of 10 to 14 is regarded as moderate severity, indicating the presence of at least eight symptoms, while a score of 14 or higher is classified as high severity (Kroenke et al., 2002). The reliability of this questionnaire, measured by Cronbach's α , typically falls around 0.80, indicating a high level of internal consistency (Hinz et al., 2017; Kroenke et al., 2002) and making it a valuable tool, particularly in large-scale research studies (Zijlema et al., 2013).
- The SCL-90 SOM dimension is a component of a 90-item questionnaire designed to evaluate nine sub-scales: somatisation, obsession-compulsion, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, and psychoticism (Derogatis et al., 1973). Within the somatisation dimension, there are 12 items that assess the level of distress stemming from bodily sensations experienced in the past 7 days. These symptoms encompass a range of complaints related to cardiovascular, gastrointestinal, respiratory, and other systems influenced by autonomic processes. Respondents are asked to carefully consider each problem or complaint listed and then choose one of the numbered descriptors that best represents the extent to which the problem has bothered or distressed them over the past week, including today. Symptom severity is evaluated on a 5-point Likert-type scale from 1 (not at all bothered) to 5 (extremely bothered). Higher sum scores reflect a higher severity of SS (Fridell et al., 2002; van Driel et al., 2018).

Both of these instruments extend beyond medically unexplained symptoms to encompass symptoms in general, and they both assess the severity of symptoms. Nevertheless, the PHQ-15 and the SCL-90 SOM exhibit certain distinctions. Notably, they exhibit a significant, albeit not very high, correlation, and only six symptoms overlap between them (Appendix C, p. 246)(Zijlema et al., 2013). These differences can be attributed to variations in the underlying conceptual frameworks of the two questionnaires. The PHQ-15 comprises the most prevalent symptoms encountered in U.S. primary care settings, while the SCL-90 SOM focuses on a subset of SS associated with psychopathology (*ibidem*). Another notable contrast is that the PHQ-15 includes items related to reproduction, such as menstruation problems and pain or issues during sexual intercourse, whereas the SCL-90 SOM does not. Moreover, the PHQ-15 and SCL-90 SOM employ different scales for measuring symptom severity, with the former using a 3-point scale and the latter utilising a 5-point scale. Both questionnaires demonstrate acceptable internal consistency, and factor analyses have revealed meaningful factors (*ibidem*). Test-retest reliability assessments have indicated that the results of the PHQ-15 and SCL-90 SOM remain relatively stable over short time intervals. Furthermore, correlations between the PHQ-15 and SCL-90 SOM and other measures of somatisation have demonstrated some degree of overlap, suggesting that they assess a comparable construct (Dimsdale et al., 2009). Notably, there is also some overlap with related constructs such as health anxiety and illness behaviour, which are particularly pertinent as they are components of the proposed diagnostic criteria for somatic symptom disorder in the DSM (*ibidem*).

1.4 Definition and measurement of Somatic Symptoms in the present thesis

Given the different positions presented in this chapter, it is imperative to elucidate our stance regarding the term we have chosen to employ in this thesis: Somatic Symptoms (SS).

In 2001, an article published by Sharpe and Carson proposed a paradigm shift in which unexplained symptoms would be remedicalised around the notion of a functional disturbance of the nervous system, and treatments that were considered “psychiatric” would be integrated into general medical care. Additionally, the DSM-5 in 2013 emphasised the need to abandon the adjective “unexplained” and concentrate on the personal experience of patients. However, almost twenty years later, many authors still decide to employ this adjective (Husain & Chalder, 2021; Sarter et al., 2021). We have chosen not to employ the term "Medically-Unexplained Symptoms" in this thesis because, as noted by Davidson and Menkes in a recent article (2021),

“*unexplained*” does not mean “*unexplainable*”. We firmly believe that this adjective, historically entrenched in psychosomatic medicine, has yielded detrimental consequences, both within research and clinical settings. It not only fosters patient frustration by implying inexplicability, but also perpetuates an outdated mind-body dualism that does not align with the contemporary understandings of the human experience and functioning. Furthermore, the label “*functional*”, frequently employed in research, perpetuates a dichotomy between organic and functional conditions, with the former indicating a documented organ injury and the latter implying somatic dysfunction without overt organ damage (Porcelli, 2022). Our choice also avoids utilising the term “*Somatic Symptoms Disorder*” for several reasons. Firstly, while this category was established by the DSM-5, the consistent application of this term in research remains elusive. Secondly, it mandates symptoms to persist for over 6 months, a criterion not assessed in the cross-sectional studies presented in this thesis. Lastly, the ongoing discourse surrounding diagnostic criteria shows that there is a clear need for improvement and refining of such categories. Our approach aims to examine the experience of symptoms apart from diagnostic categories and their corresponding terminology. Instead, we find that the use of “*persistent somatic symptoms*”, as employed by other authors (e.g., Hüfner et al., 2023; Kitselaar et al., 2023; Kube et al., 2020; Lehmann et al., 2021), gives the idea of persistency which captures the essence of these experiences. When do SS truly gain significance for us? What makes their handling so challenging? The answer lies in their persistency. However, we believe that in large-scale population-based studies this term should not be employed, unless a longitudinal methodology is used. In fact, questionnaires as the PHQ-15 and the SCL-90 SOM question whether subjects felt “bothered” or “distressed” by physical symptoms, not giving an insight into the temporal component that should characterised SS interpreted as a sign of somatisation. Hence, despite the limitation of the term “somatic symptoms” (SS) in fully capturing the nuanced complexity discussed in this chapter, which extends beyond mere physical sensations, we have opted to utilise this terminology. Thus, our primary objective in this thesis is to emphasise the comprehension of the individual's experience, placing greater importance on it rather than fixating on the inherent nature or classification of these experiences.

SS in this thesis are assessed in different studies using the PHQ-15 and SCL-90 SOM questionnaires following the recommendations from previous studies (as explained in section 1.3).

KEY POINTS

Traditional Biomedical Model: The traditional biomedical model has often joined the concept of symptom with the one of sign and viewed physical symptoms as sensory experiences caused only by injury or disease. However, this model often proves ineffective. However, the limitations of this model become evident when symptoms lack clear explanations through observable signs or when treatments fail to produce desired outcomes, presenting a significant challenge in effective healthcare.

Shift in Psychosomatic Medicine: Since the 1970s, psychosomatic medicine has evolved from a focus on psychogenesis to more complex, circular models of causality. This shift is influenced by concepts like George Engel's biopsychosocial model and David Kissen's concept of illness heterogeneity.

SS and their Perception: SS are a multi-dimensional experience with sensory-discriminative, affective-emotional, cognitive, and behavioral components.

Somatic Symptoms Definition: MUS refers to persistent bodily complaints without a clear medical cause. However, this term is not accepted by patients and doctors and criticised for being based on what symptoms are not, rather than what they are. There is no consensus on a replacement term, and various terms like "psychosomatic symptoms," "functional symptoms," and "somatic symptom distress" have been used.

Development of the Concept of Somatization in DSM and ICD: The diagnostic criteria for psychosomatic disorders have evolved in the DSM and ICD. In DSM-5, the focus shifted from unexplained symptoms to how patients cope with physical symptoms emotionally, cognitively, and behaviourally.

Definition and Measurement in the Present Study: Despite its limitations, we will employ the term "Somatic Symptoms" (SS), emphasizing the importance of understanding the individual's lived experience over classification or terminology. The study will assess SS using the PHQ-15 and SCL-90 SOM questionnaires, following previous recommendations.

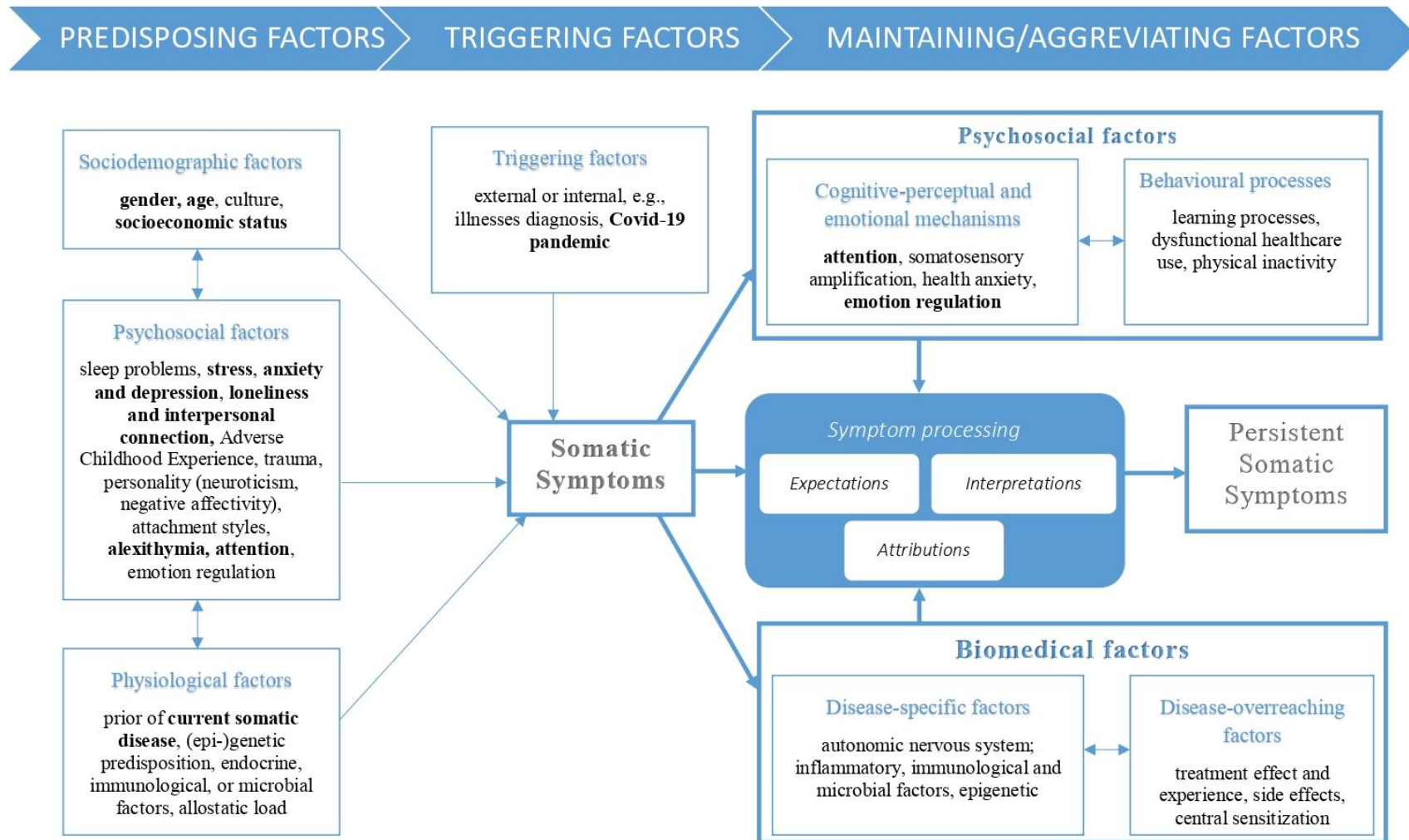
2. Aetiology of Somatic Symptoms

In the past, the term "somatisation" was used to simplistically attribute bodily symptoms solely to underlying psychological distress. However, this perspective now appears overly simplistic in light of our evolving understanding of its complexity.

It is crucial to acknowledge that somatisation, like other psychological disorders, does not have a singular cause. Consequently, multiple aetiological factors have been proposed to account for somatisation (Löwe, Andresen, et al., 2022; Mai, 2004). Drawing from the intricate findings in the literature, it becomes evident that the roots of SS involve a multifaceted interplay among emotional, behavioural, and physiological factors, encompassing predisposing, triggering, and maintaining/aggravating elements, with symptom processing occupying a central role in the persistence and amplification of SS. Hence, this chapter delves into several factors associated with SS. The inclusion of certain factors in Figure 2 seeks to enrich the comprehension of the proposed studies, whereas others are subject to evaluation within the studies outlined in this thesis (variables highlighted in bold in Figure 2).

Figure 2

Some of the risk factors and aetiological mechanisms highlighted in the literature of Somatic Symptoms (an adaptation from the diagram of Löwe et al., 2022). In bold the variables assessed in this thesis.



2.1 Sociodemographic factors

The documented demographic correlates of SS include female sex, low socioeconomic status, and fewer years of education (Creed, Barsky, et al., 2011). Nevertheless, some of the sociodemographic aspects related to SS warrant additional exploration and discussion.

2.1.1 Age

Longitudinal studies revealed that SS tend to increase with age (Beutel et al., 2020; Bohman et al., 2012; Nummi et al., 2017). In a study looking at the evolution of SS reporting in the German General Population from 1975 to 2013, SS were consistently associated with older age (Beutel et al., 2020). Similarly, in an Iranian population, age showed a significant association with SS, with individuals aged 71-90 years being 36.10 times more likely to experience SS compared to those aged 10-30 years, and participants aged 51-70 years being 2.81 times more likely to report such symptoms (Garrusi et al., 2019).

However, the relationship between SS and age might not be direct (Nummi et al., 2017). The increased SS could be the result of a combination of different variables related to increased age. In a sample of 7,925 participants aged 40 to 80 years, SS reporting increased with age, but when confounding variables have been reduced, psychosocial factors (lack of social support, adverse life events, loneliness, depression, generalised anxiety, panic, social phobia) remained the strongest predictors of SS (Beutel et al., 2019). Similarly, a separate study suggested that older individuals might cope better with SS than younger individuals (Hilderink et al., 2015). Indeed, in the study, as individuals aged, while the impact of medically explained symptoms on health-related quality of life remained consistent, the influence of medically unexplained symptoms (MUS) lessened. Among the elderly, the effect of MUS weakened even further compared to the effect of medically explained symptoms on health-related quality of life. This implies that older individuals adapted more to MUS or experienced less severe forms of MUS in their later years. A possible hypothesis explaining these contrasting results is that the correlation between SS and increasing age might be a somatic expression of depression in later life. In this sense, depressive symptoms would tend to shift with age from being predominantly mood-related to being more somatic/vegetative (Schaakxs et al., 2017). Thus, in older persons

aged ≥ 70 years, late-life depression may not be adequately recognised because they may show less mood and motivational symptoms compared to younger persons (Hegeman et al., 2015).

2.1.2 Gender

The occurrence of SS has consistently been linked to the female gender (Beutel et al., 2020). Specifically, women tend to experience a higher number, intensity, and frequency of SS compared to men (Barsky et al., 2001). This prevalence of somatisation among women has been observed in both clinical and non-clinical populations (Beutel et al., 2019). The underlying reasons for this gender difference appear to be intricate, involving multiple variables that require careful consideration. For instance, the higher prevalence of psychological distress, such as depression, anxiety, trauma and abuse, in women could contribute to the SS greater prevalence. However, it is important to note that innate differences in nociception and gender-specific socialisation skills may also contribute to women's heightened awareness and expression of distress compared to men (Beutel et al., 2019).

An intriguing research undertaken by Ballering et al. (2020) delved into the differentiation between the constructs of sex and gender and their respective associations with common SS. Biological sex encompasses inherent biological attributes, such as physical features, chromosomes and hormones, while gender encompasses the psychosocial dimensions of biological sex, including socially constructed roles, behaviours and identities. Unlike biological sex, which exhibits relative stability, gender roles and embodiment display dynamic characteristics and significantly influence an individual's experiences related to femininity and masculinity. In the study, female sex was linked to a greater prevalence of SS in comparison to male sex. However, in approximately 10% of the participants the gender index was not in line with participants' sex. Most importantly, feminine characteristics, such as cooking, engagement in household activities, and certain personality traits (which effectively classified 80% of the participants as female in the study), were linked to an increased burden of SS particularly among men. In conclusion, the study's approach highlights that, despite the prevalent oversight in distinguishing between sex and gender in health studies, differences in gender roles may mediate the observed sex-related disparities in SS (Ballering et al., 2020).

2.1.3 Culture

According to cross-cultural studies, adopting an isolated syndrome-specific perspective may have limitations in different cultural settings (Guo et al., 2019). The process of focusing on, amplifying, and clinically presenting somatic distress appears to be universal across cultures (Khoo et al., 2012). However, somatic symptom reporting varies across different cultural contexts. Prevalence rates of SS have been found to range from 7.6% to 36.8% in primary care settings, with higher rates observed in South American countries (Üstün & Sartorius, 1995). Moreover, Asian countries, such as China, have reported higher rates of somatisation compared to European countries, leading to the hypothesis of 'Asian somatisation' versus 'Western psychologisation' (Dreher et al., 2017; Karasz et al., 2007). Hence, cross-national comparisons confirmed that people of Chinese heritage are more likely to present more somatic and fewer psychological depression symptoms compared to people of Western European heritage. Moreover, cross-national comparisons have revealed differences in the presentation and patterns of SS. For instance, cardiopulmonary-related symptoms were grouped differently in Chinese samples compared to European samples in factor analysis of the Patient Health Questionnaire for Somatic Symptoms (PHQ-15) (Leonhart et al., 2018). Various explanations have been proposed for this phenomenon. Some argue that the higher rates of somatic complaints in Chinese populations may be due to variations in the experience and expression of distress, as well as the conceptualisation and communication of distress, influenced by traditional Chinese cultural values (Ryder & Chentsova-Dutton, 2012; Zhou et al., 2016). Therefore, factors such as externally-oriented thinking in Asian cultures, stigma, and help-seeking behaviours may also contribute to higher rates of SS (Ryder et al., 2008; Zaroff et al., 2012). For example, a lack of doctor-patient relationship has been considered a factors influencing the high rate of SS in Latin America (Gureje, 2004). Overall, transcultural research on somatisation indicates that SS can vary in prevalence and patterns between countries. “However, it is less the symptom or syndrome itself but rather the clinical presentation and the associated features, such as experience and manifestation of distress, which needs to be considered through a cultural lens” (Guo et al., 2019).

2.1.4 Socioeconomic status and education level

Several studies have identified socioeconomic as a determinant of SS (Escobar et al., 1987; Obimakinde et al., 2015; Sebastian et al., 2015). In a 26-year longitudinal study involving

1,001 Swedish participants, it was observed that the blue-collar group experienced more SS than the white-collar group, indicating disparities between different occupational groups (Sebastian et al., 2015). Similar findings were reported in studies with Nigerian participants diagnosed with somatoform disorder, where those from polygamous families and earning below a dollar per day exhibited more severe somatoform disorder (Obimakinde et al., 2015).

The number of years of education has also shown to influence SS. Individuals with fewer years of education living in urban areas have shown a higher risk of SS in the past (Swartz et al., 1989). However, a recent review on the predictors of SS has labelled the impact of education as inconsistent (Kitselaar et al., 2023)

2.2 Physiological factors

2.2.1 Interoception and attention

According to the theory of "somatosensory amplification" there exists a connection between somatisation and an individual's tendency to react in a heightened state of vigilance when confronted with uncomfortable physical sensations (Barsky et al., 1988). This heightened response entails a selective concentration on physical sensations and the interpretation of these sensations as potential indicators of a health concern.

Attention comprises alertness, orientation, and executive control functions that oversee the allocation, selection, and direction of an individual's limited cognitive resources (Petersen & Posner, 2012). Therefore, attention is a necessary precursor of awareness and conscious experience (Damasio, 1999) and it is a central aspect of emotion regulation processes (as described in Chapter 3). Focusing one's attention on the self can increase awareness of self-aspects, including the physical self. This idea aligns with Pennebaker's "competition of cues hypothesis" which suggests that the likelihood of noticing internal cues depends on the balance between internal and external information (Pennebaker, 2012). Thus, directing attention to the self enhances the chances of internal information entering conscious awareness, a crucial step for experiencing physical symptoms. Studies have supported this notion, demonstrating that individuals who concentrate their attention on themselves report more physical symptoms and perceive somatic activity as more intense compared to those who focus away from the self (Pennebaker, 2012). Indeed, the attention to bodily sensations is usually high in subjects who report SS (Mirams et al., 2013; Mehling, 2016). This might be due to the fact that comorbid

high-state anxiety and depression can induce physiological changes, an intensified attention to the body and an alteration of the cognitive processing of physical sensations, representing important precipitating factors (Mayou and Farmer, 2002; Janssens et al., 2010; Mallorquí-bagué et al., 2016). Nonetheless, it's worth mentioning that both negative and positive emotions can lead to self-focused attention (Gendolla et al., 2005). Still, it's important to note that positive emotions do not promote the experience of symptoms (*ibidem*). Instead, as noted by Gendolla et al. (2005), self-focused attention in a negative mood amplifies the experience of SS.

Research has frequently examined self-focused attention within the framework of interoceptive accuracy (Gabriele et al., 2022). Interoception refers to the comprehensive perception of one's own body's internal state. This process encompasses a set of processes involving the perception and understanding of bodily signals, comprising interoceptive accuracy, sensibility, and awareness (Garfinkel et al., 2015). Interoceptive accuracy, which has been the primary focus of current research, assesses how accurately individuals perceive internal bodily signals, such as heart rate changes. Interoceptive sensibility involves an individual's belief in their interoceptive abilities and their level of engagement in processing these signals, especially noticing changes in bodily sensations. Instead, interoceptive awareness operates at a metacognitive level and reflects an individual's ability to recognise their accuracy in detecting internal body signals during interoceptive accuracy tests. It involves aligning one's true interoceptive abilities (accuracy) with their perceived abilities (sensibility) (*ibidem*).

Aetiological perspectives on the influence of interoception on SS vary, with some suggesting heightened sensitivity to interoceptive signals, while others propose decreased and biased sensitivity (A. Martin & Van den Bergh, 2020; Wolters et al., 2022). The first perspective posits that individuals experience SS due to misinterpreting even minor physiological changes, driven by heightened attention to bodily sensations. These misinterpretations can reinforce hypervigilant attention to the body, perpetuating symptoms (Barsky et al., 1988; Hanback & Revelle, 1978; Rief & Broadbent, 2007). “In these etiological frameworks, individuals with high somatic symptom burden are assumed to exhibit higher interoceptive accuracy” (Wolters et al., 2022, p. 2). Alternatively, the predictive coding perspective suggests that SS develop independently of actual physiological changes. According to this view, the brain constructs perceptions by matching predictions with sensory input, and even incorrect predictions can influence perception, particularly when physiological stimuli are ambiguous. Thus, SS may be perceived irrespective of actual psychophysiological changes, as they align with the individual's

prediction models (*ibidem*). In this aetiological framework a reduced and biased interoception is hypothesised in SSD (Van den Bergh et al., 2017).

However, when it comes to empirical observations of interoception in people with SS or chronic illness, results are ambiguous. Some studies have indicated heightened or unaltered interoceptive accuracy in individuals with SSD, while others show a decreased interoceptive accuracy (Locatelli et al., 2023; Witthöft et al., 2020; Wolters et al., 2022). When it comes to interoceptive biases, numerous studies have observed a propensity for heightened response bias among individuals with somatic symptoms (Wolters et al., 2022).

2.2.2 Autonomic nervous system

The dysfunctions of the interoceptive processes might also be related to their interaction between the autonomic nervous and affective systems. The autonomic nervous system acts as a crucial link between the body, its environment, and the maintenance of bodily equilibrium (Kozłowska et al., 2020). For this reason, in certain countries physicians have adopted terminology for SSD that implies the role of the autonomic nervous system. Examples include the use of terms like "autonomic dysregulation" in Taiwan and "vegetative syndrome" in Japan (Tu et al., 2021). The autonomic nervous system comprises the sympathetic and parasympathetic systems. In normal, low-stress conditions, these systems collaborate to uphold bodily functions in a balanced state. The sympathetic system acts as an accelerator, increasing heart rate and immune-inflammatory responses when necessary, while the parasympathetic system serves as a brake, slowing heart rate and promoting restorative processes like digestion and tissue repair. However, when confronted with stress or perceived threats, both systems switch into defensive modes. The sympathetic system intensifies energy consumption and heart rate, giving rise to symptoms such as increased heart rate, sweating, and temperature changes. It can also affect salivary gland function, disrupt sleep, and influence digestion and bowel movements. Conversely, stress triggers alterations in both restorative and defensive parasympathetic responses. Restorative parasympathetic activity diminishes, allowing heart rate to rise, while defensive parasympathetic programs become more active, particularly in the heart and gut, leading to symptoms like dizziness, fainting, nausea, vomiting, abdominal pain, and changes in bowel and bladder function. As a result, autonomic dysregulation is highly responsive to stress and can be triggered by physical or psychological stressors, resulting in consistent and recurring symptom patterns across various body systems (*ibidem*).

Recent research suggest that disturbed interactions between the autonomic nervous, affective, and interoceptive systems may be involved in the pathophysiology of SS (Lee et al., 2018). Thus, an altered resting-state autonomic activity and reactivity to emotional processing has been highlighted (Lee et al., 2018, 2023).

2.2.3 Allostatic load

The adaptive response of the organism, useful for maintaining homeostasis in response to stressors, is called "allostasis" (McEwen & Stellar, 1993). Allostasis refers to the dynamic regulatory processes that enable the body to adapt to different situations, underscoring the idea that maintaining health involves continuous adjustments to the body's internal physiological balance. While allostasis is essential for optimal bodily function, it is not without consequences, leading to what is known as allostatic load. Allostatic load represents the accumulated effects of stress on daily life, representing the wear and tear on the body resulting from ongoing adaptation (Goldstein & McEwen, 2002; Panayiotou et al., 2021).

In typical circumstances, adaptive allostasis involves fluctuations in various bodily systems, including neuroendocrine (e.g., cortisol, (nor)epinephrine), cardiovascular (e.g., blood pressure, heart rate), metabolic (e.g., glucose, insulin), and immune (e.g., cytokines) responses (Panayiotou et al., 2021). However, when an individual's emotional response does not align with the situation, it can lead to allostatic load and increased vulnerability to illness due to dysfunctions in neuroendocrine, cardiovascular, metabolic, and immune systems. Allostatic overload occurs when the cost of chronic exposure to heightened neural or neuroendocrine responses exceeds an individual's coping abilities. Over time, allostatic load can deplete the body's stress response systems, reduce the functionality of various bodily systems (e.g., cardiovascular, respiratory, gastrointestinal), and raise the risk of disease (*ibidem*).

McEwen's insights shed light on the intricate interplay of cognitive, behavioural, and early life experiences in influencing allostatic load mechanisms. While these factors are all relevant, perhaps the most crucial one for SS lies in how individuals interpret and respond to stressful events on a cognitive level (Porcelli, 2022). When a situation is perceived as threatening, the brain can trigger specific behavioural responses, such as avoidance behaviours or risk-taking behaviours. Additionally, the brain regulates hormonal stress responses, a mechanism designed to protect the body in the short term. However, over time, these prolonged and frequent hormonal stress responses can become detrimental to one's overall health. This

cognitive response to perceived threats becomes particularly significant in individuals with somatic amplification and health anxiety (*ibidem*). These individuals tend to interpret even minor physical sensations as potentially harmful, regardless of whether they have previously experienced similar sensations as transient and reversible. This heightened hypervigilance to bodily sensations can contribute to the persistence of SS.

Clinical criteria for diagnosing allostatic overload have been developed, based on the presence of identifiable sources of distress, such as life events or chronic stress exceeding an individual's coping capacity, along with clinical signs of distress and impaired well-being (Fava et al., 2017). These criteria, part of the revised Diagnostic Criteria for Psychosomatic Research (DCPR-R), have been utilised in several studies, demonstrating clinical and prognostic significance and associations with changes in biological markers (Fava et al., 2017).

2.3 Psychological factors

2.3.1 Somatic symptoms, Anxiety and Depression (the SSAD triad)

In primary care, SS are often the object of medical consultation of patients suffering from anxiety and/or depression, who are less likely to mention psychological distress if they are not specifically asked about it (Haug et al., 2004; Simon et al., 1999). Depression, anxiety, and SS, referred to as the SSAD triad in this thesis, have overlap in diagnostic criteria that can lead to an increased likelihood of co-occurrence (American Psychiatric Association, 2013). In addition, anxiety can be a risk factor for depression or SSD (Norton & Paulus, 2016). The coexistence of this triad is well-documented. Extensive evidence indicates that the presence of SS increases the likelihood of having either disorder by twofold (Bair et al., 2003; Bekhuis et al., 2016; Groen et al., 2021; Janssens et al., 2010; Kroenke, 2006; Kroenke et al., 2010; Lieb et al., 2007; Mergl et al., 2007; van Boven et al., 2011). Comorbidity rates between the disorders have been reported to be as high as 40-60% (Hettema, 2008a). However, a recent cross-sectional study known as the Netherlands Study of Depression and Anxiety, in a population of patients with a diagnosis of depressive and/or anxiety disorder, found SSAD comorbidity to range from 18.7% to 82.0% (Bekhuis et al., 2015). In the study all clusters of SS were independently associated with all depressive and anxiety disorders (except for dysthymic disorder), and major depressive disorder showed the strongest association. Results were not influenced by the presence of a chronic illness, by lifestyle or sociodemographic factors, which was in line with a large

community sample study, finding the association of SSAD to be equally strong in both sex and in all age groups (Haug et al., 2004). However, in a recent latent profile analysis study, in a sample of the 1027 participants, being female and younger predicted membership to the higher comorbidity class of the three found by the study. Most importantly, in the study comorbidity classes were distinguished only by symptoms severity, rather than the presence or absence of specific SS, showing a high degree of similarity among SSAD (Kim et al., 2022).

Symptoms of depression and anxiety are often categorised into physical symptoms (neurovegetative symptoms) like fatigue and insomnia and cognitive/affective symptoms such as depressed mood or anxiety (Bekhuis et al., 2016). The contributions of specific symptoms to SSAD association has been investigated through a network analysis which found that neurovegetative and cognitive/affective symptoms of anxiety and depression have similar strength of connections to the SS domain. However, specific symptoms like anxiety and fatigue had strong connections with SS, while hypersomnia and insomnia had no significant links to the somatic domain. Some SS, like excessive perspiration and pressure/tight feeling in the chest, showed many strong connections, while others like muscle pain and tingling in fingers had limited and weak associations.

Despite robust evidence of the co-occurrence of SSAD, the aetiological mechanisms explaining the development and maintenance of such comorbidity remain controversial in the literature. Several theoretical hypothesis have been proposed: 1) anxiety and depression, via an intensified attention to the body and an alteration of the cognitive processing of physical sensations, could cause the onset of SS (Janssens et al., 2010; Mallorquí-bagué et al., 2015; Mayou & Farmer, 2002); 2) internalised symptoms such as anxiety and depression could be a consequence of the physical and emotional inconveniences caused by SS (Cohen & Rodriguez, 1995; Henningsen et al., 2003); 3) shared aetiological factors (e.g., environmental, psychological, and biological) could independently cause the onset of all three pathologies (Fishbain et al., 1997; Gillespie et al., 1999; Henningsen et al., 2003). Furthermore, as discussed in recent review, shared neural pathways and physiological mechanisms underlying pain (e.g., inflammatory processes) and the dysfunction of the stress systems could also influence and exacerbate the co-occurrence of SSAD (Bervers et al., 2016).

The existing literature has also suggested the possibility of a genetic predisposition for SS, as well as for depressive and anxiety disorders (Gillespie et al., 2000; Hettema, 2008b; Lembo et al., 2007). However, unlike in anxiety and depression, the role of heritability in SS

remains less clear (Henningsen, 2018; Rief et al., 2010). Twin studies have provided support for the presence of genetic components in certain functional somatic syndromes, such as chronic fatigue and irritable bowel syndrome (Bengtson et al., 2006; Buchwald et al., 2001; Lembo et al., 2007, 2009). However, genetic factors appear to contribute only to a limited extent and efforts to identify single genes responsible for this predisposition through genome-wide investigations have yielded inconsistent results, leading researchers to increasingly consider the relevance of epigenetic mechanisms (Denk et al., 2014; K. Kato et al., 2010; Lembo et al., 2007). To explore the interplay between genetic and environmental factors in the comorbidity of functional SS and psychiatric disorders, Kato et al. (2009) conducted a large population-based twin study. While specific genetic components were identified for each functional syndrome, the findings suggest a multifactorial pathogenesis for these conditions. Among women, the co-occurrence of functional somatic syndromes was influenced by two latent traits: one predominantly linked to psychiatric disorders and driven by genetic factors, and the other not associated with psychiatric disorders but particularly related to chronic widespread pain, influenced more by environmental factors. Thus, the role of genetic factors in SS development and maintenance can only be fully understood when considering environmental factors (K. Kato et al., 2009) and comorbid psychiatric disorders (Lembo et al., 2007; Lembo et al., 2009), with early and prenatal experiences potentially playing a significant role in shaping these mechanisms. These experiences may provide a link to the well-established role of childhood adversities as predisposing factors for SS, increasing the odds of developing SS up to fourfold (Afari et al., 2014).

2.3.2 Loneliness and interpersonal connection

Julianne Holt-Lunstad, one of the leading researchers on social connection, has identified loneliness as one of the upcoming major public health challenges (Holt-Lunstad et al., 2015). Loneliness is a universally experienced emotion, yet its perception and experience are highly individualised. It is in fact important to distinguish this concept with the actual number of social connections a person has in their immediate environment (Cacioppo & Cacioppo, 2018; Conti et al., 2023). People may feel surrounded and supported having only a few social connections or they might view loneliness positively as a sign of independence and personal growth, rather than a negatively as a distressing condition (Conti et al., 2023; Porcelli, 2022).

While loneliness has been linked to various medical conditions, a recent study revealed that, when compared to healthy controls, patients with SSD not only experience higher levels of loneliness but have also a more negative perception of their social support (Vos et al., 2023). Furthermore, the study found a correlation between loneliness and the severity of SS experienced. In another study, alongside a higher risk of being diagnosed with SSD, loneliness has found to be significantly associated with anxiety and depressive symptoms (Werner et al., 2021).

The World Health Organization declared the outbreak of SARS-CoV-2 coronavirus as a Public Health Emergency of International Concern in January 2020, and as a pandemic in March 2020. Given the high transmissibility of the virus, many countries adopted restrictive measures such as lockdown, quarantine, social distancing, and limits to movements and travel. An increased sense of subjective loneliness has been seen from pre-pandemic to pandemic situation (Conti et al., 2023; Werner et al., 2021). In a longitudinal study examining the effects of loneliness during the COVID-19 pandemic on the psychological well-being of students, no significant differences in SS levels were observed when comparing groups with varying degrees of loneliness (Conti et al., 2023). Instead, what emerged was a concerning trend of increasing depression, anxiety, and alexithymia over time, particularly among students experiencing high levels of loneliness. Notably, the study's key finding was that students who already exhibited higher levels of depressive symptoms and alexithymic traits prior to the lockdown, and whose depression and alexithymia intensified during this period, were at a heightened risk of experiencing a profound sense of loneliness. Instead, in a cross-sectional study, SS were reported as a strong independent risk factor for loneliness and all other mental health outcomes, such as depressive and anxiety symptoms, and PTSD (Xu et al., 2021). These ambiguous results underscores the intricate relationship between SS and the perceived sense of loneliness during the pandemic.

KEY POINTS

The etiology of SS is multifaceted, characterized by intricate interactions among emotional, behavioral, and physiological components. These include predisposing, triggering, and perpetuating elements, with symptom processing assuming a central role in the persistence and intensification of SS.

Sociodemographic factors: SS tend to increase with age, but this relationship may be mediated by psychosocial factors, particularly in older individuals. Women report a higher prevalence of SS compared to men.

Physiological factors:

- 1) Genetic predisposition may play a role in SS, but it appears to be influenced by environmental factors, psychiatric comorbidities, and early life experiences.
- 2) Attention to bodily sensations and interoceptive accuracy are linked to SS, with heightened self-focused attention and interoceptive sensitivity contributing to symptom amplification. Both negative and positive emotions can lead to self-focused attention, but only negative emotions amplify SS.
- 3) Dysfunctions in the autonomic nervous system with altered autonomic activity and reactivity to emotional processing have been observed in individuals with SS.
- 4) Allostatic load, plays a role in the development and persistence of SS. Stress and perceived threats, especially in individuals with somatic amplification and health anxiety, can contribute to allostatic overload and heightened SS.

Psychological factors: 1) SS increase the likelihood of co-occurring anxiety and depression (the SSAD triad). The relationship is complex, with multiple explanations, including shared causes. 2) Loneliness correlates with SS, anxiety, and depression. However, mixed findings have been found during the COVID-19 pandemic, with some studies showing an association between loneliness and mental health issues and others not finding associations between loneliness and SS.

3. Emotion regulation processes in Somatic Symptoms

In recent decades, there has been a persistent interest in understanding how individuals effectively manage and regulate their emotional responses in diverse situational contexts. A significant challenge in the rapidly evolving field of emotion regulation (ER), regards the application of this construct to a wide spectrum of processes and behaviours that may not fit the emotion regulation paradigm. To address this concern, this chapter embarks on a theoretical exploration of existing models within the emotion regulation literature and gives a definition of ER, distinguishing it from related concepts. The considerable growth in emotion regulation research has led to a convergence of leading emotion regulation models. Some authors proposed classifying these models based on their focus at the micro or macro level and/or on strategies or abilities (Fombouchet et al., 2023; Gratz et al., 2018; Tull & Aldao, 2015). The firsts concentrate on emotion regulation strategies (e.g., Gross, 1998a, 2015a), and the second group emphasise individuals' effectiveness in regulating their emotions (e.g., Preece et al., 2018).

In this chapter, Micro, Macro and "Meso" models of emotion regulation are discussed. Subsequently, the chapter establishes a foundational framework for analysing emotion regulation within the context of SS, proposing an integrated framework for emotion regulation Flexibility adapted for the study of SS. Following this, the focus shifts to the important integration of Alexithymia within the domain of ER, highlighting the significance of connecting these two constructs in the investigation of SS.

3.1 Emotion and emotion regulation processes

3.1.1 At the roots of Emotion Regulation: a definition of Emotions

*"Everyone knows what an emotion is, until asked to give a definition.
Then, it seems, no one knows" (Fehr & Russell, 1984, p. 464).*

As posited by Gross (1998): “any discussion of emotion regulation presupposes an understanding of what emotion is”. The word 'emotion' is derived from the Latin word *emovere*, meaning 'to move', 'to bring out'. The inclusion of a sense of movement to this word gives to emotions the characteristic of something that sets us in motions, denoting a psychological or physical reaction to a situation or to daily life event. However, the word emotion names both an everyday concept and a scientific one (Widen & Russell, 2010). From a scientific point of view, the definition of emotion has proved to be a long-standing problem (Wierzbicka, 1992). An historic conception that influenced a century of research has been the James-Lange theory of emotion (P. J. Lang, 1994), for which emotions appeared as the response to physical changes following an external stimulus. However, almost a century later from this theory, many definition of emotions exists (e.g., Barrett, 2009; Lazarus, 1991) and there is “no generally accepted definition” within science (Izard, 2010, p. 370). However, most authors agree on several core features (Gross & Feldman Barrett, 2011). Empirical evidence shows that emotions are multifaceted (Mauss et al., 2005), unfold and fluctuate across time, and consisting of experiential, behavioural and physiological components (Kuppens & Verduyn, 2017). Also, while there is little consensus on how many types of emotions exist (Ekman & Friesen, 1971; Montag & Panksepp, 2017), most authors agree that they can have a negative or positive valence (Kensinger, 2004; Rasmussen & Berntsen, 2009) and that they can be used in an adaptive or maladaptive way, depending on whether their type, intensity and duration facilitates or not goal attainment (Panayiotou et al., 2019; Panksepp, 2005; Rotenberg & Boucsein, 1993). Moreover, emotions are impacted by cultural concepts and representations, and moulded by sociocultural preconceptions regarding our emotional experiences, their appropriate expressions, and expected feelings (Ekman & Friesen, 1971; Uchida & Kitayama, 2009).

To summarise these points, taking from Koole, Van Dillen and Sheppes (2011), in the present thesis the word emotion is used to indicate “people’s valenced (positive or negative) reactions to events that they perceive as relevant to their ongoing concerns. Emotions in the present conception consist of multiple components that include specific thoughts and feelings, along with behavioural and physiological responses”.

3.1.2 Differentiating Emotion regulation from related constructs

“Virtually any stimulus or activity that can cause changes in people’s emotional states may be recruited in emotion regulation” (Koole et al., 2011, p. 23). Therefore, before further discussing this construct, it is important to frame the concept of emotion regulation in relationship to similar constructs that are sometimes interchangeably used and that overlap to some degrees. In fact, in the literature a distinction is made between emotion regulation and affect regulation (Baumeister & Vohs, 2004), mood regulation (Parkinson et al., 1996), stress or coping regulation (Lazarus & Folkman, 20) or self-regulation (Baumeister & Vohs, 2004).

According to Gross and Thompson, affect regulation is an over-ordered category encompassing all of these regulatory processes (Gross & Thompson, 2007). In regards to mood regulation, academic literature makes a distinction between emotion (which are experienced moment to moment) and mood (which tend to last longer periods of times), such as negative affective states (Ekkekakis, 2012). In addition, they also differ in terms of intensity, effects on physiology, causes, and consequences (Beedie et al., 2005). The word self-regulation is often used as a synonym of ER. However, in developmental psychology, self-regulation is also used to indicate behavioural self-control (Baumeister & Vohs, 2004). As defined in Bandura's theory (1991), self-regulation is a system of self-reflective and self-reactive capabilities that enable people to manage and control their thoughts, feelings, motivation, and actions. According to Baumeister et al. (2007) model of self-regulation, the construct is formed by four components: standards of desirable behaviour, motivation to meet standards, monitoring of situations and thoughts that do not respect these norms and lastly, willpower. As shown by this theoretical framework, most of the components are considered as conscious meanwhile the concept of emotion regulation can refer to both, conscious and non-conscious processes (L. E. Williams et al., 2009). A final construct that has strong similarities with the one of emotion regulation is the concept of coping. Lazarus and Folkman (Lazarus & Folkman, 20, p. 141) define coping as "cognitive and behavioural efforts that constantly evolve in order to manage external and/or

internal constraints and that are evaluated as costly or even exceeding the person's resources". As intended by these authors, coping involves a sense of intentional control and voluntary goal-directed effort in order to *cope* with stressful situations. Thus, while both coping and emotion regulation are conceptualised as processes of regulation, coping involves "the presence or expectation of emotional arousal (generally resulting from stress or danger)" (Eisenberg et al., 1997, p. 228). Instead, emotion regulation is a continuous process that concerns a much wider range of situations and stimuli. In this sense, coping can be conceived as a type of emotion regulation that takes place in stressful circumstances (Compas et al., 2014).

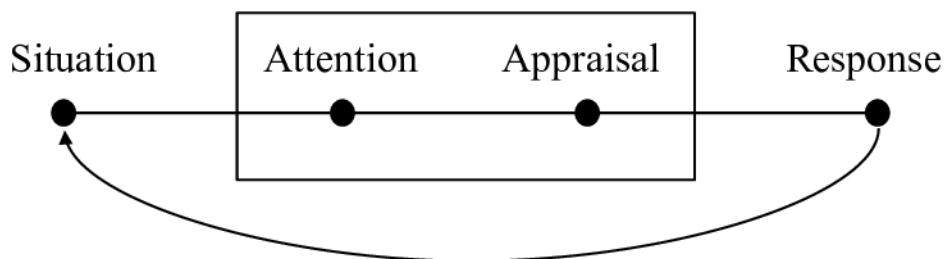
3.1.3 From a definition of Emotion to a definition of Emotion Regulation

The term "emotion regulation" (ER) is relatively new. Until 1990, only four studies used this expression (Gross & Feldman Barrett, 2011). As a consequence, similarly to the literature on emotions, there is no consensus among researchers on a unique definition and conceptualisations of emotion regulation (Gratz et al., 2018; Gratz & Tull, 2022). The term "emotion regulation" has significant implications, especially when it comes to distinguishing between how emotions are generated and how they are controlled. This poses challenges for psychological models because emotions are closely linked to thoughts and cognitive processes. The boundary between creating an emotion and controlling is not always clear as even the mere possibility of modifying an emotional state is a defining characteristic of that particular emotion. Moreover, the word "regulation" suggests that the control processes occur after the emotion has already been experienced or constructed. Thus, in paradigms where emotion regulation is believed to begin from the very start of an emotional event, a question arises about whether the implicit influence of our knowledge on subsequent emotions can be considered a form of regulation by itself. For instance, such as when we have a prior belief that a SS is a sign of illness. These different approaches influence the definition and understanding of ER. However, there have been efforts to establish a common ground for exploring how emotions can be modified. The "modal model" of emotion serves as a general framework and foundation for investigating ER, as it integrates common features from different emotion theories (Gross, 1998a, 2014). This model of emotion (Figure 3) can be described as a loop or sequence of steps, starting with a psychologically relevant situation, involving external factors or internal representations. Individuals pay attention to and appraise these situations in the context of their current goals (Moors et al., 2013). This contextual evaluation triggers interconnected changes in subjective, behavioural, and physiological systems, leading to the experience of emotion.

Importantly, the emotional response often modifies one of the previous steps, like the situation itself, creating a recursive and unfolding process. Therefore, in a comprehensive sense, emotion regulation encompasses all conscious or unconscious, inherent or external, behavioural, psychological or cognitive processes that are engaged in monitoring, evaluating, and/or adjusting emotional responses (Gross, 2015a).

Figure 3

Modal model of emotion (Gross & Thompson, 2007, p. 6)



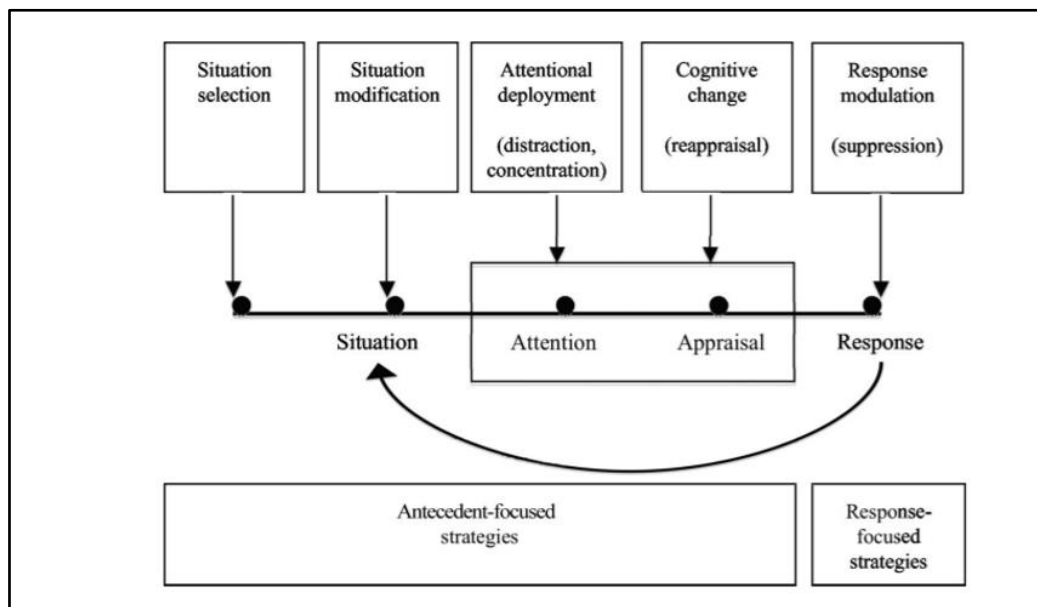
3.1.4 Micro level models of emotion regulation: Emotion Regulation Strategies

Most of the research on emotion regulation using a micro-level approach are based on the process models of Gross (Gross, 1998b, 2015b). The last model Gross has formulated, named “extended”, is the continuation of two of Gross’s earlier models, the modal model of emotion and the process model of emotion regulation. This model describes the ways in which individuals regulate their emotions at different points in the emotion generation process in order to change or modify the trajectory of an emotion and facilitate the achievement of a desired goal. The model is based on a priori conception of emotions for which the process of generating emotions begins with the evaluation of emotional signals. Instead of being a singular process, emotion regulation is understood as a broad term encompassing a range of strategies (Webb et al., 2012). These strategies vary in their timing, target, degree of voluntary control, and the extent to which the emotion regulation goal is explicit or implicit (Braunstein et al., 2017). According to the process model of emotion regulation (Gross, 1998b, 2015b), emotions can be regulated through cognitive processes that intervene at specific moments during the course of

emotional experiences. The model divides the strategies an individual may use to regulate emotions in groups set at a different points of a temporal emotion generation scale (see Figure 4).

Figure 4

Process model of emotion regulation. Reproduced from “Emotion Regulation: Conceptual Foundations,” by J.J. Gross and R.A. Thompson, 2007, in J.J. Gross (Ed.), Handbook of Emotion Regulation, p. 10, Guilford Press. Copyright 2007 by Guilford Press.

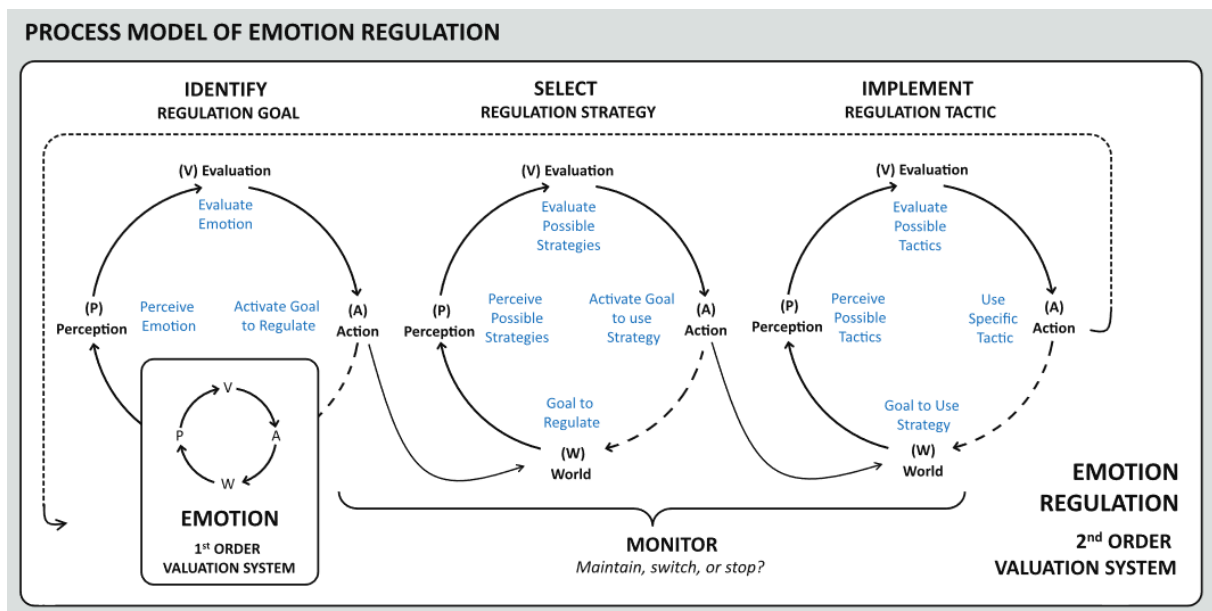


As shown in Figure 4, Gross’s model identifies five major families of emotion regulation strategies. Four of these are antecedent-focused strategies and happen early in the emotion-generating process by altering the impact of emotion-eliciting cues, and one is a response-focused strategy and is applied once the emotion has been generated. The antecedent-focused strategies are: (1) the selection of situations by addressing or avoiding certain situations to regulate emotion (e.g. influencing exposure to a situation that could provoke desirable or undesirable emotions); (2) modifying the situation by changing the characteristics of an emotional situation (i.e., altering a situation to modify its emotional impact); (3) deploying attention on certain aspects of the situation in order to modify the emotional state (e.g. distraction), (4) cognitively changing or modify the evaluation of a situation (i.e., changing the evaluation of a situation to influence its emotional impact). The final point at which emotion regulation can occur is a response-focused strategy: response modulation (5), in which, once the emotion has been elicited and may continue to be generated, one can modify the

physiological, experiential or behavioural expression of the emotion (i.e., engaging in a behaviour, such as expressive suppression, to influence some aspect of a generated emotion e.g. expressive suppression). The timing and type of emotion regulation strategy employed has emotional, cognitive and behavioural consequences (Gross, 2015b). In fact, it is important to note that emotions do not follow a prescribed order as they unfold. Overall, the process model of emotion regulation offers insights into the connection between emotional components and cognitive processes, enabling the formalisation and description of different strategies. However, understanding why an individual chooses to initiate or fail to implement a specific strategy instead of another is a crucial aspect of studying ER, as described in the extended process model of ER.

Figure 5

The extended process model of Gross (reprinted from Ford et al., 2019)



The extended process model of emotion regulation incorporates the concepts of interacting valuation systems and context, which become central to the conceptualisation of emotion regulation (Figure 5). In this model emotion regulation evolves from a general dispositional tendency to a dynamic situation-dependent process directed towards a specific goal (Gross, 2015b). The fundamental idea of this framework is that emotions involve distinguishing between what is "good for me" versus "bad for me." A valuation system can be represented by different aspects, such as states of the world ("W"), perceptions of those states ("P"), valuations

of these perceptions in relation to relevant goals ("V"), and actions taken to achieve those goals ("A"). These valuation systems can interact and be active simultaneously, creating a complex spiral of processes. Moreover, one valuation system can trigger another at a second-level. For example, a first-level valuation system might evaluate experiencing a headache as "bad for me" and elicit negative emotions (e.g., frustration and anger). However, a second-level valuation system can assess the first-level system itself as "bad for me" (since I believe that feeling frustrated for the headache is not going to help me) and the current goal becomes to modify the unfolding emotional response (e.g., accepting the headache and trying to understand if it is related to a physical or psychological need). This extension of the process model involves three meta-steps to ER: identification (whether to regulate emotions), selection (which strategy to use), and implementation (the efficient application of a chosen strategy). The emotional process ends if the goal is achieved, otherwise it returns to the first valuation system. Overall, the extended process model of emotion regulation highlights the significance of considering both emotion characteristics (e.g., valence and intensity) and contextual elements ER, providing a more dynamic framework compared to the initial model. However, the model lacks explicit descriptions of the factors influencing the development of valuation systems, the inter- and intra-individual differences in their implementation, and the variations in the effectiveness and outcomes of emotion regulation attempts (Riediger & Luong, 2015).

3.1.5 Macro level models of emotion regulation: Emotion Regulation Abilities

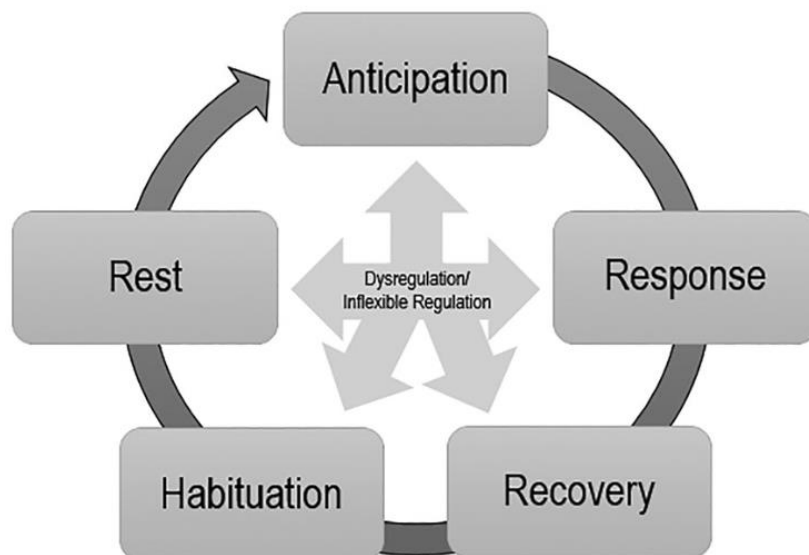
In contrast to the micro approach of Gross' emotion regulation models, Gratz and Roemer's acceptance-based model takes a broader perspective on emotion regulation (Gratz & Roemer, 2004). This model recognises that emotion regulation involves more than just controlling emotional arousal; it encompasses the ability to be aware of and understand emotions, accept them, access effective regulation strategies, and act in alignment with one's goals regardless of emotional state. Adaptive responses in this model involve using emotions as valuable information while pursuing meaningful actions and goals. It also includes managing impulsive behaviours and maintaining goal-directed actions even when experiencing negative emotions. Rather than viewing intense or reactive emotions as deficits in ER, this model sees them as opportunities to influence one's trajectory and outcomes (Gratz & Tull, 2010). These core abilities form the basis of the four domains assessed by the Difficulties in Emotion Regulation Scale (DERS), which consolidates various aspects of emotion regulation into a

single instrument, offering a more comprehensive evaluation of individuals' emotion regulation difficulties.

Encompassing a diverse array of psychological and physiological processes, the dynamic-phasic model, as proposed by Panayiotou, Panteli, and Vlemincx in 2018, emerges as a crucial framework to “investigate beyond simple reactivity to emotional stimuli, in order to understand mental and physical health conditions where emotional dysregulation plays a role” (Panayiotou et al., 2019). Their proposal revolves around the central idea that an effective and adaptive emotion regulation system is characterised by its capacity for flexibility, one that serves the individual's life goals and values. In this dynamic-phasic view, the emphasis is placed on understanding (dys)regulation throughout five fundamental phases of emotion: anticipation, response, recovery, habituation, and rest (Figure 6). This perspective draws upon well-established theories of emotion, emotion processing, and regulation and includes McEwen's allostatic model (Chapter 2.2, section 2.2.4) to posit that rigid and inflexible emotion regulation can lead to an accumulation of allostatic load. Thus, allostatic load might be the consequence of a mismatch between affective responses and situational demands. This arises from frequent stress, inadequate reactivity, failed shutdown, and impaired habituation, ultimately contributing to the onset of both physical and mental illnesses.

Figure 6

A dynamic-phasic model of emotion processing, reproduced from Panayiotou et al. (2019)



The phases of recovery, habituation and rest are meant as processes happening once the stimulus ends. In fact, following the emotional stimulus, recovery is essential for restoring equilibrium, both physiologically and psychologically. It involves returning to resting state, in order to restore homeostasis, deactivating the sympathetic nervous system and activating the parasympathetic system to conserve energy and facilitate exploration, need satisfaction, and life goals. Instead, habituation refers to the process of becoming less reactive to repeated or familiar stimuli. The speed of habituation depends on factors such as stimulus intensity and familiarity. Anomalies in habituation rates have been associated with various mental health conditions, including PTSD, anxiety, and depression (Panayiotou et al., 2019).

In summary, the dynamic-phasic model underscores the importance of flexibility in emotion processing and regulation. Flexibility enables psychological and physiological responses that are timely and appropriate for the context, ultimately promoting overall well-being. Embracing a diverse range of strategies and the ability to select contextually appropriate ones are pivotal components of this adaptive process.

3.1.6 Meso level models of emotion regulation: Emotion regulation flexibility

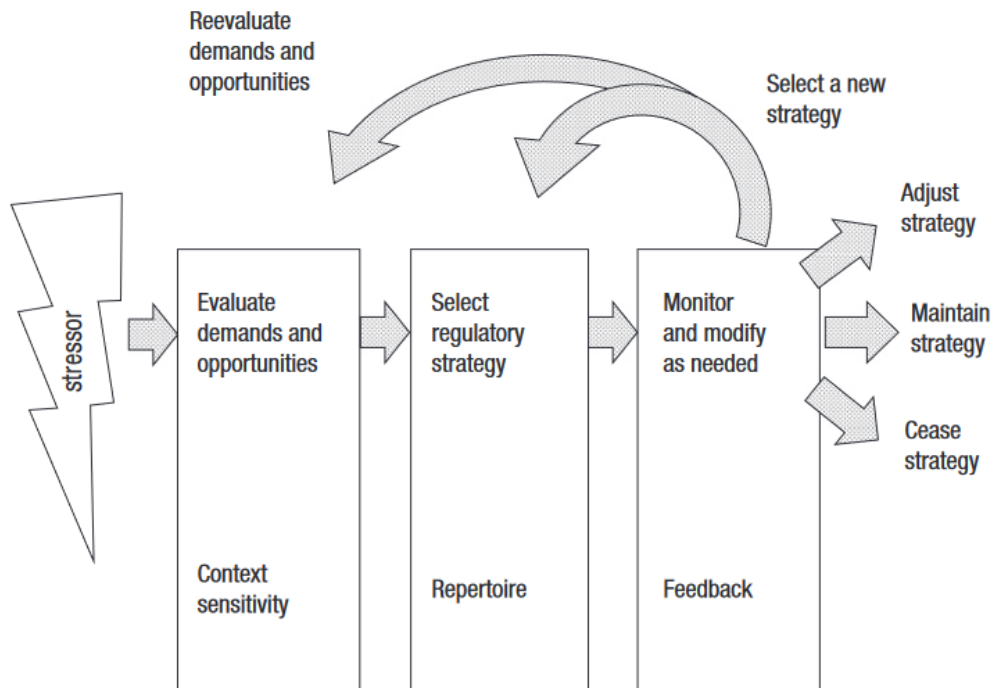
While the micro and macro models (i.e., process-models and ability models) of emotion regulation focus on distinct aspects of emotion regulation, they do not contradict each other and can coexist (Tull & Aldao, 2015). Recent concepts have emerged that integrate elements from both approaches, such as emotion polyregulation (i.e.; employing multiple strategies to cope with an emotional event, (B. Q. Ford et al., 2019) and emotion regulation flexibility (i.e.; shifting emotion regulation efforts based on contextual demands, Aldao et al., 2015). We concentrate on the concept of flexibility which is used in the proposed integrated framework of emotion regulation that we present in section 3.1.7.

The literature suggests that emotion regulation effectiveness varies among individuals and across different situations, emphasising the importance of flexibility (Aldao et al., 2015; Bonanno & Burton, 2013; Cheng et al., 2014). Bonanno and Burton (2013) proposed a framework for evaluating emotion regulation flexibility based on individual differences. They argue that regulatory flexibility varies among individuals, influenced by factors such as context, time, and choice, determining which strategies are effective, when, and for whom (Bonanno & Burton, 2013). Similar to Gross's extended process model, their regulatory flexibility model

comprises three sequential steps in the emotion regulation process: context sensitivity, repertoire, and responsiveness to feedback (Figure 7).

Figure 7

Three sequential components of regulatory flexibility and their corresponding abilities (Bonanno and Burton, 2013)



In fact, a flexible emotion regulation involves a sequence of abilities: (1) perceiving and appraising contextual demands (i.e., context sensitivity), (2) selecting adapted regulatory strategies to meet those demands (i.e., *repertoire*), and (3) monitoring the feedback of the strategy applied (i.e., feedback responsiveness) (Bonanno & Burton, 2013; S. Chen & Bonanno, 2021; Cheng et al., 2014). To note is that in the past some strategies were categorised as 'adaptive' (e.g., reappraisal, problem-solving, acceptance) or 'maladaptive' (e.g., avoidance, rumination, catastrophising, expressive suppression) based on their usual impact on health. However, it is crucial to consider the context in which these strategies are applied, as strategies labelled as maladaptive might actually be adaptive in certain situations.

Building on the model of emotional regulation flexibility by Bonanno & Burton (2013), Aldao et al. (2015) introduced an additional distinction between emotional regulation variability and flexibility. Emotional regulation variability refers to using different strategies

based on the context. However, true emotional regulation flexibility requires connecting the use of different strategies to the specific characteristics of the situation. In accordance with this model, emotional regulation flexibility is defined as "the degree of correlation between emotional regulation variability and changes in the environment, where the environment may consist of external events and/or internal evaluations of emotional reactions to these events" (Aldao et al., 2015, p.16). It's essential to note that emotional regulation flexibility is not inherently adaptive; its adaptiveness is evident when it enhances the likelihood of achieving meaningful goals for the individual, while considering the constraints and opportunities of the situation. These goals can be either extrinsic, like maintaining positive social relationships, or intrinsic, such as seeking to experience more positive emotions.

3.1.7 Cognitive emotion regulation strategies, SS and psychological distress

At the heart of the concept of emotion regulation and the models we have explored lies the pivotal stage of selecting regulatory strategies. While the majority of research has primarily focused on investigating two strategies, cognitive reappraisal and expressive suppression, it's important to note that a diverse array of emotion regulation strategies has been examined in the literature. Among these strategies, specific ones, such as rumination, suppression, avoidance, and problem-solving, may exhibit stronger associations with mental health outcomes compared to others like acceptance and reappraisal (Aldao et al., 2010).

Among emotion regulation strategies, cognitive emotion regulation strategies, specifically focuses on cognitive conscious self-regulative processes through which individuals regulate and/or modify the magnitude and/or type of their response to emotion-eliciting events (Aldao & Nolen-Hoeksema, 2010a; Garnefski et al., 2001; Naragon-Gainey et al., 2017). These responses are considered separate from the behavioural strategies (the action taken), as they can be understood as two different processes employed at different times, with the cognitive processes generally preceding the behavioural processes (Aldao & Nolen-Hoeksema, 2010a). Prior research has categorised nine distinct cognitive emotion regulation strategies into two conceptual groups: 1) adaptive strategies, considered theoretically more suitable, encompassing positive-focused cognitive emotion regulation techniques such as acceptance, positive refocusing, refocus on planning, putting into perspective, and positive reappraisal; 2) maladaptive strategies, regarded as theoretically less appropriate, encompassing negative-focused cognitive emotion regulation methods like self-blame, blaming others, rumination, and

catastrophising (Garnefski et al., 2001; Garnefski & Kraaij, 2007). The assessment of these cognitive emotion regulation strategies is integrated into the Cognitive Emotion Regulation Questionnaire (CERQ) (Garnefski et al., 2001), a 36-item questionnaire employing a 5-point Likert scale to evaluate the strategies individuals employ in response to stressful experiences. The resulting scores are divided into nine strategy subscales, further grouped into adaptive (CERQ-A: acceptance, positive refocusing, refocus on planning, positive reappraisal, and putting into perspective) and maladaptive strategies (CERQ-M: self-blame, rumination, catastrophising, and blaming others)(Aldao & Nolen-Hoeksema, 2010a; Garnefski et al., 2001)(Table 1) .

Table 1

Definitions of the adaptive and maladaptive Cognitive Emotion Regulation Strategies (adapted from Domaradzka & Fajkowska, 2018 and Garnefski, Kraaij, et al., 2002)

Maladaptive strategies	
Self-blame	Blaming oneself for the negative event
Rumination	Repetitive thinking about the thoughts and feelings about the event
Catastrophising	Focusing on how terrible the event was
Other-blame	Blaming others for what happened
Adaptive strategies	
Acceptance	Resigning to what happened
Positive refocusing	Directing thoughts to pleasant matters
Refocus on planning	Thinking about actions that can help dealing with the event
Putting into perspective	Diminishing the meaning of the event
Positive reappraisal	Finding a positive side to the negative event

Findings from previous studies shown that the engagement in self-blame, rumination and catastrophising is frequently associated to both depression and anxiety (Garnefski & Kraaij, 2007; R. C. Martin & Dahlen, 2005), as well as to a higher vulnerability in the development of SS (Garnefski et al., 2017; Joormann & Quinn, 2014; Omran, 2011). SSD have been found to be also significantly associated with a deviant pattern of habitual strategies (selection process) including a more frequent use of expressive suppression and a less frequent use of cognitive reappraisal (Schnabel, Petzke, et al., 2022). On the other hand, a reduced utilisation of positive

reappraisal has also been noted in both anxiety and depression (Omran, 2011; Qi et al., 2020; Y. Wang et al., 2014). Moreover, even though the cognitive emotion regulation strategies of acceptance and positive refocusing contribute to reducing anxiety or depression (Q. Wang et al., 2021), few studies have pointed out to acceptance as a cognitive strategy positively connected to depression (Kraaij et al., 2002; R. C. Martin & Dahlen, 2005).

3.1.8 A proposal for an integrated framework of Emotion regulation flexibility for Somatic Symptoms

As noted by Gratz et al. (2018), “although the emotion regulation strategies and abilities models address distinguishable processes, they can be integrated”. These authors present the relationship between emotion regulation strategies and abilities as bidirectional with both positive and negative feedback loops, suggesting that they influence each other, outlining that an integration of these models can provide a more comprehensive understanding of emotion regulation processes and outcomes (Gratz et al., 2018).

Following the suggestion of these authors, we propose an integrated model tailored to enhance the study and comprehension of emotion regulation processes in individuals struggling with SS or persistent SS (Figure 8, p. 54). This proposed model operates at a "meso" level, including the most pertinent emotion regulation strategies and abilities with the concept of allostasis (McEwen & Stellar, 1993). In pursuit of this integration, we draw from Gross's process model of emotion regulation and Bonanno and Burton model of regulatory flexibility (Bonanno & Burton, 2013; Gross, 1998a, 2015b) and incorporate elements from the dynamic-phasic model of emotion processing of Panayiotou, Panteli, and Vlemincx (2018). Central to this model is the concept of flexibility, which we deem particularly relevant in understanding somatisation.

One of the main reasons motivating this integrated framework is the necessity to underline the presence of an anticipation stage to previous models of emotion regulation (Bonanno & Burton, 2013; Gross, 1998a, 2015b). In fact, as outlined in the work of Cravo, Rohenkohl, Santos, and Nobre (2017), organisms possess the capacity to foresee challenges by utilising contextual cues to predict forthcoming significant stimuli based on past learning and memory. Thus, our long-term memories can guide attention proactively and dynamically based on learned temporal associations. However, the anticipation stage is shaped by various factors, including characteristics of the cueing environment and individual differences, such as

hypervigilance and attentional avoidance, which are central in condition such as rumination, anxiety and SS (Melzig et al., 2008). Indeed, rumination has been associated with increased neural response to pain perception and pain anticipation (Kokonyei et al., 2019). Furthermore, in the anticipation phase, we have incorporated emotional schemas, which play a mediating role in the connection between emotion regulation and symptomatology (Faustino & Vasco, 2023), and serve as significant risk factors for SS when they exhibit maladaptive characteristics (Henker et al., 2019).

After the anticipation phase, we have incorporated the three stages of emotion processing outlined by Bonanno and Burton (2013) and merged them with Gross's extended process model (2015). The first phase, context sensitivity, involves the perception and evaluation of situational demands (i.e., internal or external) (Bonanno & Burton, 2013). As explored in Chapter 2, attention and evaluation (interpretation) are part of the aetiology of SS. For instance, the regulation of bodily signals (e.g. stomach growling due to hunger) will be altered if an incorrect interpretation is given to that signal (e.g. determining if it is a symptom of illness or anxiety) (Murphy et al., 2019). Research has consistently shown that individuals reporting SS tend to exhibit heightened attention to bodily sensations (Mirams et al., 2013; Mehling, 2016). Consequently, increased sensitivity to interoceptive signals may lead to the misinterpretation of minor physiological changes, potentially perpetuating symptoms, aligning with the somatosensory amplification theory. In the upcoming section (section 3.2), we also delve into how alexithymia could influence this phase, as difficulties in identifying feelings (DIF) are often associated with higher reporting of SS (De Gucht & Heiser, 2003).

The second phase, Repertoire, involves the flexible use of emotion regulation strategies. However, the utility of strategy is dependent on the context, and strategies commonly categorised as maladaptive (e.g., avoidance) could actually have an adaptive role in some situations (Bonanno & Burton, 2013). For example, researchers have shown that “anxiety and other disorders can be caused and maintained not only by attentional bias away from (avoidance of) threat, but also by attentional bias toward threat” (Britton, 2019). Also, in non-avoidant populations, drawing attention to difficulties can actually increase anxiety (Barry et al., 2015; MacLeod et al., 2002). Evidence suggests that during the selection stage, SS patients may employ some strategies less frequently (such as reappraisal and acceptance) and relying on others more often (like suppression and rumination) when compared to healthy individuals.

Nevertheless, experimental studies have not consistently validated these observations (Schnabel, Petzke, et al., 2022).

In the behavioural response phase, we've made a distinction between action tendency (or action readiness) and actual behaviours. As elucidated by Luminet et al. (2021), “due to socialisation and normative constraints, emotions rarely lead to observable behaviours (e.g. verbal or physical aggression while experiencing anger)”. Instead, emotions manifest as action tendencies, which encompass the inhibitory capacities for potential behaviours that may not align with societal norms or personal values. Research on this phase of emotion regulation is limited in patients with SS, and the available evidence is inconclusive. Some studies suggest difficulties in consciously and purposefully applying emotion regulation strategies, while laboratory studies indicate that these individuals can effectively regulate their emotions when provided with guidance (Schnabel, Petzke, et al., 2022). Therefore, a further differentiation between action tendencies and behaviours could improve the understanding on how SS patients implement antecedent-focused emotion regulation regulation.

After the response focused emotion regulation phase, we have integrated the recovering, habituation and resting state phases of the dynamic-phasic model of emotion processing (Panayiotou et al., 2019). The recovery phase involves swiftly returning to a state of cognitive and emotional rest, which is crucial for conserving energy and re-establishing internal balance and homeostasis, including physiological and psychological equilibrium through the deactivation of the sympathetic nervous system and the activation of the parasympathetic (*ibidem*). Failure to disengage from stressors can lead to exhaustion due to sustained hyperarousal, as described by McEwen (1998) with the concept of allostatic load. A delayed recovery and struggle with processing safety signals, as it happens for anxiety, can lead to exhaustion and a decreased ability to respond effectively to genuine threats later on (Pieper et al., 2007).

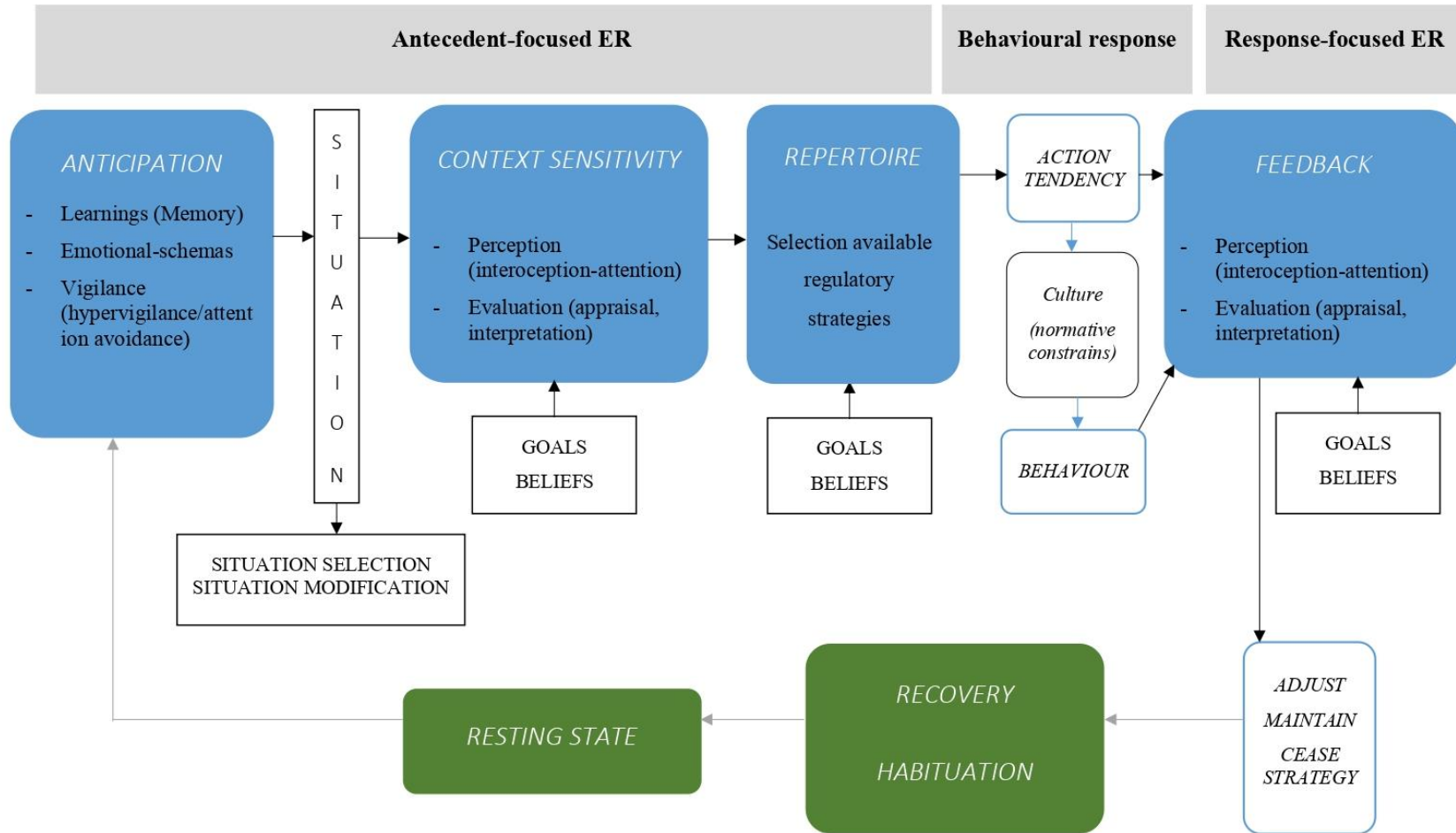
In an adaptive habituation phase, responsiveness to repetitive or familiar stimuli should diminish, and the degree of this adaptation is shaped by factors such as stimulus intensity and familiarity (Herman, 2013). Issues related to the habituation of physiological reactivity have been proposed as one of the processes underlying SS (Rief & Auer, 2001). Finally, the resting state, occurring when an imminent challenge is neither present nor anticipated, serves as the adaptive phase for resource conservation and recuperation (Panayiotou et al., 2019). An excessive emotional and physiological activation during this phase can hinder goal pursuit and

life experiences, often associated with conditions like anxiety and depression (Abercrombie et al., 1998).

In conclusion, while the extended process model of emotion regulation provides valuable insights into critical points where difficulties in regulating emotions can contribute to different forms of psychopathology (Sheppes et al., 2015), we contend that a comprehensive incorporation of these processes with the concepts of anticipation, recovery, habituation, and resting state as proposed by Panayiotou et al. (2019) could further advance research in SSD and expand our existing comprehension of disturbances in emotional regulation within the realm of SS.

Figure 8

An original integrated framework of Emotion Regulation Flexibility for studying somatic symptoms



3.2 Alexithymia and emotion regulation

3.2.1 The construct of alexithymia

Alexithymia has been a well-known concept in psychiatry and psychosomatic medicine since it was first introduced by Sifneos in 1973. Often described as the condition of having "no words for feeling", it constitutes a vulnerability factor for both mental and somatic illnesses (Baudic et al., 2016; Nemiah & Sifneos, 1970; Porcelli et al., 2007; Preece et al., 2022; Sifneos, 1973). In fact, individuals with high scores in alexithymia can feel emotions and become distressed by them. However, they struggle to have clear and expressible mental representations of these emotions (Luminet et al., 2021).

In the literature, the definition of alexithymia has included five dominant features: (1) difficulty in identifying one's emotion; (2) difficulty in describing feelings; (3) a reduction or incapability to experience emotions; (4) an absence of tendencies to image one else's emotion, or an externally oriented cognitive style; and (5) poor capacity for fantasise or symbolic thoughts (J. Chen et al., 2011). Building on the multidimensional structure of alexithymia described by Nemiah and Sifneos (1970), Parker, Bagby, and Taylor integrated cognitive theories such as Bucci's multiple code theory (1997) and Lane and Schwartz's cognitive-developmental theory of levels of emotional awareness (1987). This theory posits that emotional awareness develops over time and is influenced by the individual's emotion schemas - cognitive structures that guide emotion processing. This integration resulted in the development of the 20-item Toronto Alexithymia Scale (TAS-20), comprising three interrelated components: difficulty identifying feelings in oneself (DIF), difficulty describing feelings (DDF), and an externally oriented thinking style (or operative thinking; EOT) (Bagby et al., 1994; Parker et al., 1993). The initial version of TAS-20 also included a fourth component called "difficulty fantasising" (DFAN), which was later removed in subsequent revisions because it did not meet specific statistical criteria or displayed a socially desirable response bias (G. J. Taylor et al., 1985, 1992, 2023). Nevertheless, the EOT factor scale demonstrates a negative correlation with fantasy measures, indicating an indirect assessment of this facet of operative thinking (Bagby et al., 2020).

Currently, the Toronto model of Alexithymia, as conceptualised in the TAS-20 (DDF, DIF, EOT), is widely embraced and employed as the predominant definition of alexithymia in

the literature (Preece et al., 2020; Watters, Taylor, Quilty, et al., 2016). Taxometric research indicates that the TAS-20 produces continuous scores, reinforcing the perspective of alexithymia as a continuous dimension (Bagby et al., 2020). Moreover, the TAS-20 scores remain relatively stable over time, independent of negative affect like psychological distress or medical/psychiatric symptoms, despite score reductions linked to symptom improvement (Luminet et al., 2001, 2007). Therefore, contemporary researchers continue to employ the term "alexithymia" to describe a cluster of emotional processing conceptualised as a dimensional trait that exists across the general population (American Psychiatric Association, 2013, 2013; Luminet et al., 2018; Parker et al., 2008). However, some evidence have also shown that it can manifest as a temporary state associated with both psychological conditions and high stress levels (Pollatos et al., 2011).

There are two distinct theoretical models that provide explanations for alexithymia: the first model views alexithymia as a deficit in emotional processing, while the second model regards alexithymia as an amplification in emotional processing, often termed "over-responding" (Luminet et al., 2021). The over-responding view conceptualise alexithymia as a protective reaction to exceedingly intense emotions (Luminet et al., 2021; Marchesi et al., 2014). Instead, traditionally alexithymia has been seen as a struggle in identifying and expressing emotions and in managing emotions cognitively (G. J. Taylor, 2004). This view is in line with the attention-appraisal model of alexithymia introduced by Preece et al. (2017), which conceptualises it as an "ability/deficit", suggesting that individuals with higher alexithymia scores have less organised emotional schemas, making it challenging for them to focus on key aspects of their emotional responses and accurately interpret emotional information. "These models are not mutually exclusive, with some authors adopting both the deficit and the defensive approaches" (Luminet et al., 2021).

Luminet et al. (2021) conducted an integrative review, applying a framework inspired by the modal model of emotion (Chapter 3, Section 3.1.3), to examine evidence supporting both deficit and over-responding models of alexithymia across five key cognitive-emotional processes: attention, appraisals, memory, language, and action tendencies and behaviours. These factors were assessed using both the total score of the TAS-20 and the distinct roles of the three facets of alexithymia. Here we summarise the review's findings:

- Attention: the weight of evidence suggested that alexithymia is linked to deficits in both early, automatic attention to emotional stimuli and later, controlled

attention. These findings were in line with the deficit-oriented perspective on alexithymia. EOT was the facet most commonly observed.

- Appraisals: the review indicated that challenges in the appraisal phase of emotional processing may be a central characteristic of alexithymia. Consistently, the primary contributing factors were DDF and EOT, while DIF was related to the negative emotional valence of experiences.
- Memory: alexithymia impairs memory, especially for emotional stimuli. These memory deficits extended to neutral stimuli when presented in neutral contexts. EOT is a key factor, reducing cues necessary for memory formation.
- Language: alexithymic individuals may have deficits in language reception, although facet distinctions were not clearly outlined in the review.
- Action Tendencies and Behaviours: Clinical studies suggest that highly alexithymic individuals often manifest their emotions through overt behaviours, raising the hypothesis that they might regulate their emotional states more through behavioural means rather than cognitive processes. This regulation could manifest as impulsive behaviours, including substance abuse or eating disorders. The review did not find studies examining how alexithymia may moderate the type and intensity of action tendencies. However, studies assessing the actual behaviour suggest that in individuals with high alexithymia, there is a heightened propensity for aggression, attributed to the utilisation of dysfunctional emotion regulation strategies, such as suppression, experiential avoidance, and emotion dysregulation when confronted with emotional situations. Furthermore, a facet-level analysis indicates that the facets of DIF and DDF are consistently associated with over-responding tendencies, while EOT appears to be linked to deficits in responsiveness.

In summary, the review uncovered that when examining total alexithymia scores, a consistent pattern of deficits was observed. Yet, upon closer examination of alexithymia facets, a nuanced picture emerged. While EOT echoed the deficit pattern seen in total scores, facets such as DIF and DDF exhibited a lower incidence of deficits and a heightened inclination towards over-responding. Moreover, contrary to expectations, the review revealed that DIF wasn't notably linked to early emotional processing like attention or appraisal, and DDF wasn't

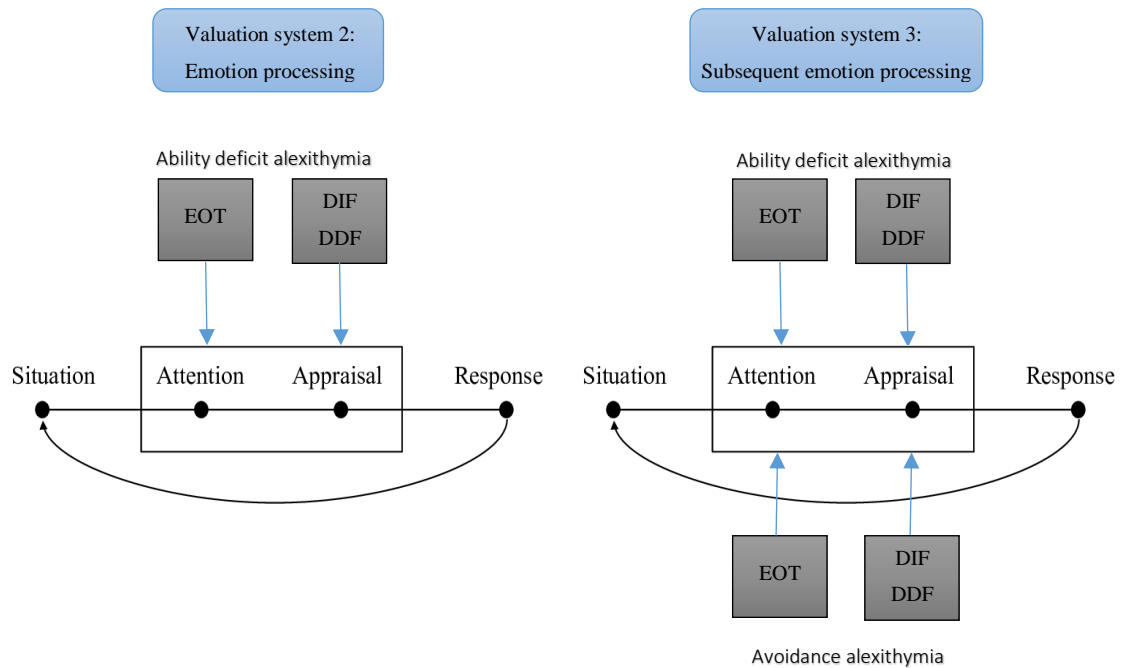
strongly associated with later processes like memory or language (Luminet et al., 2021). These ambiguous findings underscore the need for a fine-grained, process-oriented examination of alexithymia facets to better comprehend its impact on cognition and emotion, as such an approach can unveil nuanced relationships and prevent oversimplifications or false negatives. In conclusion, the authors recommend employing the TAS-20 total score for clinical assessments but advocate for facet-level analysis in research to gain deeper insights into alexithymia's intricate influence on cognitive-emotional processes, facilitating a more thorough understanding.

3.2.2 The attention-appraisal model of alexithymia

The attention-appraisal model of alexithymia has proposed a new theoretical framework to understand the nature of alexithymia as an integration of Gross's extended process model of emotion regulation (2015) and Lane and Schwartz's cognitive-developmental theory of levels of emotional awareness (1987). According to the attention-appraisal model, alexithymia can be understood as a set of difficulties during two key stages of the emotion processing system ideated by Gross: the attention stage and the appraisal stage of emotion valuation (Figure 9). Preece et al. (2017) redefined the EOT component of alexithymia, suggesting that it represents a challenge in the attention stage of the second valuation system, meaning that people with alexithymia have difficulty directing their attention inward to recognise and acknowledge their emotional states. Instead, their focus is primarily on external stimuli, leading to challenges in differentiating between various emotions and reduced awareness of their internal emotional experiences. Moreover, DIF and DDF are conceived as issues in the appraisal stage. This aspect is only partially supported by the findings of a recent review, in which appraisal was significantly associated with DDF and EOT (Luminet et al., 2019). Furthermore, according to this prospective, difficulties in the attention and appraisal stages of emotion valuation are related to the level of development of emotion schemas, leading to an "ability deficit alexithymia". In this type of alexithymia a lack of sophisticated emotion schemas results in challenges to recognise emotions beyond basic bodily sensations.

Figure 9

Visual representation of where, according to the attention-appraisal model of alexithymia, alexithymia manifests during the emotion valuation process, adapted from Preece et al. (2017)



In addition to ability deficit alexithymia, people might experience "avoidance alexithymia", which occurs when individuals use avoidant emotion regulation strategies to cope with their emotions. At the response stage of emotion valuation, these individuals may attempt to suppress or ignore their emotional responses as a regulation strategy. However, this avoidance behaviour may lead to regression to lower developmental levels of emotion processing during subsequent attention and appraisal stages. Furthermore, Preece et al. (2017, 2020) argued that "difficulty fantasising" (DFAN) should be considered a correlate of alexithymia, not a component of the construct. This assertion is supported in part by their factor analytic study, where various self-report scales assessing different aspects of fantasising did not align with a general alexithymia factor encompassing both TAS-20 and self-report Perth Alexithymia Questionnaire factor scales (Preece et al., 2017).

The proposal of Preece has received several critics by the Toronto group and other authors (G. J. Taylor et al., 2023; G. J. Taylor & Bagby, 2021) as the assertion that EOT only represents an affect awareness difficulty, dismisses the concept of *pensée opératoire* as clinically observed and defined by Nemiah (1976) and by Marty and de M'Uzan (1963). Indeed, while

the Paris School of Psychosomatics (*École Psychosomatique de Paris*) has discussed this concept, there has been limited endeavour to validate the construct which still today remains not fully understood (G. J. Taylor et al., 2023). This construct, which is assessed by the EOT subscale of alexithymia, refers to an operational thinking style accompanied by a lack of metallisation and fantasy or imaginal activity and an emphasis on factual details, often manifesting in an empty inner world without emotional or symbolic depth (see G. J. Taylor et al., 2023 for a summary of different definitions given to the construct). However, if Nemiah et al.'s (1976) view of *pensée opératoire* as closely associated with impairments in affect awareness, the Perth Alexithymia Questionnaire (PAQ), developed by Preece et al. (2018) and based on the attention-appraisal model of alexithymia, focuses solely on inattention to emotions, failing according to these authors, to capture the complexity of this thinking style (G. J. Taylor et al., 2023; G. J. Taylor & Bagby, 2021).

Ultimately, although these authors recognise deficits in affect development and defensive avoidance as fundamental components within the theoretical framework of alexithymia, they critique the distinction between "ability deficit" and "avoidance" types (G. J. Taylor & Bagby, 2021), as they argue that such differentiation might only complicate the categorical and dimensional comprehension of the alexithymia construct.

3.2.3 Alexithymia and somatic symptoms

Alexithymia has been repeatedly associated with SS and with a tendency to attribute emotions to physical sensations, rather than identifying the associated feelings (Bankier et al., 2001; De Gucht & Heiser, 2003; Erkić et al., 2018; Mattila et al., 2008; Ogrodniczuk et al., 2011; Timoney & Holder, 2013), as well as with depression and anxiety (Berardis et al., 2008; Duddu et al., 2003; Marchesi et al., 2000; Sagar et al., 2021). However, the connection between alexithymia and SS reporting has been examined through a quantitative review conducted by De Gucht and Heiser (2003), revealing a small to moderate relationship. Notably, among the facets of alexithymia, it was DIF that exhibits the most robust association with SS reports. The findings for the DDF dimension were less consistent, revealing a small effect size, while the results for the EOT dimension were inconclusive (De Gucht & Heiser, 2003). DIF has, indeed, repeatedly been the strongest dimension of alexithymia to be associated with SS (Mattila et al., 2008). Conversely, when it comes to the EOT dimension in the context of SS, its significance has often been negligible (De Gucht & Heiser, 2003; Mattila et al., 2008). Nevertheless, Lumley

and Norman discovered that EOT was linked to a decreased probability of SS patients of seeking outpatient treatment and psychotherapy, yet an increased likelihood of utilising preventive health services (Lumley & Norman, 1996).

The intricate link between alexithymia and somatisation becomes more complex due to their close association with negative affectivity, involving a propensity for both emotional and somatic distress (Porcelli & Taylor, 2018). Indeed, certain studies have revealed that the relationship between SS and alexithymia ceased to be statistically significant once psychological distress was taken into account (Bailey & Henry, 2007; De Gucht & Heiser, 2003; Mattila et al., 2008). In another study, DIF has been found to be an important moderator of the relationship between SS and negative affect (Van Den Houte et al., 2017). Indeed, in this study the exposure of participants to images designed to induce negative emotional states led to an increased report of physical symptoms, with this phenomenon being notably more pronounced among individuals displaying elevated levels of DIF and a heightened self-absorption. A separate study, examining SS in asthma patients, found that alexithymia had no direct impact on physical symptoms. However, the DIF subscale indirectly influenced physical symptoms through its association with negative affect (Khosravani et al., 2020). Some answers to this intricate relationship have been offered by a recent study, which found that the influence of DIF on somatisation might occur both directly and through the mediation of emotional distress (Lanzara et al., 2020).

KEY POINTS

The chapter explores existing emotion regulation models, starting with a definition of emotions. It acknowledges the difficulty in defining emotions but highlights their multifaceted nature, valence, and adaptability. Distinctions between emotion regulation and related constructs are presented in section 3.1.2 (i.e., affect regulation, mood regulation, coping, and self-regulation)

Defining Emotion Regulation: The term "emotion regulation" is relatively new, and there is no consensus on its definition. In this thesis we use emotion regulation to refer to "people's valenced (positive or negative) reactions to events that they perceive as relevant to their ongoing concerns. Emotions in the present conception consist of multiple components that include specific thoughts and feelings, along with behavioural and physiological responses" (Koole, Van Dillen & Sheppes, 2011).

Models of ER: Various models and theories of emotion regulation are discussed, dividing them into:

- **Micro-Level Models of emotion regulation:** particularly Gross's **process model**, which categorizes emotion regulation strategies into antecedent-focused and response-focused strategies, emphasizing that emotions do not follow a prescribed order, and Gross's **extended process model**, which includes interacting valuation systems and context, highlighting the dynamic and situational nature of ER. It introduces the concepts of identification, selection, and implementation of emotion regulation strategies.
- **Macro-Level Models of emotion regulation:** such as Gratz and Roemer's **acceptance-based model**, which emphasizes awareness, understanding, acceptance, and goal-directed actions in managing emotions, and the **dynamic-phasic model** introduced by Panayiotou, Panteli, and Vlemincx (2019). This model focuses on the flexibility of emotion regulation across different phases of emotion, including anticipation, response, recovery, habituation, and rest.

Meso-Level Models of emotion regulation: such as the regulatory Flexibility of Bonanno and Burton (2013), which emphasizes the variation in emotion regulation effectiveness among individuals and across situations considering context sensitivity, repertoire, and responsiveness to feedback.

KEY POINTS

A proposal for an integrated framework of Emotion regulation flexibility: we propose an integrated model of emotion regulation which operates at a "meso" level to understand emotion regulation processes in individuals with SS and persistent somatic symptoms (SS). This framework includes several emotion regulation strategies and abilities relevant to the concept of somatization. The model incorporates elements from various emotion regulation models, including Gross's process model and Bonanno and Burton's model of regulatory flexibility. It also considers the recovery, habituation, and resting state phases in emotion processing of the dynamic-phasic model (Panayiotou et al., 2019).

Alexithymia and Emotion Regulation:

- The Toronto Alexithymia Scale (TAS-20) is widely used to measure alexithymia, focusing on three components: difficulty identifying feelings (DIF), difficulty describing feelings (DDF), and an externally oriented thinking style (EOT).
- Alexithymia can be viewed through two theoretical models: a deficit in emotional processing and an amplification in emotional processing ("over-responding").
- The attention-appraisal model of alexithymia of Preece suggests that alexithymia arises from difficulties in the attention and appraisal stages of emotion processing.

Alexithymia and SS:

- The relationship between alexithymia and SS is moderate, with difficulty identifying feelings (DIF) being the most robust dimension associated with SS.
- The association between alexithymia and SS can be complex, as both are closely related to negative affectivity. DIF can indirectly influence physical symptoms through its association with negative affect.
- Some studies have found that the relationship between alexithymia and SS diminishes when accounting for psychological distress. The influence of DIF on somatization can occur both directly and through the mediation of emotional distress.

4. Research Questions, Objectives, and Methodology

In this chapter, we explore the fundamental research questions shaping this thesis, delving into the complex relationship between SS and emotional regulation processes. Through the subsequent sections, we outline the rationale, objectives and hypotheses guiding the studies presented in first part of the thesis. Then, we describe the two samples used for the studies and the measures included. Our main aim is to enrich the comprehension of somatic experiences and contribute to the refinement of possible interventions for SS.

4.1 Objectives and hypothesis

4.1.1 Research question 1 and 2: Somatic symptoms in the context of COVID-19 pandemic

The COVID-19 pandemic has not only posed significant health risks associated with COVID-19 infection but has also been a substantial stressor on the psychological well-being of people worldwide, particularly affecting those who were vulnerable and already dealing with pre-existing mental health conditions. In this thesis, we captured the role of a major and worldwide stress condition in the understanding of SS expressions and psychological distress of people during this period. Throughout the pandemic, numerous studies have consistently shown that COVID-19-related anxiety and fear have led to an increase in anxiety and depression, with associations observed in various conditions, including addiction, PTSD, insomnia, mood swings, and stress (Mahmud et al., 2023; Xu et al., 2021). Furthermore, concerns have been raised about the effect of COVID-19-related anxiety on individuals experiencing SS, as the pandemic was the 'perfect storm' for an increase in SS in the population (C. Willis & Chalder, 2021), with previous instances showing significant rises in response to unpredictable threats (Guerriero et al., 2014). This specific anxiety, stemming from fears of infection and the constant monitoring for possible symptoms, has led to a significant increase in the incidence of frequent SS-related visits to emergency departments (Daniels et al., 2021), as individuals often sought medical explanations "in an attempt to medically explain the unexplainable" (Colizzi et al., 2020).

If SS like chest pain, dizziness, fatigue, abdominal discomfort, and musculoskeletal pains are frequent (Hinz et al., 2017), with prevalence varying between 6.7 and 17.4% among the general population (Löwe, Levenson, et al., 2022), and raising up to 45% in primary care and specialised settings (Haller et al., 2015; Löwe, Levenson, et al., 2022; Sirri et al., 2017; Zantinge et al., 2005), during the initial pandemic wave elevated rates of SS were reported in various countries: Spain (23.8%; Pérez et al., 2021), Germany (29%; Biermann et al., 2021), Iran (31.1%; Mohammadi et al., 2020) China (45.9%; Ran et al., 2020) and Brazil, where a staggering 62.6% of individuals reported experiencing SS (Goularte et al., 2021).

In 2020, the COVID-19 Psychological Research Consortium (C19PRC) initiated a longitudinal, multi-country project, initially in the UK and later expanded to other nations (McBride et al., 2021). Two separate studies, conducted in the UK and Italy, aimed to explore the link between self-reported COVID-19-related anxiety and SS in representative samples of adults (Bruno et al., 2020; Shevlin, Nolan, et al., 2020). Both studies hypothesised that COVID-19-related anxiety would be a predictor of SS scores, even when considering potential confounding factors.

The UK study included data from 2,025 participants collected between March 23 and 28, 2020, while the Italian study gathered data from 1,038 participants between July 13 and 28, 2020. Therefore, while results of the UK study presented a picture of the beginning of the lockdown, the Italian study represented an adaptation to life with COVID-19 two months after the end of the first lockdown, indicating a long-lasting impact of the pandemic on psychological distress. In both studies SS was measured using the PHQ-15 scale and its subscales (pain, gastro, cardio, fatigue) alongside the total score. The UK study incorporated five control variables in their analysis (age, gender, income, pre-existing health conditions, generalised anxiety disorder), while the Italian study included additional information (region, mourning for COVID-19 human losses, perceived risk of contracting COVID-19).

The findings revealed significant and positive correlations between the PHQ-15 subscales, total score, and COVID-19-related anxiety, as well as generalised anxiety disorder scores (GAD-7). Notably, stronger associations were observed between generalised anxiety disorder (GAD) and SS compared to COVID-19-related anxiety scores. This suggests that participants may have acknowledged their anxiety but didn't solely attribute it to COVID-19-related factors. Nevertheless, multiple regression analyses demonstrated that COVID-19-related anxiety remained significant even after controlling for GAD. Most importantly, a non-linear increase

of SS was observed in the UK sample across COVID-19-related anxiety quintiles, with quintiles 2 to 4 displaying significant but smaller effects compared to the 5th quintile. Conversely, the Italian sample exhibited a more linear increase compared to the UK data. In both studies, the influence of COVID-19-related anxiety on SS weakened when controlling for other variables. Pre-existing health issues and high GAD-7 scores were found to significantly exacerbate specific and general SS. However, both studies provided evidence of a significant link between COVID-19-related anxiety and SS, indicating that pandemic-related anxiety might uniquely contribute to SS, alongside other factors such as pre-existing health problems, generalised anxiety, and mourning for COVID-19 losses.

In France, the COVID-19 pandemic has had four waves: spring and autumn 2020, early 2021 and summer 2021. However, while the peak decreased as the pandemic progressed, the duration of the first three waves increased each time (Costemalle et al., 2022). To date, no study has investigated the relationship between COVID-19 related anxiety and SS in France population. Therefore, the **first objective** of this work is to replicate these findings, **understanding whether COVID-19 related anxiety should be considered a specific type of anxiety contributing to SS reporting during the pandemic.**

During Covid-19 pandemic many countries adopted restrictive measures such as lockdown, quarantine, social distancing, and an increased sense of subjective loneliness has been showed from pre-pandemic scores to pandemic situation (Conti et al., 2023; Werner et al., 2021). As discussed in Chapter 2 section 2.3.2 (p. 34), loneliness and interpersonal connection have been associated with SS. However, results of the impact of loneliness during Covid-19 are ambiguous, with studies finding no association between SS and loneliness (Conti et al., 2023) and others reporting SS to be a strong independent risk factor for loneliness and other mental health outcomes, such as depressive and anxiety symptoms, and PTSD (Xu et al., 2021). Therefore, the **second objective** of this study is to **assess the impact of loneliness and connection with others on SS in the context of Covid-19.**

To address these two objectives, we have examined two distinct adult French community samples. The data presented in the initial study (Study I) represents the first measurement point of a longitudinal study, conducted following the conclusion of the first lockdown in May and June 2020. Instead, the second study (Study II) presents data of a cross-sectional study which collection took place during the second wave of COVID-19 pandemic (between November 2020 and January 2021). Therefore, Study II represents an adaptation to life with COVID-19

eight months after the end of the first lockdown, indicating a long-lasting impact of the pandemic on psychological distress. Thus, allowing a long term vision on the evolution of COVID-19 related anxiety as predictor of SS throughout the pandemic. Moreover, in both studies, the independent variables were entered into the multiple regression equation in a step-wise manner (i.e.: sequential multiple regression) as follows: COVID-19 related anxiety, anxiety and depression, all other sociodemographic and psychological variables. This allowed us to determine the proportion of the variation in the dependent variable explained by the addition of new independent variables.

Furthermore, while Study II employed the same questionnaire as the UK and Italian C19PRC studies to assess SS (PHQ-15 scale and subscales), Study I utilised a different questionnaire (somatisation dimension of the SCL-90)(Bruno et al., 2020; Shevlin, McBride, et al., 2020; Shevlin, Nolan, et al., 2020). Thus, the employment of these two different scales allowed us to verify whether COVID-19-related anxiety was a significant predictor of SS even utilising another measure of SS. In fact, the PHQ-15 and SCL-90 SOM are considered the most suitable scales for large-scale population-based studies (van Driel et al., 2018; Zijlema et al., 2013). However, even if correlations between these two questionnaires and other measures of somatisation have demonstrated some degree of overlap, suggesting that they assess a comparable construct, only six symptoms overlap between them (Appendix C, p. 246)(Dimsdale et al., 2009; Zijlema et al., 2013).

4.1.2 Research question 3: Emotion regulation processes as predictors of Somatic Symptoms

After examining key factors contributing to the aetiology of SS in Chapter 2 and exploring modern frameworks of emotional regulation in Chapter 3, we have delved into the association between SS and alexithymia (Chapter 3, section 3.2). Thus, extensive research has studied the relationship between alexithymia and SS (Bankier et al., 2001; De Gucht & Heiser, 2003; Erkić et al., 2018; Mattila et al., 2008; Ogrodniczuk et al., 2011; Timoney & Holder, 2013). However, recent efforts in alexithymia research have aimed at more effectively integrating this construct into the domain of emotion regulation (Da Silva et al., 2017; Luminet et al., 2021; Luminet & Zamariola, 2018; Panayiotou et al., 2019; Preece et al., 2023). Thus, a recent study has found that the relationship between alexithymia and affective disorders is mediated by emotion regulation difficulties (Preece et al., 2022).

To explain how alexithymia interacts with emotion regulation processes, Preece et al. (2017) have proposed the attention-appraisal model of alexithymia, which hypothesises that elevated External Oriented Thinking (EOT) may lead to challenges in directing attention toward emotions, while higher Difficulty Identifying Feelings (DIF) and Difficulty Describing Feelings (DDF) scores could lead to difficulties in the appraisal phase and in the processing of emotions. However, in the literature of SS the significance of EOT dimension of Alexithymia has often been negligible (R. V. Aaron et al., 2019; De Gucht & Heiser, 2003; Mattila et al., 2008). Thus, authors have hypothesised that this might be due to weak psychometric properties of the EOT subscale of the TAS-20 (Kooiman et al., 2002), particularly in non-Western cultures (Dere et al., 2013). In fact, it has been hypothesised that EOT would be more pertinent in East Asian cultures, characterised by a reduced focus on emotions rather than an incapacity to feel or express them, in contrast to Western cultures, in which there would be a tendency to exhibit a propensity for reporting psychological symptoms associated with depression (Ryder et al., 2008). Instead, the dimension of alexithymia that has been repeatedly associated with SS reporting is DIF (R. V. Aaron et al., 2019; Mattila et al., 2008). This is reinforced by a recent study pointing-out that in chronic pain patients DIF affects somatisation both directly and through the relevant contribution of emotional distress, pain interference and health-related quality of life as mediating factors (Lanzara et al., 2020). However, another study has found that in asthmatic patients each of the three alexithymia subscales had indirect effects on SS through the non-adaptive cognitive emotion regulation strategy of catastrophising (Ghorbani et al., 2017). Furthermore, Silva, Vasco and Watson (2016), in a study on the relationship between alexithymia, emotion regulation and SS severity, found two indirect mediation effects: between DIF and severity of symptoms; and between EOT and emotional differentiation. Instead, DDF did not show any direct or indirect significant effect. Moreover, direct effects were found between DIF and limited access to emotion regulation strategies; between EOT and lack of emotional awareness. In the non-clinical sample, the significance was observed only in the relationship between DIF and symptom severity, whereas in the clinical sample the impact of EOT on symptom severity was significant. Thus, the study hinted at EOT potentially serving as an avoidance strategy or contributing to symptom severity in individuals with high levels of alexithymia.

Given the diversity of the results regarding the effect of different dimensions of alexithymia in the emotional processing of people presenting SS and the relatively limited

research on EOT compared to other facets of alexithymia (Luminet & Zamariola, 2018), the **third objective** in this thesis is to **investigate the emotional regulation determinants of SS using the lens of the attention-appraisal model of alexithymia for the antecedent-focused emotion regulation phase** (Preece et al., 2017, 2017). This model, fits well with both contemporary frameworks of emotion regulation (Bonanno & Burton, 2013; Gross, 2015b), as well as with the integrated framework proposed in chapter 3, section 3.1.8. More specifically, we aim to determine whether EOT has an indirect relationship with symptoms reporting.

To achieve this goal, we have investigated the relationship between alexithymia and other emotional regulation processes in a serial mediation, which hypothesises a causal chain linking of the mediators. In accordance with the attention-appraisal model of alexithymia, EOT can be regarded as a disruption in the attention phase of this evaluation system, potentially hindering or basing the processing of emotional stimuli. This is noteworthy because attention is a crucial prerequisite for awareness and conscious experience (Damasio, 1999) and plays a central role in the processes of ER. Therefore, we have sequentially entered EOT, DIF and DDF, as part of an antecedent-focused phase representing the attention, appraisal and processing of emotional stimuli. Subsequently, our hypothesis was centred on the notion that, in the selection phase, pertinent emotion regulation strategies in SS, specifically 1) rumination and 2) catastrophising, would constitute a sequential process through which EOT affects SS. While previous research (Ghorbani et al., 2017) has already demonstrated the indirect effect of the three alexithymia subscales on SS via the non-adaptive cognitive emotion regulation strategy of catastrophising, it's essential to recognise that catastrophising, particularly in the context of pain, can be viewed as a multifaceted and intricate construct, encompassing elements of rumination, magnification, and feelings of helplessness (Sullivan et al., 1995). Consequently, we postulated that rumination would assume a central role within catastrophising and decided to include it as the initial emotional strategy influencing the subsequent catastrophising strategy in our sequential model. In the final segment of our serial mediation model, we introduced the concept of psychological distress, which encompasses anxiety and depression. As previously discussed in Chapter 2 (section 2.3.1), these three disorders often co-occur (the SSAD triad). However, it's essential to note that not all patients presenting with SS exhibit comorbid anxiety and/or depression. Hence, we put forth the hypothesis that EOT, through DIF, could directly influence SS without necessitating the intermediary influence of psychological distress. By incorporating psychological distress into the sequential model, we aimed to test this hypothesis.

4.1.3 Research question 4: Using a person centred approach to study emotional regulation processing in the co-occurrence of somatic, anxiety, and depressive symptoms (SSAD)

As discussed in chapter 2 (section 2.3.1), the intricate relationship among SS, depression, and anxiety, collectively referred to as the SSAD triad in this study, is marked by strong comorbidity and intricate mutual maintenance mechanisms. The overlapping diagnostic criteria among these conditions significantly heighten the likelihood of their co-occurrence, with research indicating that the presence of SS doubles the likelihood of either depression or anxiety (Bair et al., 2003; Bekhuis et al., 2016; Groen et al., 2021; Janssens et al., 2010; Kim et al., 2022; Kroenke, 2006; Kroenke et al., 2010; Lieb et al., 2007; Mergl et al., 2007; van Boven et al., 2011). A recent study assessing chronic pain, depression, anxiety, and SS in middle-aged and older adults using Latent Profile Analysis, identified three distinct classes based on symptom severity and comorbidity (Kim et al., 2022). These classes were primarily differentiated by the severity of chronic pain, depression, anxiety, and SS rather than specific symptom types. The study also revealed that being female and younger were associated with membership in a higher symptom severity class, aligning with previous research indicating that these factors increase the risk of chronic pain and psychological comorbidities (*ibidem*). The presence of three classes of comorbidity based on symptom severity (i.e., high, moderate and low) was also validated in another study, assessing levels of posttraumatic stress disorder (PTSD), depression, anxiety, and SS in a population of refugees (Jongedijk et al., 2020).

Despite substantial evidence supporting the co-occurrence of SSAD, the exact underlying mechanisms responsible for the development and persistence of this comorbidity remain contentious in the literature.

As suggested by the current version of the Hierarchical Taxonomy of Psychopathology (HiTOP), a pivotal factor in the aetiology and pathogenesis of these internalising disorders is disturbances in emotion regulation (Watson et al., 2022). Emotion dysregulation, defined as the inability to modulate emotional responses flexibly and adaptively, has been identified as a common thread in the SSAD triad (Campbell-Sills et al., 2014; Domaradzka & Fajkowska, 2018; Joormann & Quinn, 2014; Okur Güney et al., 2019; Schnabel, Petzke, et al., 2022). Moreover, across all three conditions, studies have emphasised challenges related to recognising and appraising emotions. This is evidenced by the robust correlation between all three disorders and the Difficulty to Identify Feelings subscale of alexithymia (Bylsma et al.,

2008; Coifman & Bonanno, 2010; Southward & Cheavens, 2017). As alexithymia signifies difficulties in comprehending and expressing emotions, individuals with heightened alexithymia levels may be more likely to experience vague negative emotions and their associated physical symptoms (Luminet et al., 2018).

Furthermore, cognitive emotion regulation strategies play a significant role in the onset and perpetuation of SSAD. Patterns such as self-blame, rumination, and catastrophising are frequently linked to both depression and anxiety (Garnefski & Kraaij, 2007; Joormann & Quinn, 2014; R. C. Martin & Dahlen, 2005; Omran, 2011). These maladaptive strategies, together with a habitual pattern of suppression have also been associated to a higher vulnerability in the development of SS (Garnefski et al., 2017; Joormann & Quinn, 2014; Omran, 2011; Schnabel, Petzke, et al., 2022). Previous research findings have also showed reduced utilisation of positive reappraisal has been noted in all these conditions (Omran, 2011; Qi et al., 2020; Schnabel, Petzke, et al., 2022; Y. Wang et al., 2014)(Omran, 2011; Qi et al., 2020; Y. Wang et al., 2014). However, even though the cognitive emotion regulation strategies of acceptance and positive refocusing contribute to reducing anxiety or depression (Q. Wang et al., 2021), few studies have pointed out to acceptance as a cognitive strategy positively connected to depression (Kraaij et al., 2002; R. C. Martin & Dahlen, 2005).

Despite these insights, a comprehensive understanding of emotion regulation processes within the context of SSAD co-occurrence remains elusive. A comparative examination of emotion regulation within SSAD has the potential to shed light on common and different vulnerability factors and provide evidence of difficulties in emotion regulation as transdiagnostic factors underlying SSAD comorbidity. Until now, the majority of studies focused on emotional regulation have utilised a variable-centred approach, exploring relationships between separate aspects. This approach is the one that we have chosen for exploring the determinants of SS in Chapter 6. However, this thesis employs a hybrid method, considering both variables and individual characteristics. We argue that understanding emotional regulation in context necessitates a person-centred approach (Bergman & Wångby, 2014). This approach enables the clustering of individuals with comparable traits, facilitating a comprehensive ecological understanding of their overall functioning (Laursen & Hoff, 2006). While previous studies have explored comorbidity in SSAD utilising a person-centred approach (Jongedijk et al., 2020; Kim et al., 2022), there is a notable gap in research concerning differences in emotion regulation within SSAD comorbidity using such approach. Thus, to the

best of our knowledge, no studies have delved into this aspect, highlighting a significant gap in our understanding of how emotion regulation functions within the context of SSAD comorbidity. Therefore, the **fourth objective** of this thesis is to **analyse the comorbidity of SSAD using a Latent Profile Analysis (LPA) and to contribute to the development of integrated models encompassing emotional disorders and their coexisting conditions**. In terms of ER, this thesis connects alexithymia and cognitive emotion regulation strategies by focusing on the underlying processes and characteristics of specific subgroups of SSAD co-occurrence. The results obtained have broader explanatory purposes, identifying, for example, the characteristics of subjects who seem to struggle the most.

Building upon prior research highlighting the SSAD comorbidity using person-centred approaches (Jongedijk et al., 2020; Kim et al., 2022), our study posits the existence of at least a three-class solution based on symptom severity within individuals experiencing SSAD. However, as previous literature has shown that generalised anxiety can be comorbid with depression but it can also present itself as a unique symptomatology (Hofmann et al., 2010), we have also hypothesised the presence of a unique profile primarily characterised by anxiety without concurrent depression. Notably, our hypotheses are informed by the understanding that anxious depression represents a more severe form of depression than its non-anxious counterpart (D. P. Goldberg et al., 2014), leading us to anticipate that a distinct class solely characterised by depression and lacking anxiety symptoms may not emerge within our symptom severity profiles.

Regarding alexithymia, consistent with prior research linking the Difficulty in Identifying Feelings (DIF) subscale of alexithymia with psychiatric symptoms, we hypothesised that DIF would be the specific alexithymia subscale correlated with symptom severity, demonstrating a linear escalation. On the other hand, we expected for the EOT and DDF subscales to not be significant predictors of SSAD symptom severity (Da Silva et al., 2017; Kajanoja et al., 2017).

Due to the intricate interconnections between various emotion regulation strategies and mental health conditions, such as anxiety and depression, as indicated by studies examining different types of CERQ associations with both anxiety and depression (Aldao et al., 2010; Sakakibara & Kitahara, 2016), we opted not to formulate specific hypotheses regarding differences in these strategies across symptom severity profiles. Past research has consistently demonstrated that specific strategies like self-blame, rumination, and catastrophising are commonly intertwined with both depression and anxiety (Garnefski & Kraaij, 2007; R. C.

Martin & Dahlen, 2005). Furthermore, these strategies have been implicated in a higher vulnerability for the development of SS (Garnefski et al., 2017; Joormann & Quinn, 2014; Omran, 2011). Given these complex and overlapping relationships, we chose not to speculate on distinct variations in emotion regulation strategies among different symptom severity profiles.

These findings provide preliminary data of the emotional regulation processes among individuals experiencing SS alongside comorbid anxiety and/or depression. They advance our understanding of the emotional mechanisms underpinning psychosomatic disorders, aiding in the development of comprehensive models that encompass emotional disorders and their coexisting conditions. Thus, this understanding not only enriches our comprehension of the emotional complexities within psychosomatic disorders but also serves as a critical stepping stone for the creation of targeted interventions in the domain of mental health.

4.2 General Methodology and Participants

For the realisation of this thesis and of the findings outlined here, we gathered data from two distinct samples. The first sample originated from a study employing a short-longitudinal design, obtained from a French community sample immediately after the conclusion of the initial lockdown in May and June 2020. It's crucial to note that within this thesis, we focus solely on the analysis of the initial time measurement out of the two collected. The second sample was acquired using a cross-sectional approach during the second wave of the COVID-19 pandemic, spanning from November 2020 to January 2021. This data collection effort was part of a comprehensive study conducted simultaneously in Italy and France. The studies were conducted online, and participants for both samples were recruited through freely accessible advertisements on different social networks. To enhance the ecological validity of the study, the only requirement for inclusion was that individuals had to be at least 18 years old, allowing for a diverse and representative sample in the research.

In the following sections, both sample and measurements collected in each study are presented.

4.2.1 Sample 1

The study protocol for this study was designed and carried out in accordance with the World Medical Association Declaration of Helsinki and its subsequent revisions, and approved by the Institutional Review Board of the Laboratory of Psychology (EA4139) of the University of Bordeaux, France (protocol code: 2022.03.CLE003). Participants provided their informed consent to participate in this study online.

4.2.1.1 Participants

1207 participants provided complete responses to all questionnaires and were included in the study. After checking for outliers on main study variables (SS, depression, anxiety and COVID-19-related anxiety), the final sample was of 1117 subjects.

4.2.1.2 Measures

Sociodemographic and COVID-19-related information (e.g., having contracted the virus and the presence/absence of positive cases among relatives or friends) were among the data collected.

COVID-19-related anxiety was assessed through the question: “How anxious are you about the coronavirus COVID-19 pandemic?” (Bruno et al., 2020; Shevlin, Nolan, et al., 2020). Participants were provided with an electronic visual analog scale to indicate their degree of anxiety, ranging from 0 to 100, with higher scores reflecting higher levels of COVID-19-related anxiety.

Somatic symptoms were evaluated using the somatisation subscale of the SCL-90 which comprises 12 items about somatic complaints in the past 7 days. Symptom severity is evaluated on a 5-point Likert-type scale from 1 (not at all bothered) to 5 (extremely bothered). Higher sum scores reflect a higher severity of SS (Fridell et al., 2002; van Driel et al., 2018). Cronbach's alpha and Omega coefficients ($\alpha = 0.68$; $\omega = 0.74$) suggested a moderate level of internal consistency among the 12 items in the scale.

Psychological distress was evaluated with the hospital anxiety and depression (HAD) scale. HAD is a 14 questions self-rating scale that includes two subscales: depression (HAD-D) and anxiety (HAD-A)(Zigmond & Snaith, 1983). A HADS-A cut-off score of 8 gives the optimal

sensitivity and specificity to categorise individuals as having an anxiety and/or depression (Bjelland et al., 2002; Wu et al., 2021). Thus, we defined participants with a cut-off score of ≥ 8 as cases with moderate-to-severe anxiety and depressive symptoms. Cronbach's alpha and Omega coefficients for the HAD-A (HAD-A: $\alpha = 0.81$; $\omega = 0.87$) indicated good internal consistency and scale's reliability, and for HAD-D (HAD-D: $\alpha = 0.67$; $\omega = 0.74$) a moderate internal consistency reliability.

Perceived interpersonal closeness was measured with an adaptation of the Inclusion of the Other in the Self Scale (IOS; Appendix A, p. 240)(Aron et al., 1992), a pictorial tool for measuring the subjectively perceived closeness considered a psychologically meaningful and highly reliable measure of the subjective closeness of relationships (Gächter et al., 2015). This scale included a set of 7 pairs of concentric circles (one labelled 'Self' and one labelled 'Other') that vary in their degree of overlap from 1 (two separate circles) to 7 (almost completely overlapping circles; Aron et al., 1992). Participants selected the pair of circles that best depicted their degree of connection to others.

4.2.2 Sample 2

The data of the second sample represents a cross-sectional study which collection took place in Italy and France during the second wave of COVID-19 pandemic (between November 2020 and January 2021).

The study was designed and carried out in accordance with the World Medical Association Declaration of Helsinki and its subsequent revisions, and approved by the Institutional Review Board of the Laboratory of Psychology (EA4139) of the University of Bordeaux, France (protocol code: 2022.03.CLE003). Participants granted their informed consent to engage in this study online.

4.2.2.1 Participants

The second sample comprised participants from both Italy and France, who participated in an online survey investigating the effects of Covid-19 on emotional well-being and physical health. This survey was disseminated through social networks. To uphold ecological validity, inclusion criteria stipulated respondents to be a minimum of 18 years old and to have completed at least 50% of the questionnaire. The final sample consisted of 1050 subjects (France, $N = 790$;

Italy, N = 260). These individuals were specifically those who provided at least 50% of the required data and were eligible for inclusion in the study.

4.2.2.2 Measures

The full questionnaire used in this sample is presented in the Appendix A (p. 238).

Sociodemographic and COVID-19-related information (e.g., having contracted the virus and the presence/absence of positive cases among relatives or friends) were among the data collected.

COVID-19-related anxiety was assessed through the question: “How anxious are you about the coronavirus COVID-19 pandemic?” (Bruno et al., 2020; Shevlin, Nolan, et al., 2020). Participants were provided with an electronic visual analog scale to indicate their degree of anxiety, ranging from 0 to 10, with higher scores reflecting higher levels of COVID-19-related anxiety. Quintile 1 represents individuals with the lowest COVID-19 anxiety, scoring between 0 and 1. Quintile 2 includes those with slightly higher anxiety, ranging from 2 to 3. Quintile 3 encompasses individuals with moderate COVID-19 anxiety, scoring between 4 and 5. Quintile 4 consists of individuals with higher anxiety levels, scoring between 6 and 7. Finally, Quintile 5 represents individuals with the highest COVID-19 anxiety, scoring between 8 and 10.

Somatic symptoms were evaluated using the Patient Health Questionnaire (PHQ-15; Kroenke et al., 2001), a self-report measure that assessing physical health problems in the last 2 weeks. Items are rated on a three-point Likert scale ranging from 0 (“not bothered at all”) to 2 (“bothered a lot”). The total PHQ-15 score range from 0 to 30, while the subscale scores exhibit the following ranges: Pain (0 to 6), Gastrointestinal (Gastro, 0 to 8), Cardiovascular (Cardio, 0 to 8), and Fatigue (0 to 4). Previous studies attest that PHQ-15 produces reliable and valid scores (Hinz et al., 2017). The total score reliability in the current sample was high ($\alpha = 0.79$). Omega analysis suggests that the total scale has good internal consistency and reliability ($\omega = 0.86$).

Psychological distress was measured with the Generalized Anxiety Disorder 7-item Scale (GAD-7; Spitzer et al., 2006) and the Patient Health Questionnaire-8 (PHQ-8; Kroenke et al., 2009). The PHQ-8 includes eight of the nine criteria on which the DSM-IV diagnosis of depressive disorders is based (American Psychiatric Association, 1994). As in previous studies, the ninth criteria assessing suicidal and self-injurious thoughts was omitted as researchers

would not be able to provide adequate intervention due to the online design of the study and its deletion has only a minor effect on scoring (Kroenke et al., 2009; Kroenke & Spitzer, 2002). Higher scores represent increased severity of anxiety and depressive symptoms, and the cut-off score of ≥ 10 was used to identify a moderate level of anxiety and depressive symptoms (Kroenke et al., 2009, 2010; N. Williams, 2014). The reliability in the current sample for GAD-7 was excellent (GAD-7: $\alpha = 0.91$), indicating high internal consistency. Omega coefficients further supported the reliability of the measure, with an overall Omega Total of 0.94. Cronbach's alpha and Omega coefficients for the PHQ-8 indicated good internal consistency and scale's reliability (PHQ-8: $\alpha = 0.88$; $\omega = 0.90$).

Perceived interpersonal closeness was measured with an adaptation of the Inclusion of the Other in the Self Scale (IOS; Appendix A, p. 240)(Aron et al., 1992), a pictorial tool for measuring the subjectively perceived closeness considered a psychologically meaningful and highly reliable measure of the subjective closeness of relationships (Gächter et al., 2015). This scale included a set of 7 pairs of concentric circles (one labelled 'Self' and one labelled 'Other') that vary in their degree of overlap from 1 (two separate circles) to 7 (almost completely overlapping circles; Aron et al., 1992). Participants selected the pair of circles that best depicted their degree of connection to others.

The Toronto Alexithymia Scale (TAS-20) for identifying difficulties to identify feelings (TAS-DIF), difficulties describing feelings (TAS-DDF) and externally oriented thinking (TAS-EOT)(Bagby et al., 1994). Cronbach's alpha and Omega coefficients suggested a good level of internal consistency among the 20 items in the scale (TAS-TOT: $\alpha = 0.86$; $\omega = 0.88$). The subscales DIF ($\alpha = 0.84$; $\omega = 0.90$), and DDF ($\alpha = 0.80$; $\omega = 0.84$), showed good internal consistency, while EOT ($\alpha = 0.59$; $\omega = 0.71$) had a moderate level of internal consistency.

Cognitive emotion regulation strategies were assessed with the Cognitive Emotion Regulation Questionnaire (CERQ) (Garnefski et al., 2001). The CERQ is a 36-item questionnaire which uses a 5-point Likert scale to assess emotion regulation strategies that subjects use in response to the experience of stressful events. The final scores are divided in nine strategy subscales, grouped into adaptive (CERQ_A: acceptance, positive refocusing, refocus on planning, positive reappraisal, and putting into perspective), and maladaptive strategies (CERQ_M: self-blame, rumination, catastrophising, and blaming others) (Aldao & Nolen-Hoeksema, 2010a; Garnefski et al., 2001). In the current study, the Cronbach's alpha ranged between 0.66 and 0.85 for each strategy and Omega ranged between 0.73 and 0.86.

KEY POINTS

Table 2

Measurements collected in the two samples

Measures	Sample 1	Sample 2
Sociodemographic	X	X
COVID-19-related information	X	X
COVID-19-related anxiety	X	X
Somatic symptoms (SCL-90 SOM)	X	
Somatic symptoms (PHQ-15)		X
Psychological distress (HADS)	X	
Psychological distress (GAD-7 and PHQ-8)		X
Perceived interpersonal closeness	X	X
Toronto Alexithymia Scale (TAS-20)	X	X
Cognitive emotion regulation strategies	X	X
Part II: Dispositional mindfulness (Mindful-Attention-Awareness Scale)		X
Part II: Meditation Practice related information		X

KEY POINTS

Table 3*Summary of the objectives of the first part of the thesis and corresponding studies*

Objectives	Study I	Study II	Study III	Study IV
1 - Understanding whether COVID-19 related anxiety should be considered a significant predictor of SS during the pandemic	X	X		
2 – Assessing the impact of interpersonal connection on SS in the context of Covid-19.	X	X		
3 - Investigating the emotional regulation determinants of SS using the lens of the attention-appraisal model of alexithymia for the antecedent-focused emotion regulation phase			X	
4 – Analysing emotion regulation difficulties in the comorbidity of SSAD				X

5. Study I and II - Investigation of the association between COVID-19-related anxiety and perceived interpersonal closeness with Somatic Symptoms

5.1 Objective and hypothesis

The purpose of the present study was to replicate findings from the UK and Italian C19PRC studies in the French population (Tables of the models predicting PHQ-15 scale and subscale scores in the UK and Italian study are presented in Appendix B). Specifically, the study aimed to investigate whether self-reported COVID-19-related anxiety could serve as a distinctive predictor of somatic symptom scores in France. The second objective of the study was to see if perceived interpersonal closeness would impact this relationship and be a significant predictor of SS.

5.2 Study I – Analysing the impact of Covid-19 related anxiety on Somatic Symptoms with the somatisation dimension of the SCL-90 total score

5.2.1 Methods

Participants

The study initially involved 1207 participants. Following the identification and removal of outliers in key study variables such as SS, depression, anxiety, and COVID-19-related anxiety, the final sample size was reduced to 1117 subjects. The mean age of the total sample was 39 years ($SD = 13.7$, range = 18–84). Most of the participants were female ($n = 1017$, 91%), with a high level of education or university degrees (75.3%), employed (59.4%), and living with their partner or families (81.9%). Less than a quarter of the sample were infected by the SARS-CoV-2 ($n = 212$, 19%), and 32.1% of the participants reported COVID-19 infections among close friends or relatives ($n = 358$). Finally, a quarter of the population declared having a chronic illness ($n = 264$, 23.6%). Sociodemographic characteristics of this study population are presented in the Table 4.

Measures

The measures presented in this study are presented in Chapter 4, section 4.2.2.2. The study collected sociodemographic and COVID-19-related information, including having contracted the virus and the presence/absence of positive cases among relatives or friends. COVID-19-related anxiety was assessed using a visual analog scale ranging from 0 to 100, categorised into five quintiles representing varying anxiety levels. Quintile 1 represents individuals with the lowest COVID-19 anxiety, scoring between 0 and 10. Quintile 2 includes those with slightly higher anxiety, ranging from 11 to 30. Quintile 3 encompasses individuals with moderate COVID-19 anxiety, scoring between 31 and 50. Quintile 4 consists of individuals with higher anxiety levels, scoring between 51 and 68. Finally, Quintile 5 represents individuals with the highest COVID-19 anxiety, scoring between 69 and 100.

Somatic symptoms were measured using the somatisation subscale of the SCL-90, with higher scores indicating greater symptom severity (Fridell et al., 2002; van Driel et al., 2018). Participants' psychological distress was evaluated using the Hospital Anxiety and Depression Scale, distinguishing individuals with moderate-to-severe anxiety and depressive symptoms (Zigmond & Snaith, 1983). Perceived interpersonal closeness was gauged using an adaptation of the Inclusion of the Other in the Self Scale (Aron et al., 1992), involving participants selecting circles that best represented their sense of connection with others, providing a meaningful measure of relationship closeness (IOS, Appendix A, p. 240).

Statistical analyses

Scores of the COVID-19 anxiety variable were categorised into quintiles, and the quintiles were dummy-coded with the lowest one used as the reference category (Bruno et al., 2020; Shevlin, Nolan, et al., 2020). Non-parametric Spearman's rank correlation coefficient (*rho*) was used for assessing correlations between the continuous variables utilised for subsequent simple regression analyses. Regression models were used to estimate the relationship between the COVID-19 anxiety quintiles and SS total score. Model 1 includes the four dummy-coded COVID-19 anxiety variables as predictors of SS. The regression coefficient for each dummy-coded variable is interpreted as the mean difference between each quintile and the lowest one. In Model 2 the covariates (age, gender, income, pre-existing chronic illness, COVID-19 infection, COVID-19 infections among relatives, depression, anxiety and perceived

interpersonal closeness) were included as predictors. All models were specified and estimated using R version 4.0.5 (Team, 2021).

5.2.2 Results

Descriptive statistics of the sociodemographic and psychological characteristics of the population are presented in Table 4.

Table 4

Sociodemographic and psychological characteristics of the population (Study 1)

	Overall (N=1117)
Age	
Mean (SD)	39.1 (13.7)
Median [Min, Max]	38.0 [18.0, 84.0]
Gender	
F	1017 (91.0%)
M	100 (9.0%)
Educational level	
Elementary or some secondary education	12 (1.1%)
High school	264 (23.6%)
Higher level of education	841 (75.3%)
Employment status	
Employed	664 (59.4%)
Retired	75 (6.7%)
Not active or looking for a job	70 (6.3%)
Student	162 (14.5%)
Other	146 (13.1%)
Income	
Mean (SD)	1770 (1220)
Median [Min, Max]	1770 [0, 9000]
Living situation	
Alone	177 (15.8%)
Partner	521 (46.6%)
Children	117 (10.5%)
Family	277 (24.8%)
Friends	19 (1.7%)
Other	6 (0.5%)
Working situation during lockdown	
Working from home	417 (37.3%)
Partial unemployment	172 (15.4%)
Continue going to workplace	173 (15.5%)
Not applicable	267 (23.9%)
Other	88 (7.9%)
Region	
Corse	3 (0.3%)
Ile de France	272 (24.4%)
North Est	149 (13.3%)
North West	123 (11.0%)
French overseas departments	41 (3.7%)
South Est	155 (13.9%)
South West	328 (29.4%)

	Overall (N=1117)
HAD-D	
Mean (SD)	6.32 (3.45)
Median [Min, Max]	6.00 [0, 16.0]
HAD-D \geq 8	300 (26.9%)
HAD-A	
Mean (SD)	6.55 (3.86)
Median [Min, Max]	6.00 [0, 18.0]
HAD-A \geq 8	315 (28.2%)
Chronic Illness (Yes)	264 (23.6%)
COVID-19 infection (Yes)	212 (19.0%)
COVID-19 among relatives (Yes)	358 (32.1%)
Somatic Symptoms	
Mean (SD)	18.1 (4.48)
Median [Min, Max]	17.0 [12.0, 34.0]
Absent-low SS	595 (53.3%)
Medium-high SS	522 (46.7%)
COVID-19-related anxiety	
Mean (SD)	39.2 (27.7)
Median [Min, Max]	40.0 [0, 100]
Interpersonal Closeness	
1- Distant	27 (2.4%)
2- Quite distant	146 (13.1%)
3- A bit distant	113 (10.1%)
4- A moderate degree of connection	251 (22.5%)
5- A bit close	318 (28.5%)
6- Quite close	187 (16.7%)
7- Very close	75 (6.7%)

COVID-19-related anxiety did not exhibit significant association with either personal experiences of contracting the virus ($t(302.32) = 0.653, p = 0.51$) or the presence of cases among relatives ($t(688.59) = 0.34, p = 0.73$). A moderate positive correlation was found between COVID-19-related anxiety and SS ($\rho = 0.23$), depression ($\rho = 0.26$) and anxiety ($\rho = 0.33$), suggesting that individuals who experience more COVID-19-related anxiety are also likely to have higher levels of anxiety and depression and to experience more SS. Correlations between SS and anxiety and depression were similar to those with COVID-19-related anxiety scores.

Interpersonal closeness showed a very small significant association with SS ($\rho = -0.06$). However, interpersonal closeness showed moderate associations with anxiety ($\rho = -0.21$) and depression ($\rho = -0.20$).

Table 5*Correlation table for continuous variables included in the regression Models*

	Age	1	2	3	4	5
1. Salary	0.422 (<i><.001</i>)					
2. COVID-19-related anxiety	0.022 (.474)	-0.026 (.383)				
3. HAD-A	-0.089 (.003)	-0.147 (<i><.001</i>)	0.330 (<i><.001</i>)			
4. HAD-D	0.001 (.974)	-0.078 (.010)	0.263 (<i><.001</i>)	0.715 (<i><.001</i>)		
5. Somatic symptoms	0.018 (.561)	-0.112 (<i><.001</i>)	0.231 (<i><.001</i>)	0.375 (<i><.001</i>)	0.294 (<i><.001</i>)	
6. Interpersonal closeness	0.071 (.020)	0.077 (.011)	-0.013 (.662)	-0.210 (<i><.001</i>)	-0.206 (<i><.001</i>)	-0.069 (.023)

Note: Computed correlation used spearman-method with list wise-deletion.

Table 6 shows the estimates from the three regression models. COVID-19-related anxiety is a significant predictor of SS in all models, with a linear increase and a larger effect for the 5th quintile. In Model 2, which included anxiety and depression, the pattern of results for COVID-19-related anxiety was similar. However, with the introduction of several control variables in Model 3, the magnitude of the effects of COVID-19-related anxiety was significant but, expectedly, attenuated. The estimates for the 3rd, 4th and 5th quintile all remained statistically significant after controlling for other variables. Having contracted COVID-19 or having cases of COVID-19 among relatives were not significant predictors of SS. The effect of having clinically relevant levels of anxiety, to have health problems and to live in the North East of the country were positive and statistically significant. Negative significant associations were found with being male, and living in the French overseas departments.

Table 6*Unstandardised regression coefficients from models predicting SCL-90 Somatisation Scale Scores*

	Model 1	Model 2	Model 3
COVID-19 related anxiety			
Quintile 2	0.326	0.440	0.441
Quintile 3	0.895**	0.799**	0.805*
Quintile 4	1.495***	1.412***	1.289***
Quintile 5	2.735***	1.981***	1.740***
Anxiety (HAD-A score ≥ 8)		1.974***	1.733***
Depression (HAD-D score ≥ 8)		0.566	0.585
Age			0.006
Sex (M)			-0.928*
Income (Maximum)			
No earnings			0.757
Between 1 to 1000 €/month			0.563
Between 1001 to 1800 €/month			0.336
Between 1801 to 2500 €/month			-0.160
Health Problems (No)			1.865***
Covid-19 infection (Yes)			-0.321
COVID-19 among relatives (Yes)			-0.323
Interpersonal Closeness (Distant)			
2- Quite distant			1.300
3- A bit distant			0.453
4- A moderate degree of connection			0.996
5- A bit close			0.542
6- Quite close			1.161
7- Very close			0.149
Region (Ile de Paris)			
Corse			-3.175
North East			0.767*
North West			0.073
French overseas departments			-1.302*
South East			0.238
South West			0.167
Constant	17.071***	16.519***	15.321***
Observations	1,117	1,117	1,045
R ²	0.047	0.099	0.158
Adjusted R ²	0.044	0.094	0.135
Residual Std. Error	4.381 (df = 1112)	4.265 (df = 1110)	4.208 (df = 1017)
F Statistic	13.862*** (df = 4; 1112)	20.289*** (df = 6; 1110)	7.053*** (df = 27; 1017)

5.3 Study II - Analysing the impact of Covid-19 related anxiety on Somatic Symptoms with the PHQ-15 total score and subscales

5.3.1 Methods

Participants

The mean age of the total sample (N = 569) was 39.8 years (SD = 14.5, range = 18–89). Most of the participants were female (n = 512, 90%), with a high level of education or university degrees (54.3%), employed (60.5%), and living with their families or partners (78.4%). A quarter of the sample were infected by the SARS-CoV-2 (n = 139, 24.4%), and half of the participants reported COVID-19 infections among close friends or relatives. Finally, 17.6% of the population self-reported the presence of psychological problems, and 25% declared having a chronic illness.

Measures

The study collected sociodemographic and COVID-19-related data (e.g., having contracted the virus and the presence/absence of positive cases among relatives or friends), assessing COVID-19 related anxiety using a visual analog scale, ranging from 0 to 10, categorised into quintiles (Bruno et al., 2020; Shevlin, Nolan, et al., 2020). Quintile 1 represents individuals with the lowest COVID-19 anxiety, scoring between 0 and 1. Quintile 2 includes those with slightly higher anxiety, ranging from 2 to 3. Quintile 3 encompasses individuals with moderate COVID-19 anxiety, scoring between 4 and 5. Quintile 4 consists of individuals with higher anxiety levels, scoring between 6 and 7. Finally, Quintile 5 represents individuals with the highest COVID-19 anxiety, scoring between 8 and 10.

Somatic symptoms were measured with the PHQ-15 total scale and subscales (i.e., Pain, Gastrointestinal, Cardiovascular, Fatigue) (Kroenke et al., 2001), exploring SS reported in the past two weeks. Psychological distress was evaluated through GAD-7 (Spitzer et al., 2006) and PHQ-8 (Kroenke et al., 2009). Higher scores indicated greater anxiety and depressive symptoms, with a cut-off of ≥ 10 for identification of moderate symptoms. Perceived interpersonal closeness was gauged using the IOS scale (Aron et al., 1992), where participants selected circles representing their closeness to others (IOS, Appendix A).

Statistical analyses

Multiple imputation by chained equations (MICE) using a predictive mean matching method has been performed on the 3.8% of data of Study II, representing missing values in the mandatory questions of the survey. Scores of the COVID-19 anxiety variable were categorised into quintiles, and the quintiles were dummy-coded with the lowest one used as the reference category (Bruno et al., 2020; Shevlin, Nolan, et al., 2020). To examine correlations between the continuous variables employed in subsequent simple regression analyses, we utilised the robust non-parametric Spearman's rank correlation coefficient (*rho*). Regression models were used to estimate the relationship between the COVID-19 anxiety quintiles and SS total score. Moreover, relationships between the COVID-19 anxiety quintiles and the PHQ-15 subscales (pain, gastrointestinal, cardiopulmonary, and fatigue) were analysed. Model 1 of each study includes the four dummy-coded COVID-19 anxiety variables as predictors of SS. The regression coefficient for each dummy-coded variable is interpreted as the mean difference between each quintile and the lowest one. In Model 2 of each study the covariates (age, gender, income, pre-existing chronic illness, COVID-19, COVID-19 among relatives, depression, anxiety and social connection) were included as predictors. All models were specified and estimated using R version 4.0.5 (Team, 2021).

5.3.2 Results

Descriptive statistics of sociodemographic and psychological characteristics of the population are presented in Table 7.

Table 7

Sociodemographic characteristics of the population (Study 2)

	Overall (N= 569)
Age	
Mean (SD)	39.8 (14.5)
Median [Min, Max]	39.0 [18.0, 89.0]
Gender	
Male	53 (9.3%)
Female	512 (90.0%)
Other	4 (0.7%)
Region	
North Est	85 (14.9%)
North West	113 (19.9%)
Overseas France regions	2 (0.4%)
Paris region	84 (14.8%)

	Overall (N= 569)
South Est	102 (17.9%)
South West	183 (32.2%)
Educational level	
Elementary or some secondary education	55 (9.7%)
High school	205 (36.0%)
Higher level of education	309 (54.3%)
Employment status	
Employed	344 (60.5%)
Retired	46 (8.1%)
Not active or looking for a job	41 (7.2%)
Student	98 (17.2%)
Other	40 (7.0%)
Working situation	
Working from home	90 (15.8%)
Partial unemployment	25 (4.4%)
Going to the Workplace	193 (33.9%)
Lost the employment	39 (6.9%)
Other	210 (36.9%)
Not working	12 (2.1%)
Monthly personal income	
Mean (SD)	1850 (1410)
Median [Min, Max]	1800 [0, 12000]
Living arrangements	
Alone	98 (17.2%)
Family	297 (52.2%)
With partner	149 (26.2%)
Flatmates	23 (4.0%)
Other	2 (0.4%)
COVID-19 infection (Yes)	128 (22.5%)
Positive Covid test	66 (11.6%)
COVID-19 among relatives (Yes)	267 (46.9%)
Psychological problems	87 (15.3%)
Chronic illness	137 (24.1%)
PHQ-8	
Mean (SD)	9.42 (6.09)
Median [Min, Max]	9.00 [0, 24.0]
PHQ-8 score \geq 10	255 (44.8%)
GAD-7	
Mean (SD)	8.56 (5.99)
Median [Min, Max]	8.00 [0, 21.0]
GAD-7 score \geq 10	214 (37.6%)
PHQ-15	
Mean (SD)	11.1 (5.83)
Median [Min, Max]	11.0 [0, 30.0]
PHQ-15 score \geq 10	327 (57.5%)
Cardio Mean (SD) [Min, Max]	1.41 (1.57) [0, 8.00]
Gastro Mean (SD) [Min, Max]	3.42 (2.07) [0, 8.00]
Pain Mean (SD) [Min, Max]	2.50 (1.65) [0, 6.00]
Fatigue Mean (SD) [Min, Max]	2.57 (1.22) [0, 4.00]
COVID-19-related anxiety	
Mean (SD)	4.28 (2.88)
Median [Min, Max]	5.00 [0, 10.0]
Interpersonal Closeness	
1- Distant	36 (6.3%)
2- Quite distant	136 (23.9%)
3- A bit distant	77 (13.5%)

	Overall (N= 569)
4- A moderate degree of connection	129 (22.7%)
5- A bit close	103 (18.1%)
6- Quite close	57 (10.0%)
7- Very close	31 (5.4%)

COVID-19-related anxiety exhibited a significant association with personal experiences of contracting the virus ($t(197.73) = 3.056, p = 0.002$). However, there was no significant association between COVID-19-related anxiety and the presence of cases among relatives ($t(532.67) = -0.52, p = 0.59$). Correlations for all the variables included in the study are showed in Table 8. In this sample COVID-19-related anxiety had moderate positive and significant correlations with SS total score ($\rho = 0.23$) and four subscales, and with depression ($\rho = 0.23$) and anxiety ($\rho = .31$), suggesting that individuals who experience more COVID-19-related anxiety are also likely to have higher levels of anxiety and depression and to experience more SS. Correlations between SS, anxiety and depression were higher than for the COVID-19-related anxiety scores.

Interpersonal closeness was not significantly correlated SS. However, interpersonal closeness showed moderate and significant associations with both anxiety ($\rho = -0.27$) and depression ($\rho = -0.30$).

Table 9 presents unstandardised regression coefficients from three models predicting PHQ-15 scale and subscale scores (Pain, Gastrointestinal, Cardiovascular, Fatigue, and Total) based on COVID-19-related anxiety and several control variables. Model 1 focus is solely on COVID-19-related anxiety and its association with PHQ-15 scale and subscale scores. The R-squared values indicate that COVID-19-related anxiety explains a small but significant proportion of the variance in each subscale score. The regression coefficients show that COVID-19 anxiety has a significant positive association with all subscale scores in a graded manner, i.e., as the quintile of COVID-19 anxiety increases, so does the severity of PHQ-15 subscale scores. For total PHQ-15 scores, participants in the highest quintile of COVID-19 anxiety scored 3.81 points higher than those in the lowest quintile.

Table 8*Correlation table for all the variables included in Model 1*

<i>Variable</i>	<i>Age</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>
1. Salary	0.518 (<i><.001</i>)									
2. COVID-19 related anxiety	-0.041 (.335)	-0.049 (.249)								
3. GAD-7	-0.219 (<i><.001</i>)	-0.158 (<i><.001</i>)	0.319 (<i><.001</i>)							
4. PHQ-8	-0.233 (<i><.001</i>)	-0.197 (<i><.001</i>)	0.236 (<i><.001</i>)	0.709 (<i><.001</i>)						
5. PHQ-15	-0.148 (<i><.001</i>)	-0.200 (<i><.001</i>)	0.238 (<i><.001</i>)	0.574 (<i><.001</i>)	0.574 (<i><.001</i>)					
6. PHQ-15 (Pain)	-0.012 (.772)	-0.139 (.001)	0.172 (<i><.001</i>)	0.382 (<i><.001</i>)	0.353 (<i><.001</i>)	0.732 (<i><.001</i>)				
7. PHQ-15 (Gastro)	-0.132 (.002)	-0.159 (<i><.001</i>)	0.177 (<i><.001</i>)	0.405 (<i><.001</i>)	0.424 (<i><.001</i>)	0.816 (<i><.001</i>)	0.439 (<i><.001</i>)			
8. PHQ-15 (Cardio)	-0.047 (.272)	-0.131 (.002)	0.171 (<i><.001</i>)	0.398 (<i><.001</i>)	0.412 (<i><.001</i>)	0.761 (<i><.001</i>)	0.487 (<i><.001</i>)	0.503 (<i><.001</i>)		
9. PHQ-15 (Fatigue)	-0.096 (.023)	-0.100 (.018)	0.196 (<i><.001</i>)	0.607 (<i><.001</i>)	0.619 (<i><.001</i>)	0.716 (<i><.001</i>)	0.421 (<i><.001</i>)	0.492 (<i><.001</i>)	0.460 (<i><.001</i>)	
Interpersonal closeness	0.069 (.103)	0.028 (.509)	-0.043 (.316)	-0.274 (<i><.001</i>)	-0.308 (<i><.001</i>)	-0.087 (.041)	-0.017 (.688)	-0.062 (.146)	-0.019 (.655)	-0.171 (<i><.001</i>)

Note: Computed correlation used spearman-method with list wise-deletion.

In Model 2, anxiety (GAD-7) and depression (PHQ-8) were added to the previous model. It is observed that the effects of COVID-19 anxiety quintiles on SS are attenuated when accounting for anxiety and depressive symptoms. For instance, in Model 1, Quintile 4 showed positive effects of Gastro and Fatigue subscales, as well as on the total PHQ-15 score. However, in Model 2 all effects of the 4th quintile disappears and the effects of the 5th quintile remain significant only for the Gastro subscale and the Total scale, which scores are moderated by the presence of GAD-7 and PHQ-8 scores, indicating that this effect may be partly explained by underlying anxiety and depressive symptoms. Quintile 2, on the other hand, often shows negative effects on SS, suggesting a potential beneficial impact of moderate anxiety levels.

Model 3 builds upon Model 2 by incorporating a wide array of control variables, including demographic factors (age, gender, income, region), health-related factors (health problems, psychological problems, COVID-19 status), social factors (connection with others), and geographical factors (region). The coefficients for COVID-19 anxiety across different quintiles present a mixed picture. In Quintile 2, the coefficient for Pain is negative and significant ($p < 0.05$), suggesting that COVID-19-related anxiety is associated with lower Pain scores. However, for other quintiles, the coefficients for COVID-19 anxiety are positive and are not statistically significant, indicating that its impact on subscale scores and total SS score is no longer relevant ones accounting for other control variables. Moreover, in Model 2 being female is linked to increase in Pain and Total scores, while having contracted Covid-19 is associated with an increase in all scores of SS. Earning less than 1000 €/month and having health problems are associated with increased in all scores except for fatigue, and feeling a moderate degree of connection with others is linked to higher cardiovascular, gastrointestinal and total scores. Furthermore, individuals with GAD-7 scores above 10, indicating clinically relevant symptoms of generalised anxiety disorder, and those with PHQ-8 scores above 10, indicative clinically relevant depression symptoms, exhibit higher PHQ-15 subscale scores.

Table 9

Unstandardised regression coefficients from models predicting PHQ-15 Scale and Subscale Scores (n = 569).

	Pain	Gastro	Cardio	Fatigue	Total
Model 1					
COVID-19 anxiety					
Quintile 1	–	–	–	–	–
Quintile 2	-0.610***	0.264	-0.265	-0.072	-0.759
Quintile 3	0.054	0.714***	0.218	0.216	1.459**
Quintile 4	0.185	0.504*	0.005	0.328**	1.236*
Quintile 5	0.713***	1.254***	0.754***	0.693***	4.125***
Constant	2.463***	2.911***	1.293***	2.366***	10.016***
R ²	0.056	0.038	0.039	0.042	0.069
Adjusted R ²	0.050	0.031	0.032	0.035	0.062
Residual Std. Error (df = 564)	1.610	2.033	1.546	1.195	5.645
Model 2					
COVID-19 anxiety					
Quintile 1	–	–	–	–	–
Quintile 2	-0.527***	0.376	-0.177	0.031	-0.303
Quintile 3	-0.023	0.615***	0.138	0.124	1.043*
Quintile 4	0.064	0.318	-0.131	0.162	0.527
Quintile 5	0.270	0.626**	0.276	0.123	1.632**
Control variables					
GAD-7 ≥ 10	0.747***	0.774***	0.718***	0.755***	3.664***
PHQ-8 ≥ 10	0.416***	0.924***	0.555***	0.777***	2.976***
Constant	2.089***	2.338***	0.875***	1.854***	7.831***
R ²	0.140	0.152	0.149	0.308	0.285
Adjusted R ²	0.131	0.143	0.139	0.300	0.278
Residual Std. Error (df = 562)	1.539	1.912	1.458	1.018	4.954
F Statistic (df = 6; 562)	15.276***	16.754***	16.342***	41.627***	37.367***
Model 3					
COVID-19 anxiety					
Quintile 1	–	–	–	–	–
Quintile 2	-0.631***	0.195	-0.256	-0.005	-0.761
Quintile 3	-0.146	0.410	-0.032	0.032	0.345
Quintile 4	-0.019	0.163	-0.209	0.151	0.129
Quintile 5	0.011	0.426	-0.011	0.044	0.774
Control variables					
GAD-7 ≥ 10	0.725***	0.631***	0.658***	0.696***	3.356***
PHQ-8 ≥ 10	0.554***	0.769***	0.546***	0.775***	2.800***
Age	0.011**	-0.009	0.002	-0.0002	-0.009
Gender Male (Female)	-0.348	-0.346	0.097	-0.127	-1.211*
Gender Other (Female)	-0.192	0.031	0.572	0.363	0.270
Income (Maximum)					

No earnings	0.442*	0.214	0.103	-0.015	1.003
Between 1 to 1000 €/month	0.562***	0.591**	0.332*	0.094	1.797***
Between 1001 to 1800 €/month	0.131	0.024	0.087	-0.004	0.072
Between 1801 to 2500 €/month	0.242	-0.097	-0.003	-0.107	-0.071
Health problems (No)	0.269*	0.582***	0.269**	0.155	1.369***
Psychological Problems (Yes)	-0.041	-0.135	-0.300*	-0.117	-0.754
Covid-19 (No)	-0.628***	-0.512**	-0.812***	-0.198*	-2.370***
Covid-19 among relatives (No)	0.181	0.160	0.116	-0.170*	0.240
Connection with others (Distant)					
2-Quite distant	0.348	0.307	0.229	0.121	1.286
3-A bit distant	0.893***	0.723*	0.493*	0.186	2.508**
4-Moderate degree of connection	0.587*	0.807**	0.567**	0.262	2.584***
5-Quite close	0.566*	0.666	0.687**	0.031	2.463**
6-Very close	0.712**	0.225	0.467	0.237	2.028*
7-Connected	0.769*	0.367	0.739**	-0.200	2.221*
Region (Ile de France)					
North East	-0.051	-0.149	0.013	-0.065	0.204
North West	-0.145	-0.801***	-0.199	-0.271*	-1.304*
French overseas departments	0.867	-0.033	0.828	0.608	2.890
South East	-0.422*	-0.439	-0.348*	-0.195	-1.381**
South West	-0.306	-0.157	-0.318*	-0.173	-0.885
Constant	1.424***	2.873***	1.184***	2.229***	8.819***
R ²	0.233	0.217	0.263	0.347	0.396
Adjusted R ²	0.189	0.171	0.220	0.310	0.361
Residual Std. Error (df = 486)	1.451	1.866	1.248	1.012	4.410
F Statistic (df = 28; 486)	5.268***	4.798***	6.189***	9.240***	11.372***
Note:	*p<0.1; **p<0.05; ***p<0.01				

5.4 Discussion (Study I and II)

5.4.1 COVID-19 related anxiety

The study's primary objective was to examine the relationship between COVID-19-related anxiety and SS in two community samples of the French population. Furthermore, the study sought to compare its findings with the results from two previously published studies (Bruno et al., 2020; Shevlin, Nolan, et al., 2020). To achieve these goals, the study employed two distinct samples and assessed the predictive potency of COVID-19-related anxiety concerning SS, while also considering anxiety and depression and a range of control variables.

The findings derived from both samples showcased a nuanced link between COVID-19-related anxiety and SS. In Study I, similarly to the UK and Italian cohorts, the impact of COVID-19 anxiety on SS persisted even after accounting for various demographic, health-related, and psychological factors. As suggested by Shevlin et al. (2020), this suggests that the anxiety stemming from the COVID-19 pandemic contributed uniquely to individuals' experience of SS. However, Study II, which employed the same metrics as Shevlin et al. (2020) and Bruno et al. (2020), portrayed a contrasting picture. In fact, Model 2 provides a more nuanced and comprehensive perspective on the relationship between COVID-19 anxiety and health outcomes, emphasising the need to account for the influence of anxiety and depressive symptoms to obtain a clearer picture of how these psychological factors collectively impact individuals' well-being during the pandemic. Moreover, in the second study, with the integration of other control variables into the regression model (Model 3), the influence of COVID-19-related anxiety on SS did not demonstrate statistical significance. This divergence in outcomes across the UK, Italian, and French samples suggests that the connection between COVID-19-related anxiety and SS could exhibit variability. Thus, it is noteworthy to consider that the UK study's data collection occurred in March 2020, while the Italian study gathered information in July 2020. Contrarily, the present study collected data between May and June 2020 (Study I) and between November 2020 and January 2021 (Study II). Consequently, although Study II employed the same metrics as the previous studies, the data capture occurred approximately eight months following Shevlin et al.'s (2020) initial investigation. As a result, we can hypothesise that the data showed an adaptation to the evolving landscape of the COVID-19 pandemic. Thus, this variance might be attributed to the temporal progression of the pandemic and its associated developments. Factors such as changing public health guidelines, the introduction of vaccine, evolving societal perceptions, and varying levels of exposure to pandemic-related information could have contributed to the shifting dynamics of COVID-19-related anxiety and its impact on SS. Therefore, these contextual disparities could potentially explain the observed discrepancies in the associations between COVID-19-related anxiety and SS. Furthermore, a distinguishing factor between Study I and Study II regards the effect of psychological distress. Similar to the research conducted in the UK and Italy, COVID-19-related anxiety showed a significant positive association with generalised anxiety. However, unlike the study of Shevlin et al. (2020), in the prediction of SS, our research considered both anxiety and depression. In Study I, generalised anxiety emerged as a significant factor influencing SS. In contrast, Study II encompassed both generalised anxiety and depression as

influencing factors. This distinction might account for variations in the observed relationships between COVID-19-related anxiety and SS. The inclusion of depression as an additional psychological dimension could potentially alter the interplay between COVID-19-related anxiety, generalised anxiety, and somatic manifestations, leading to differences in outcomes between the two studies.

In both studies, COVID-19-related anxiety did not exhibit significant correlations with having contracted COVID-19 or having relatives infected with COVID-19, with the exception of a small the association found in Study II with Covid infection. This observation suggests that in the first period of the pandemic, COVID-19-related anxiety might have been more closely associated with general worries and concerns surrounding the pandemic rather than direct personal experiences with the virus itself.

In conclusion, the temporal progression of the pandemic and the inclusion of different psychological factors underscore the intricate and evolving nature of the relationship between COVID-19-related anxiety and SS. The observed disparities across the studies serve as a reminder of the multifaceted dynamics at play and the importance of considering the evolving context when interpreting psychological and somatic associations. These findings highlight the importance of understanding the complex interplay between SSAD, and how their associations may differ across different study designs and populations. The co-occurrence of these psychological symptoms underscores the broader impact that the pandemic had on mental health, extending beyond the specific fears related to contracting the virus. Further research is warranted to explore the underlying mechanisms and potential implications of these associations. Moreover, these findings emphasise the importance of addressing not only the physical health aspects of the pandemic but also the psychological well-being of individuals who may be experiencing heightened anxiety and depressive symptoms due to the ongoing COVID-19 situation.

5.4.2 Interpersonal closeness

The second objective of this study was to observe the influence of perceived interpersonal closeness on SS and COVID-19 related anxiety. In fact, several studies have shown an association between a low sense of connection with others (i.e., loneliness) and SSD, anxiety and depression (Vos et al., 2023; Werner et al., 2021). Moreover, an increased sense of subjective loneliness has been showed from pre-pandemic scores to pandemic situation (Conti

et al., 2023; Werner et al., 2021). However, while some studies have showed no effects of loneliness on SS during the COVID-19 pandemic (Conti et al., 2023), others showed that loneliness was not only associated to SS, but also on other mental health outcomes, such as depressive and anxiety symptoms, and PTSD (Xu et al., 2021).

In our current research, we have looked at the relationship between interpersonal closeness among participants and various demographic and psychological variables. Study I brought to light a positive correlation between age and interpersonal closeness, unveiling that as individuals advance in age, they might be more inclined to report heightened closeness within their relationships. Additionally, Study I uncovered a positive association between salary and interpersonal closeness, indicating that those with higher incomes tend to perceive greater closeness in their relationships. However, it's noteworthy that these two associations failed to replicate in Study II, where age and salary displayed no significant correlation with interpersonal closeness. Surprisingly, there was a lack of a substantial correlation between COVID-19-related anxiety and interpersonal closeness in both studies. This finding suggests that, despite the disruptive influence of the pandemic anxiety on daily life, it may have not directly impacted individuals' perceptions of closeness within their relationships. Nevertheless, Study II did yield a modest association between having relatives with COVID-19 infections and interpersonal closeness, offering a nuanced perspective.

Arguably, the most critical finding from our research is the consistent link between mental health and interpersonal closeness. Participants reporting fewer mental health problems consistently reported higher levels of interpersonal closeness. In Study I, a significant negative correlation emerged between anxiety, depression, and interpersonal closeness, underscoring that lower levels of anxiety and depression during the pandemic were associated with heightened closeness. Study II replicated these findings, revealing negative correlations between generalised anxiety, depression, and interpersonal closeness. This robust pattern reinforces the notion that individuals experiencing fewer mental health symptoms during the pandemic tended to perceive greater closeness in their relationships. Furthermore, our analysis of SS demonstrated a similar trend, albeit with relatively small effect sizes. In Study I, the total SS scale displayed a negative association with interpersonal closeness, indicating that a higher sense of closeness was associated with lower reports of SS. In Study II, the negative association was primarily observed in the fatigue subscale. These findings collectively shed light on the intricate relationships between psychological well-being, somatic experiences, and the

perception of interpersonal closeness, suggesting that during the pandemic feeling sufficiently detached from other people might have helped individuals to preserve themselves from interpersonal dynamics that would have impacted on their mental health.

5.5 Limitations and Future Directions:

Firstly, like all studies utilising self-report measures, the findings are subject to potential self-report biases. Moreover, it's essential to acknowledge that the utilisation of a community non stratified recruitment method in our study precludes any broad generalisations. In fact, in both studies there was an overrepresentation of women. While efforts were made to ensure a diverse and representative sample, the higher proportion of women might have influenced the generalisability of the findings, as gender differences could have impacted the relationship between COVID-19 related anxiety levels and SS. In fact, a recent meta-analysis found a moderate and significant effect of gender on COVID-19 related fear and anxiety in favour of females (Metin et al., 2022). Future studies should aim to balance the gender distribution more effectively to obtain a more comprehensive understanding of the association between these variables in the broader population.

Furthermore, it is worth noting that the prevalence rates of moderate to high SS (57%), anxiety (37%), and depression (45%) in Study II and in Study I (anxiety: 28.2%, depression 26.9% and Medium to high SS: 46.7%) were among the highest range reported in the literature during the pandemic. In fact, while the general prevalence of anxiety in the general population was estimated at 35.1 % by a recent systematic review and meta-analysis (Delpino et al., 2022), other reviews reported prevalence to be between 26.6% and 28.18% for depression and 25.7% and 29.57% for anxiety (Hajek et al., 2022; Mahmud et al., 2023). Moreover, prevalence of SS between various countries ranged between 23.8% and 31.1% (Spain, Germany and Iran)(Biermann et al., 2021; Mohammadi et al., 2020; Pérez et al., 2021). However, some countries reported prevalence of 45.9% (China; Ran et al., 2020) and of 62.6% (Brazil; Goularte et al., 2021). Hence, the elevated occurrence of SS and psychological distress observed in our sample might be ascribed to either the inherent biases linked to our sampling approach or an indication of increased anxiety resulting from the persistent uncertainty surrounding the COVID-19 pandemic.

5.6 Conclusions

The study highlights the evolving nature of the COVID-19-related anxiety and SS relationship, suggesting that although COVID-19-related anxiety may have strongly predicted SS in the early stages of the pandemic, as time progressed, individuals may have adapted to the ongoing challenges posed by the COVID-19 crisis, potentially leading to changes in this relationship. Variability across studies underscores the need to consider evolving contexts. Furthermore, the co-occurrence of generalised anxiety and depression underlines the pandemic's broader mental health impact and the importance of addressing mental health concerns during public health crises, as anxiety can manifest in physical symptoms. Additionally, our findings hinted at a nuanced relationship between SS and interpersonal closeness, emphasising the intricate interconnections between psychological well-being, somatic experiences, and perceptions of interpersonal closeness during these challenging times.

KEY POINTS

The first objective of this chapter was to investigate the relationship between COVID-19-related anxiety and SS in the French population, comparing findings from two samples (Study I and Study II) with previous studies suggesting that pandemic-related anxiety uniquely contributes to SS (Bruno et al., 2020; Shevlin, Nolan, et al., 2020).

- Study I, conducted at the end of the first lockdown, showed a significant linear relationship between COVID-19-related anxiety and SS (measured with the SCL-90 Somatization Scale).
- Study II, conducted about eight months after the initial study, provided a more nuanced perspective by considering the influence of anxiety, depression, and other control variables.
- The discrepancies in outcomes across various studies may be ascribed to the dynamic nature of the pandemic, shifts in public health guidelines, vaccine availability, changing societal attitudes, and a potential habituation of individuals to the fear and anxiety associated with COVID-19 over time.

The second objective of this chapter was to investigate how perceived interpersonal closeness affects SS and COVID-19-related anxiety.

- Surprisingly, there was no significant correlation between COVID-19-related anxiety and interpersonal closeness in both studies, despite the disruptive impact of pandemic-related anxiety.
- Both studies demonstrated negative correlations between generalized anxiety, depression and interpersonal closeness, reinforcing that lower levels of mental health symptoms during the pandemic were associated with greater perceived closeness.
- Feeling emotionally detached from others during the pandemic may have served as a protective factor against the potential negative impact of interpersonal dynamics on mental health.
- Both sample presented an elevated prevalence of somatic symptoms and psychological distress, which may be due to the convenience sampling approach or increased anxiety resulting from ongoing uncertainty related to the pandemic.

6. Study III - Investigation into emotion regulation predictors of Somatic Symptoms: a serial mediation model

6.1 Objectives and Hypotheses

While previous research has frequently established a strong association between the DIF dimension of alexithymia and SS, the significance of the EOT dimension has consistently shown minimal impact (R. V. Aaron et al., 2019; De Gucht & Heiser, 2003; Mattila et al., 2008). However, there are variations in findings. In fact, Ghorbani et al. (2017), have found that each of the three alexithymia subscales had indirect effects on SS through the non-adaptive cognitive emotion regulation strategy of catastrophising. Given the diversity of results regarding the impact of EOT on emotional processing in individuals with SS and the limited research on this dimension of Alexithymia, the thesis's third objective was to investigate emotional regulation determinants of SS. In particular, we aim to study the role of EOT using as a theoretical framework the attention-appraisal model of alexithymia, proposed by Preece et al. (2017). EOT is seen as disrupting the attention phase, hindering the processing of emotional stimuli. Consequently, the research sequentially introduces EOT, DIF, and DDF, representing attention, appraisal, and processing of emotions. Then we introduced emotion regulation strategies relevant to SS, in particular rumination and catastrophising, forming a sequential process through which EOT could influence SS. Finally, as some studies found that the relationship between alexithymia and SS could be shaded by negative affect (Bailey & Henry, 2007; De Gucht & Heiser, 2003; Mattila et al., 2008) we added psychological distress in the equation, to control that possible mediation would be relevant even when account for anxiety and depression.

The hypotheses driving this study are the following:

H1: EOT has an indirect relationship with symptoms reporting, via the mediation of DIF and DDF;

H2: Rumination has a significant effect on Catastrophising;

H3: In the selection phase, pertinent emotion regulation strategies in SS, specifically 1) rumination and 2) catastrophising, would constitute a sequential process through which DIF and DDF affect SS;

H4: EOT, through the mediation of DIF, could directly influence SS without necessitating the intermediary influence of psychological distress.

To test these hypotheses, the study examined data of cross-sectional study presented in Study II (Sample 2, p. 75). Data collection took place during the second wave of COVID-19 pandemic (between November 2020 and January 2021).

6.2 Method

6.2.1 Participants

To maximise ecological validity, the only inclusion criterion was being at least 18 years old and completing at least 50% of the questionnaire. After accounting for outliers in the variables of interest (i.e., PHQ-15, PHQ-8, GAD-7, CERQ strategies, TAS subscales), the final sample was of 793 subjects. Of the sample 68.5% ($n = 543$) lived in France and 31.5% ($n=250$) in Italy. Participants ranged in age from 18 to 89 ($M = 39.1$ years, $SD = 14.4$) with 85.8% identifying as female ($n = 680$), 13.5% as male and 0.6% as neither female nor male. Most of the participants had a high level of education or university degrees (54.7%), employed (57.4%), and living with their partner or families (81.7%). 21.9% of the sample declared having a chronic illness ($n = 174$).

6.2.2 Measures

The study incorporated sociodemographic variables, including age, gender, chronic illness, and education level. Additionally, four questionnaires were administered (for a full description of questionnaires p. 76-77):

- the Patient Health Questionnaire (PHQ-15; Kroenke et al., 2001), a self-report measure scoring SS on a scale of 0 to 30, with ≥ 10 indicating moderate to high somatisation;
- psychological distress, assessed with the Generalized Anxiety Disorder 7-item Scale (GAD-7; Spitzer et al., 2006) and the Patient Health Questionnaire-8 (PHQ-8; Kroenke et al., 2009). Higher scores represent increased severity of anxiety and depressive

symptoms, and the cut-off score of ≥ 10 was used to identify a moderate level of anxiety and depressive symptoms (Kroenke et al., 2009, 2010; N. Williams, 2014).

- the Toronto Alexithymia Scale (TAS-20) examined difficulties identifying and describing feelings and externally oriented thinking (Bagby et al., 1994).
- The cognitive emotion regulation strategies, evaluated through the Cognitive Emotion Regulation Questionnaire (CERQ). The final scores are divided in nine strategy subscales grouped into adaptive and maladaptive strategies (Garnefski et al., 2001).

6.2.3 Statistical Analyses

Analyses were performed using R version 4.2.3 (R Core Team, 2013). Multiple imputation by chained equations (MICE) using a predictive mean matching method has been performed on the 4.8% of data, representing missing values in the mandatory questions of the survey. To determine between groups comparisons, a cut-off score of ≥ 10 was used on the PHQ-15, reflecting medium and high symptom severity.

Prior to conducting further analyses, correlation analyses were performed to determine significant links between SS, psychological distress, emotion regulation strategies (CERQ) and various other correlates. As some variables' data did not follow a normal distribution, the non-parametric Spearman's rank correlation coefficient (*rho*) was used. Correlation data were then utilised for subsequent simple regression analyses, following verification of the conditions for each model (lack of outliers, independence, normality, and homoscedasticity of residuals). The variance inflation factor (VIF) was tested for multicollinearity (Hair, 2009). Hierarchical linear regressions were performed between variables significantly correlated with SS, considered as dependent variables and the independent variables were sociodemographic characteristics, TAS-20 subscales (EOT, DIF, and DDF), CERQ dimensions and psychological distress. Four regression models were estimated, and regression coefficients and the corresponding p values were calculated. In the first model, the sociodemographic characteristics were entered, and in the three following models, the added variables potentially explaining the outcome were forced in. To evaluate the contribution of alexithymia to somatisation before adjusting for other clinical variables, we included the TAS-20 dimensions in the second model. Specifically, we aimed to test the extent to which each variable (i.e., TAS-20 dimension, CERQ dimensions in the third model and psychological distress dimensions) were able to significantly add to the final explained variance of SS. According to the previous analysis, we conducted a path sequential

multiple mediation models using the Model 6 of PROCESS macro (Hayes, 2018). The aim of the model was to assess the effect of Externally Oriented Thinking (TAS-EOT) on the severity of SS reporting through the mediating role of the other TAS subscales, relevant CERQ (i.e., rumination and catastrophising) and psychological distress. Hayes' method for mediation analyses involves a series of separate regressions for the three types of variables (independent, dependent, and mediators) using the least squares method. Moreover, it utilises the indirect effect of X on Y to assess the mediating impact. The mediation analyses were conducted using Model 6 of the PROCESS macro for R (Hayes, 2013), incorporating the Bootstrap technique to test the significance of the indirect effects (Preacher & Hayes, 2008). The application of 5,000 bootstraps resample was used to evaluate the bias-corrected 95% confidence interval (CI), and sociodemographic variables were added as covariate (i.e., sex, age, presence of chronic illness). When the interval did not contain zero, the effect was considered statistically significant at $p < 0.05$.

6.3 Results

Between-Group Somatic Symptoms Comparisons

The comparisons between patients with low and high levels of somatisation are shown in Table 10. We observed differences across various domains between individuals with "Absent-low" levels of SS and those with "Medium-high" levels. Firstly, gender distribution exhibited significant variation, with a higher proportion of females in the "Medium-high" group (79.0%, $p < 0.001$) while the "Absent-low" group had more male participants. Age also differed significantly, with the "Absent-low" group having a higher mean age of 41.5 years ($SD = 15.4$) compared to the "Medium-high" group with a mean age of 37.0 years ($SD = 13.1$) ($p < 0.001$). On the psychological front, participants with "Medium-high" SS reported higher levels of anxiety, depression, and overall psychological distress compared to their counterparts with "Absent-low" SS. Additionally, individuals with "Medium-high" SS demonstrated greater levels of alexithymia and engaged more in maladaptive emotion regulation strategies, including higher self-blame, rumination, catastrophising, and other-blame. However, there was a nuanced pattern in emotion regulation strategies, with the "Medium-high" group exhibiting slightly higher acceptance scores ($p = 0.02$). Scores of the EOT dimension of alexithymia did not show any significant difference between groups.

Table 10

Comparisons of sociodemographic and clinical characteristics between subjects with absent-to-low and moderate-to-high somatisation

	Absent-low (N= 372)	Medium-high (N= 421)	P-value
	Mean (SD) [Min, Max]	Mean (SD) [Min, Max]	
Chronic Illness			
No	283 (76.1%)	296 (70.3%)	0.06
Yes	71 (19.1%)	103 (24.5%)	
Gender			
Female	294 (79.0%)	386 (91.7%)	<0.001
Male	78 (21.0%)	30 (7.1%)	
Other	0 (0%)	5 (1.2%)	
Age			
Mean (SD)	41.5 (15.4)	37.0 (13.1)	<0.001
Median [Min, Max]	39.0 [18.0, 89.0]	36.0 [18.0, 72.0]	
Education level			
Elementary or some secondary education	28 (7.5%)	31 (7.4%)	0.09
High school	126 (33.9%)	174 (41.3%)	
Higher level of education	218 (58.6%)	216 (51.3%)	
Somatic Symptoms (PHQ-15)	5.74 (2.41)	14.1 (3.52)	<0.001
Anxiety (GAD-7)	5.72 (4.43)	11.2 (5.48)	<0.001
Depression (PHQ-8)	6.15 (4.38)	11.9 (5.36)	<0.001
Psychological Distress			
Mean (SD)	11.9 (7.94)	23.1 (9.86)	<0.001
Median [Min, Max]	11.0 [0, 39.0]	23.0 [1.00, 45.0]	
Alexithymia (TAS-TOT)	46.5 (12.8)	53.8 (12.8)	<0.001
DDF	13.0 (4.98)	14.8 (5.06)	<0.001
DIF	16.1 (6.29)	21.2 (6.41)	<0.001
EOT	17.4 (4.65)	17.8 (4.52)	0.16
CERQ Maladaptive	34.1 (9.73)	39.4 (10.1)	<0.001
Self-blame	8.67 (3.38)	9.95 (3.62)	<0.001
Rumination	11.1 (3.87)	13.1 (3.86)	<0.001
Catastrophising	7.03 (3.17)	8.18 (3.34)	<0.001
Other-blame	7.25 (2.93)	8.16 (3.37)	<0.001
CERQ Adaptive	61.4 (14.4)	60.3 (14.3)	0.27
Acceptance	12.4 (3.36)	12.9 (3.35)	0.02
Positive refocus	10.1 (3.97)	9.66 (3.79)	0.08
Refocus planning	12.9 (3.69)	13.0 (3.76)	0.66
Positive reappraisal	12.8 (3.99)	12.0 (4.04)	0.006
Prospective	13.2 (3.89)	12.7 (3.78)	0.06

Between-Variable Associations

Spearman's rank correlation coefficients were calculated to determine the relationships between the selected variables (Table 11). SS presented moderate significant associations with Rumination ($\rho = 0.29$), and Catastrophising ($\rho = 0.26$), as well as with the dimensions of alexithymia DIF ($\rho = 0.46$) and DDF ($\rho = 0.24$). EOT was significantly associated with DIF ($\rho = 0.28$) and DDF ($\rho = 0.37$) and presented small association with all the CERQ strategies, except for Other-blame.

Table 12 reports the four hierarchical regression model with SS as an outcome variable. In the first model, sociodemographic characteristics (age, gender, and years of education and educational level) explained 0.8% of SS and all variables were significant. Adding TAS-20 subscales produced an added predictor of somatisation of 28% (Model 2), with the only DIF and DDF showing significant p values (DIF: $\beta = 0.53$, $t = 12.90$, $p < 0.001$; DDF: $\beta = -0.13$, $t = -3.04$, $p = 0.002$). The adding of all CERQ strategies to the Model 3 did not show a significant increase of the variance ($R^2 = 0.30$), and none of the strategies showed significant results. Finally, in Model 4 the introduction of anxiety and depression explained 48% of the variance, with age ($p = 0.03$), gender ($p < 0.001$), Chronic Illness ($p < 0.001$), DIF ($p < 0.001$), DDF ($p < 0.001$), anxiety ($p < 0.001$) and depression ($p < 0.001$) scores being the main predictors for somatisation.

Table 11*Correlations between psychological variables of the study sample*

	Age	1	2	3	4	5	6	7	8	9	10	11	12	13
1- TAS-EOT	0.008													
2- TAS-DIF	-0.13***	0.28***												
3- TAS-DDF	-0.13***	0.37***	0.66***											
4- Acceptance	-0.05	-0.13***	-0.01	-0.03										
5- Positive refocusing	0.08	-0.06	-0.14***	-0.10	0.27***									
6- Refocus on planning	-0.04	-0.26***	-0.11	-0.13***	0.38***	0.46***								
7- Positive reappraisal	-0.01	-0.27***	-0.21***	-0.21***	0.40***	0.52***	0.63***							
8- Prospective	0.04	-0.15***	-0.15***	-0.16***	0.38***	0.43***	0.44***	0.59***						
9- Self-blame	-0.24***	-0.025	0.27***	0.22***	0.16***	-0.15***	0.14***	-0.03	-0.02					
10- Rumination	-0.21***	-0.17***	0.31***	0.14***	0.27	-0.04	0.29***	0.12***	0.043	0.48***				
11- Catastrophising	-0.13***	0.11***	0.31***	0.21***	0.04	-0.07*	0.001	-0.14***	-0.25***	0.32***	0.43***			
12- Other-blame	-0.02	0.002	0.10**	0.04	0.04	0.001	0.11**	-0.03	-0.08*	0.24***	0.27***	0.38***		
13- Psychological distress	-0.21***	0.10**	0.55***	0.38***	0.01	-0.18***	-0.007	-0.22***	-0.17***	0.35***	0.43***	0.40***	0.24***	
PHQ-15	-0.16***	0.07*	0.46***	0.24***	0.04	-0.09*	0.01	-0.11**	-0.08*	0.21***	0.29***	0.26***	0.17***	0.64***

Note. Computed correlation used spearman-method with list wise-deletion. * indicates $p < .05$. ** indicates $p < .01$. *** indicates $p < .001$

Table 12*Hierarchical regression model predicting Somatic Symptoms (PHQ-15)*

	β	t	p	R	R ²
Model 1				0.24	0.08
Age	-0.198	-5.617	<0.001		
Chronic Illness	0.136	3.852	<0.001		
Gender	-0.178	-5.114	<0.001		
Education level	-0.075	-2.134	0.033		
Model 2				0.53	0.28
Age	-0.131	-4.131	<0.001		
Chronic Illness	0.100	3.204	0.001		
Gender	-0.154	-4.950	<0.001		
Education level	-0.030	-0.915	0.361		
Externally oriented thinking (TAS-EOT)	-0.013	-0.375	0.708		
Difficulty identifying feelings (TAS-DIF)	0.539	12.905	<0.001		
Difficulty describing feelings (TAS-DDF)	-0.130	-3.043	0.002		
Model 3				0.56	0.30
Age	-0.112	-3.466	0.001		
Chronic Illness	0.095	3.050	0.002		
Gender	-0.157	-5.080	<0.001		
Education level	-0.044	-1.343	0.180		
Externally oriented thinking (TAS-EOT)	0.003	0.087	0.931		
Difficulty identifying feelings (TAS-DIF)	0.469	10.640	<0.001		
Difficulty describing feelings (TAS-DDF)	-0.126	-2.907	0.004		
Acceptance (CERQ)	0.007	0.202	0.840		
Positive refocus (CERQ)	0.007	0.176	0.860		
Refocus on planning (CERQ)	0.057	1.277	0.202		
Positive reappraisal (CERQ)	-0.080	-1.665	0.096		
Prospective (CERQ)	-0.002	-0.052	0.958		
Self-blame (CERQ)	0.008	0.204	0.839		
Rumination (CERQ)	0.086	2.004	0.045		
Catastrophising (CERQ)	0.048	1.229	0.219		
Other-blame (CERQ)	0.054	1.609	0.108		
Model 4				0.70	0.48
Age	-0.060	-2.154	0.032		
Chronic Illness	0.090	3.333	0.001		
Gender	-0.117	-4.353	<0.001		
Education level	-0.042	-1.496	0.135		
Externally oriented thinking (TAS-EOT)	0.018	0.581	0.561		
Difficulty identifying feelings (TAS-DIF)	0.248	6.140	<0.001		
Difficulty describing feelings (TAS-DDF)	-0.133	-3.571	<0.001		
Acceptance (CERQ)	0.004	0.135	0.892		
Positive refocus (CERQ)	0.015	0.430	0.667		

Refocus on planning (CERQ)	0.025	0.664	0.507
Positive reappraisal (CERQ)	0.014	0.327	0.744
Prospective (CERQ)	-0.007	-0.205	0.837
Self-blame (CERQ)	-0.045	-1.371	0.171
Rumination (CERQ)	-0.008	-0.210	0.833
Catastrophising (CERQ)	-0.013	-0.378	0.705
Other-blame (CERQ)	0.013	0.459	0.646
Anxiety (HAD-A)	0.230	5.574	<0.001
Depression (HAD-D)	0.380	9.205	<0.001

Sequential Mediation Model

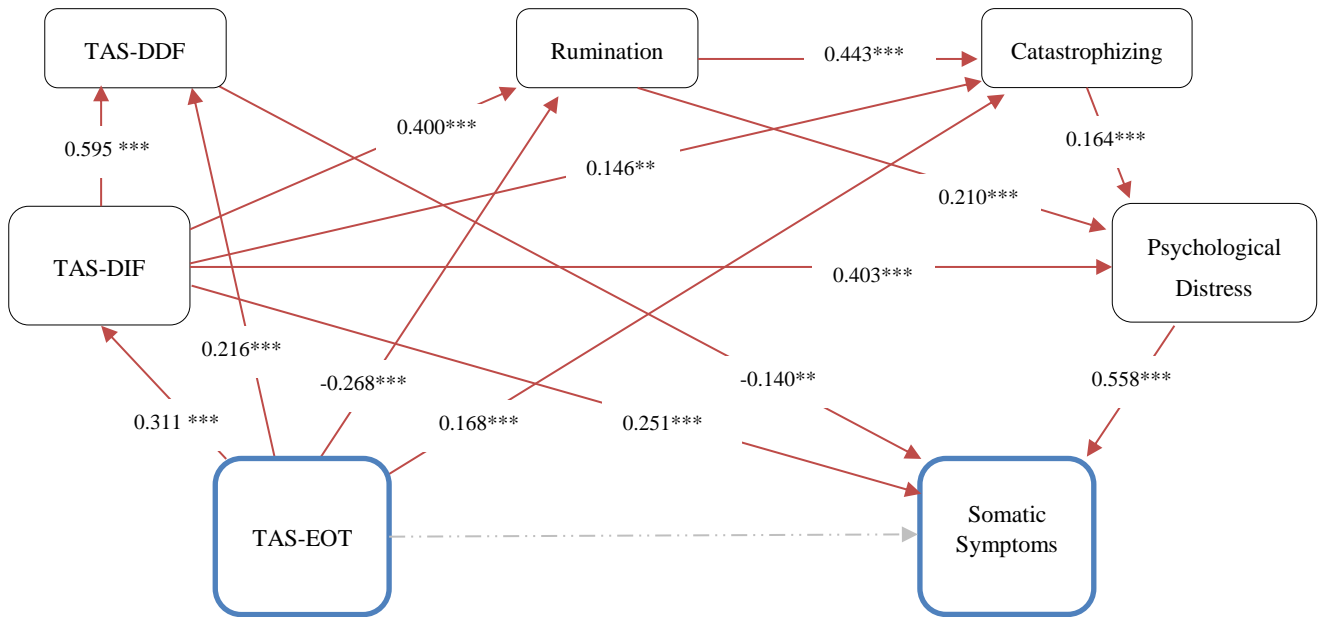
Given the correlational nature of our data, we tested our hypotheses with a multiple serial mediator regression model with the PROCESS module in R (Model 6). Serial mediation hypothesises a causal chain linking of the mediators. According to Preacher and Hayes (2008), the assessment of serial mediation models involves analysing the total, direct and all specific indirect effects. In Model 6 the independent variable (X) exerts both direct and indirect influences on the dependent variable (Y), and there are several mediators, with one mediator (M1) being a cause of the other mediator (M2). Moreover, Model 6 enables to assess the indirect impact of individual mediators while controlling for other variables. In the current study, the independent variable was TAS-EOT (X); the dependent variable was SS (Y), whilst mediators were: TAS-DIF (M1), TAS-DDF (M2), CERQ-Rumination (M3), CERQ-Catastrophising (M4) and Psychological Distress (M5). The total effect of the serial mediation model is calculated by the sums of all indirect effects plus the direct effect. A bootstrap analysis utilising 5000 bias-corrected bootstrap samples was undertaken to scrutinise the statistical significance of indirect effects.

The total effect of the full serial multiple-mediation model, accounted for 9.23% of the variance in PHQ-15 [$R^2 = 0.0923$, $F(4, 748) = 20.3612$, $p < 0.001$]. In fact, while EOT exerted its influence on SS through different indirect effects, no direct effect was noted.

As shown in Figure 10 and reported in Table 13, after accounting for gender, age and chronic illness, most of the direct effects between the EOT and other key variables in the model resulted to be significant, except for psychological distress and SS. However, the results (Table 14) showed a significant effect of EOT and SS via the mediation of both DIF ($B=0.0781$, $SE=0.0156$, 95 % CI: 0.0494 to 0.1104) and DDF ($B=-0.0304$, $SE=0.0094$, CI: -0.0502 to -0.0132), validating our first hypothesis (H1).

Figure 10

Graphical illustration of the sequential mediation analysis



Note. In red the significant effects and in dotted grey the non-significant direct effect. All value are standardized regression weights. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Rumination exhibited a notable and positive association with Catastrophising ($\beta = 0.44$; $t = 11.37$; $p < 0.001$) as well as with psychological distress ($\beta = 0.21$; $t = 6.02$; $p < 0.001$). Therefore, the second hypothesis (H2) was substantiated by the evidence, underscoring the significance of Rumination in influencing Catastrophising. However, neither regulation strategy exhibited a direct association with SS. In fact, when considering their potential role as intermediaries in the sequential path of influence from EOT, DIF, and DDF to SS, their effects consistently appeared to be mediated by psychological distress (as indicated in Table 14). Consequently, our third hypothesis, positing a direct impact of these two strategies on SS (H3), did not receive empirical support.

Table 13*Regression Results of the Mediation Analysis*

Regression		Coefficients		Model Index	
Dependent variable	Independent variable	β	t	R ²	F
TAS-DIF	TAS-EOT	0.3111	8.7809***	0.1208	28.642***
	Age	-0.1541	-4.7789***		
	Chronic Illness	0.0731	2.0859*		
	Sex	-0.0708	-2.0372*		
TAS-DDF	TAS-EOT	0.2163	7.4340***	0.4909	161.739***
	TAS-DIF	0.5959	22.5509***		
	Age	-0.0509	-1.9131*		
	Chronic Illness	-0.0288	-1.0630		
	Sex	0.0261	0.9687		
Rumination	TAS-EOT	-0.2685	-7.1029***	0.2005	33.628***
	TAS-DIF	0.4003	8.7231***		
	TAS-DDF	-0.0512	-1.0370		
	Age	-0.1667	-4.7880***		
	Chronic Illness	-0.0001	-0.0021		
	Sex	-0.0061	-0.1703		
Catastrophising	TAS-EOT	0.1681	4.3036***	0.2719	30.4397***
	TAS-DIF	0.1463	3.1283**		
	TAS-DDF	-0.0235	-0.5197		
	Rumination	0.4434	11.3732***		
	Age	-0.0176	-0.5739		
	Chronic Illness	0.0350	1.1107		
	Sex	0.0331	0.9246		
Psychological Distress	TAS-EOT	-0.0067	-0.1942	0.4247	77.0119***
	TAS-DIF	0.4036	10.2171***		
	TAS-DDF	0.0323	0.7936		
	Rumination	0.2101	6.0209***		
	Catastrophising	0.1647	4.8804***		
	Age	-0.0982	-3.4886**		
	Chronic Illness	0.0087	0.3003		
	Sex	-0.0661	-2.5452*		
Somatic Symptoms	TAS-EOT	0.0212	0.6951	0.4870	83.3649***
	TAS-DIF	0.2511	5.9157***		
	TAS-DDF	-0.1405	-3.6324**		
	Rumination	-0.0163	-0.4616		

Catastrophising	-0.0171	-0.5115
Psychological Distress	0.5580	15.0250***
Age	-0.0506	-1.8232
Chronic Illness	0.0948	3.4839**
Sex	-0.1190	-4.1428***

Note: β = Standardised coefficients.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. All variables were standardised

As illustrated in Table 14, EOT manifested its influence on SS through multiple pathways. Firstly, it exerted its impact by traversing the mediation of maladaptive emotional regulation strategies and psychological distress. Secondly, an early influence of DIF acted as a secondary mediator. Thirdly, it influenced SS through the mediation of DIF and DDF, bypassing the influence of psychological distress. Consequently, our third hypothesis, which suggested that EOT could directly affect SS via the mediation of DIF without the need for intermediary influence from psychological distress, finds empirical validation (H3).

Table 14

Total, direct, and indirect effects of externally oriented thinking on somatic symptoms via difficulty to identify feelings, difficulty to describe feelings, rumination, catastrophising, other-blame, and psychological distress (N = 793)

Path	B	SE	95 % CI
Direct effect	0.0239	0.0344	[-0.0436, 0.0914]
Total indirect effects	0.0884	0.0289	[0.0335, 0.1450]
EOT -> DIF -> SS	0.0781	0.0156	[0.0494, 0.1104]
EOT -> DDF -> SS	-0.0304	0.0094	[-0.0502, -0.0132]
EOT -> DIF -> DDF -> SS	-0.0261	0.0081	[-0.0427, -0.0112]
EOT -> Rumination -> PD -> SS	-0.0315	0.0074	[-0.0471, -0.0185]
EOT -> Catastrophising -> PD -> SS	0.0155	0.0049	[0.0071, 0.0260]
EOT -> DIF -> Rumination -> PD -> SS	0.0146	0.0037	[0.0082, 0.0227]
EOT -> DIF -> Catastrophising -> PD -> SS	0.0042	0.0017	[0.0014, 0.0080]
EOT -> Rumination -> Catastrophising -> PD -> SS	-0.0109	0.0030	[-0.0178, -0.0058]
EOT -> DIF -> Rumination -> Catastrophising -> PD -> SS	0.0051	0.0015	[0.0025, 0.0083]

Note: Bootstrap sample size = 5000. SE = standard error. CI = confidence interval. PD = psychological distress; SS = Somatic Symptoms, EOT = Externally Oriented Thinking; DIF = Difficulty to identify feelings, DDF = Difficulty to describe feelings

6.4 Discussion

The main objective of the present study was to investigate the emotional regulation determinants of SS. In fact, disturbances in emotion regulation are regarded as a fundamental element in the development and onset of SS (Koechlin et al., 2018; Okur Güney et al., 2019; Schnabel, Petzke, et al., 2022). However, as highlighted by the latest systematic review on emotion regulation processes in SS, there are numerous areas where further research is required (Schnabel, Petzke, et al., 2022).

In the domain of emotional regulation research and in the studies on alexithymia, a recurrent issue surfaces concerning the identification of emotions in patients with SS. More precisely, these investigations consistently highlight challenges related to emotional clarity and the ability to discern one's feelings, both of which have been strongly associated with somatisation (R. V. Aaron et al., 2019; Mattila et al., 2008; Schnabel, Petzke, et al., 2022). The current study reinforces these findings through various analyses, including correlation analysis, group comparisons, and hierarchical regression. Throughout these analyses, a consistent association between Difficulty Identifying Feelings (DIF), Difficulty Describing Feelings (DDF) and SS was observed.

However, while previous research has established a connection between alexithymia and SS, especially with the DIF and DDF subscales, the specific influence of the Externally Oriented Thinking (EOT) subscale within the construct of alexithymia remains unclear (R. V. Aaron et al., 2019; De Gucht & Heiser, 2003; Mattila et al., 2008). This has brought some authors to question alexithymia as a multifaceted construct and others to emit an “interoceptive hypothesis” of alexithymia, for which alexithymia would reflect a deficit in interoceptive ability involving a general confusion between bodily and affective states (Brewer et al., 2016; Gaggero et al., 2021). Indeed, EOT not only exhibits the lowest psychometric reliability among the components of the alexithymia construct but also demonstrates the weakest associations with pathological variables (Dere et al., 2012; Kooiman et al., 2002).

The present study employed a sequential mediation model to investigate the relationships between EOT and SS, using as a theoretical framework the attention-appraisal model of

alexithymia (Preece et al., 2017). This model, rooted in Gross's process model of emotion regulation (Gross, 2015a), defines EOT as the difficulty in focusing attention on one's emotional response to a stimulus, while DIF and DDF as challenges in appraising and understanding emotional responses. We hypothesised that EOT, which in original conceptualisation of the TAS corresponds to the "*pensée opératoire*" (operational thinking) observed in somatically ill patients by Marty and de M'Uzan (Marty, 1963) and was considered a major component of alexithymia by Nemiah and Sifneos (Nemiah, 1976), would have an indirect relationship with SS reporting, via the mediation of DIF and DDF.

The comprehensive sequential mediation model, encompassing EOT, DIF, DDF, Rumination, Catastrophising, Psychological distress, and PHQ-15, collectively accounted for 9.23% of the variance observed in PHQ-15 scores, highlights the complexity of the relationships among these variables and suggesting that additional unmeasured factors may contribute to the variance in somatic symptomatology. However, upon closer examination of the direct effects between EOT and other key variables, most were found to be significant after controlling for covariates, with the exception of psychological distress and SS. This might suggest that EOT dimension of alexithymia does not influence psychopathology directly but through other steps of emotion regulation processes. Indeed, within our sample, EOT did not have a direct link with SS. However, the findings did uncover a significant indirect effect of EOT on SS, mediated by both DIF and/or DDF, providing strong support for our initial hypothesis (H1).

Furthermore, following the conceptualisation contemporary theorisation of emotion regulation (Bonanno & Burton, 2013; Gross, 2015a), we have hypothesised that if alexithymia would impact mainly the antecedent-focused phase of emotion regulation (i.e., attention and appraisal), the use of relevant maladaptive emotion regulation strategies (i.e., rumination and catastrophising), would further mediate the association between EOT, DIF and DDF and psychological distress and SS. We extended our hypothesis to suggest a causal relationship between Rumination and Catastrophising, based on the understanding that the former constitutes one facet of the multifaceted construct of catastrophising, which also includes elements like magnification and feelings of helplessness (Sullivan et al., 1995). Our study yielded significant evidence of a positive association between Rumination and Catastrophising, thereby substantiating our second hypothesis. These findings emphasise the interconnectedness of maladaptive emotional regulation strategies and their contribution to psychological distress

and symptomatology. Moreover, when considering their potential roles as mediators in the sequential path from EOT, DIF, and DDF to SS, their effects consistently appeared to be mediated by psychological distress. Consequently, our third hypothesis, proposing a direct influence of these two strategies on SS (H3), did not receive empirical support. This highlights the pivotal role of psychological distress as a mediator in the relationship between emotional regulation difficulties and somatic symptomatology.

6.5 Conclusions, limitations and future directions

To our knowledge this is the first study to explore a sequential processing model associating the Externally Oriented Thinking subscale of alexithymia with emotion regulation processes and psychophysiological distress. Our study provides valuable insights into the intricate web of relationships among externally oriented thinking, emotional regulation difficulties, psychological distress, and SS. These findings underscore the importance of considering the mediating role of psychological distress in understanding the impact of emotional regulation difficulties on somatic symptomatology. The complexity of these relationships suggests the need for further research to explore additional contributing factors and potential interventions for individuals experiencing SS.

Whilst the results are encouraging, the interpretation of the study's findings necessitates careful consideration of several inherent limitations. Firstly, our study's exclusive dependence on self-reports raises concerns about potential biases and social desirability effects in the data. Especially the assessment of alexithymia which, while common, highlights the need for a more comprehensive multi-method approach, such as structured interviews advocated by Bagby et al. (2006), in future investigations. Moreover, the cross-sectional design employed in this study impedes our ability to establish causal relationships, particularly regarding the predictive impact of Externally Oriented Thinking (EOT) on the development and persistence of somatisation symptoms over time. To gain a more nuanced understanding of these dynamics, longitudinal studies or experimental methods are imperative. Lastly, the uneven gender distribution within the sample further adds complexity to the study's results, emphasising the need for more balanced and representative participant selection in future investigations.

Nevertheless, the results offer valuable insights for future studies, suggesting the potential utilisation of mixed methods or longitudinal designs, which could yield more definitive

sequencing of the variables involved. While our study serves as a starting point, offering a foundational understanding, it opens doors for further research and potential clinical applications in addressing somatic complaints. Consequently, these findings hold significance for both the assessment and treatment of SS, paving the way for improved approaches in healthcare.

KEY POINTS

- Although earlier studies have established a link between alexithymia and SS, particularly concerning the DIF and DDF subscales, the precise impact of the Externally Oriented Thinking (EOT) subscale remains uncertain.
- **The main objective of this study** was to investigate the emotional regulation determinants of SS using the lens of the attention-appraisal model of alexithymia for the antecedent-focused emotion regulation phase.
- The study tested a comprehensive multiple-mediation model, encompassing EOT, DIF, DDF, Rumination, Catastrophizing, Psychological distress, and PHQ-15, which collectively accounted for 9.23% of the variance observed in PHQ-15 scores.
- Direct effects of EOT: in the sample studied, neither EOT nor DIF exhibited a direct connection with SS, highlighting a complex relationship between these variables.
- Indirect Influence of EOT on Psychopathology: The study suggests that the EOT dimension of alexithymia might not directly impact psychopathology. Instead, it seems to influence psychopathology through other facets of emotion regulation processes. This effect was mediated by both DIF and/or DDF, supporting the initial hypothesis and underscoring the intricate interplay between these components.
- Implications for Emotion Regulation: These findings emphasize the importance of understanding the nuances of emotion regulation processes, indicating that the impact of certain dimensions of alexithymia, like EOT, might be mediated through intricate pathways involving DIF and DDF, rather than through direct connections with SS.

7. Study IV - Emotion Regulation and Alexithymia in SS and in the co-occurrence of somatic symptoms, anxiety, and depression (SSAD): a latent profile analysis

7.1 Objectives and Hypotheses

To date, a comprehensive understanding of emotion regulation processes in the context of SSAD co-occurrence is still lacking. A comparative examination of emotion regulation within SSAD has the potential to shed light on common and different vulnerability factors and provide evidence of difficulties in emotion regulation as transdiagnostic factors underlying SSAD comorbidity. The objective of the current study is to analyse the comorbidity of SSAD using a person-centred approach and to contribute to the development of integrated models encompassing emotional disorders and their coexisting conditions.

We formulated three exploratory hypotheses for the current study, as detailed below:

H1: Symptom Severity Profiles in SSAD comorbidity: The study hypothesises the existence of at least a three-class solution based on symptom severity within individuals experiencing SSAD.

H2: As previous research has shown that generalised anxiety can occur alongside depression, but it can also appear as a distinct set of symptoms (anxiety without depression), we hypothesise the existence of a specific profile primarily characterised by anxiety without concurrent depression.

H3: Alexithymia and Symptom Severity in SSAD: The study posits that the Difficulty in Identifying Feelings (DIF) subscale of alexithymia would be specifically linked to symptom severity in SSAD, showing a linear escalation. However, the Externally Oriented Thinking (EOT) and Difficulties Describing Feelings (DDF) subscales are not expected to be significant predictors of SSAD symptom severity.

Finally, no specific hypotheses were formulated in regards to specific differences in emotion regulation strategies across SSAD symptom severity profiles.

7.2 Materials and Methods

Section 4.2.2 (Chapter 4, p.75) presents a full description of the sample and of the measurements used in this study.

7.2.1 Participants and Procedure

The study includes data from 829 subjects from Italy and France who responded to an online survey on the impact of Covid-19 on emotions and physical health, advertised on social networks from November 24 2020 to January 29 2021. Of the sample 68.6% ($n = 569$) lived in France and 31.3% ($n = 260$) in Italy. Participants ranged in age from 18 to 89 ($M = 39.2$ years, $SD = 14.4$) with 85.2% identifying as female, 14.1% as male and 0.6% as neither female nor male.

7.2.2 Measures

The study employed established measures to assess various psychological factors. Somatic symptoms were evaluated using the Patient Health Questionnaire (PHQ-15; Kroenke et al., 2002). The total PHQ-15 score ranges from 0 to 30, with proposed cut-off points of 5, 10, and 15, indicating mild, moderate, and severe somatic symptom severity, respectively (Kroenke et al., 2002). Depressive symptoms were measured through the Patient Health Questionnaire-8 (PHQ-8; Kroenke et al., 2009). Anxiety symptoms were assessed using the Generalized Anxiety Disorder 7-item Scale (GAD-7; Spitzer et al., 2006). The cut-off score of ≥ 10 was used to identify a moderate level of depressive and anxiety symptoms (Kroenke et al., 2009, 2010). Alexithymia was measured using the Toronto Alexithymia Scale (TAS-20), encompassing Difficulty Identifying Feeling (DIF), Difficulty Describing Feelings (DDF), and Externally Oriented Thinking (EOT) dimensions. Cognitive emotion regulation strategies were evaluated through the Cognitive Emotion Regulation Questionnaire (CERQ; Garnefski et al., 2001).

7.2.3 Statistical Analyses

Analyses were performed using R version 3.0 (Team, 2013). Multiple imputation by chained equations (MICE), using an incremental tree-based missing data multiple imputation for LPA variables (Waldman, 2019, 2020) and a predictive mean matching for other variable,

has been performed on the 4.8% of data, representing missing values in the mandatory questions of the survey. Descriptive statistics were used to describe the sociodemographic characteristics of the respondents and included analyses of prevalence. To determine prevalence rates, a cut-off score of ≥ 10 was used on the PHQ-15, the PHQ-8 and the GAD-7, because the range of ≥ 10 reflects medium and high symptom severity. Non-parametric Spearman's rank correlation coefficient (*rho*) was used to assess the association between SS, age, generalised anxiety, depression, alexithymia and emotion regulation (adaptive and maladaptive). Latent profile analyses (LPA) were used to identify comorbidity classes based on the co-occurrence of SSAD. To avoid possible bias to the results of LPA, multivariate outliers were detected using the Mahalanobis distance based on the minimum covariance determinant (Leys et al., 2018), which is a procedure recommended before using cluster analytic techniques (Spurk et al., 2020). The final sample obtained included data of 827 participants.

To identify the optimal LPA model with an adequate number of latent profiles/classes, the first step was to determine the number of profiles based on the total scores of SS (PHQ-15), anxiety (GAD-7) and depression (PHQ-8). Table 16 shows the fit coefficients for a series of LPA models with up to 8 profiles. In addition to the substantive significance and theoretical conformity of the class profiles, we run an Analytic Hierarchy Process (AHP), including various test and model fit indices: 1) Akaike Information Criteria (AIC), Approximate Weight of Evidence (AWE), Bayesian Information Criterion (BIC), Classification Likelihood Criterion (CLC) and Kullback Information Criterion (KIC) (Akogul & Erisoglu, 2017). After determining the optimal number of the latent profiles and profile membership probabilities of the participants, various characteristics of the latent profiles were investigated and the latent profiles were labelled according to common characteristics of members.

In the second step, differences across latent profiles were examined using the one-way analysis of variance (ANOVA). The third step included multinomial regression analysis in which subscales of alexithymia and cognitive emotion regulation strategies (CERQ) were regressed on posterior profile membership probabilities. An analysis of variance (ANOVA) was conducted to compare the two multinomial models, namely Model 1 (including TAS-DIF, TAS-DDF, and TAS-EOT) and Model 2 (including additional CERQ strategies), using likelihood ratio tests. The analysis aimed to assess the likelihood ratio between the two models in terms of explaining the variation in the data.

7.3 Results

7.3.1 Study Variables' Descriptive Statistics

On average, participants were 39.2 ($SD = 14.4$, range = 18-89) years old, and the majority were female (85.2%). In the sample 14 % self-reported the presence of psychological problems and 22.2% declared having a chronic illness. By using the cut-off scores described above, the total prevalence of persistent SS at a moderate to severe level (≥ 10) was estimated to be 51.0%, while the prevalence of depression and anxiety were 41.1% and 37.2% respectively. Depression and anxiety were comorbid in 27.7% of the population, and 23.1% presented a moderate to high co-occurrence of SSAD (Table 17).

Correlations among study variables across the sample are shown in Table 15.

Table 15

Associations between SSAD study variables

	Age	1	2	3	4	5	6	7
1. PHQ-15	-0.170 (<i><.001</i>)							
2. PHQ-8	-0.200 (<i><.001</i>)	0.636 (<i><.001</i>)						
3. GAD-7	-0.218 (<i><.001</i>)	0.585 (<i><.001</i>)	0.743 (<i><.001</i>)					
4. TAS-DIF	-0.147 (<i><.001</i>)	0.484 (<i><.001</i>)	0.558 (<i><.001</i>)	0.513 (<i><.001</i>)				
5. TAS-DDF	-0.147 (<i><.001</i>)	0.242 (<i><.001</i>)	0.374 (<i><.001</i>)	0.329 (<i><.001</i>)	0.662 (<i><.001</i>)			
6. TAS-EOT	0.020 (.574)	0.060 (.085)	0.119 (.001)	0.110 (.001)	0.306 (<i><.001</i>)	0.397 (<i><.001</i>)		
7. CERQ Adaptive	0.003 (.922)	-0.091 (.009)	-0.191 (<i><.001</i>)	-0.141 (<i><.001</i>)	-0.188 (<i><.001</i>)	-0.192 (<i><.001</i>)	-0.244 (<i><.001</i>)	
8. CERQ Maladaptive	-0.239 (<i><.001</i>)	0.353 (<i><.001</i>)	0.471 (<i><.001</i>)	0.493 (<i><.001</i>)	0.372 (<i><.001</i>)	0.235 (<i><.001</i>)	-0.025 (.475)	0.038 (.281)

Note: Computed correlation used spearman-method with list wise-deletion.

As expected, large significant associations were found between SS, depression and anxiety ($r_{ho} \geq .58$). DIF and DDF showed stronger positive associations with depression and

anxiety than with SS. The same pattern was showed by maladaptive CERQ strategies. Moreover, a correlation was found between maladaptive CERQ and DIF ($\rho(825) = 0.37, p < 0.001$) and DDF ($\rho(825) = 0.27, p < 0.001$). However, there was no significant correlation between maladaptive CERQ and EOT.

7.3.2 Identification and Description of the Best-Fitting Latent Class

Table 16 presents the diagnostic test results and fit values of the latent mixture models that hypothesise one to eight classes. The correct class assignment probabilities for the 5-class model were good, suggesting a good discriminability and a reliable result of LPA with the 5-class model. Moreover, the 5-class model showed good entropy. Therefore, five classes were identified that best represented the profiles of comorbid SS, depression and anxiety in this sample.

Figure 11 illustrates the profiles of subtypes of SSAD co-occurrence for the 5-class model, in which the Y-axis shows the score of symptom severity, and the X-axis represents the three different questionnaires of SS, anxiety and depression used for LPA.

Table 16

Fit indices of the latent profile models

No. of profiles	LL	SABIC	BLRT(p)	AIC	BIC	Entropy
1	-3518.88	7059.02	-	7049.77	7084.07	1
2	-3085.53	6206.48	866.70 (p < .001)	6191.06	6238.24	0.818
3	-2958.13	5917.86	254.78 (p < .001)	5944.27	6010.32	0.792
4	-2911.30	5886.37	93.65 (p < .001)	5858.61	5943.53	0.751
5	-2863.50	5804.93	95.61 (p < .001)	5771.00	5874.79	0.788
6	-2844.69	5781.47	37.62 (p < .001)	5741.38	5864.04	0.780
7	-2833.36	5773.00	22.64 (p < .001)	5726.73	5868.27	0.793
8	-2820.67	5761.78	25.39 (p < .001)	5709.34	5869.75	0.793

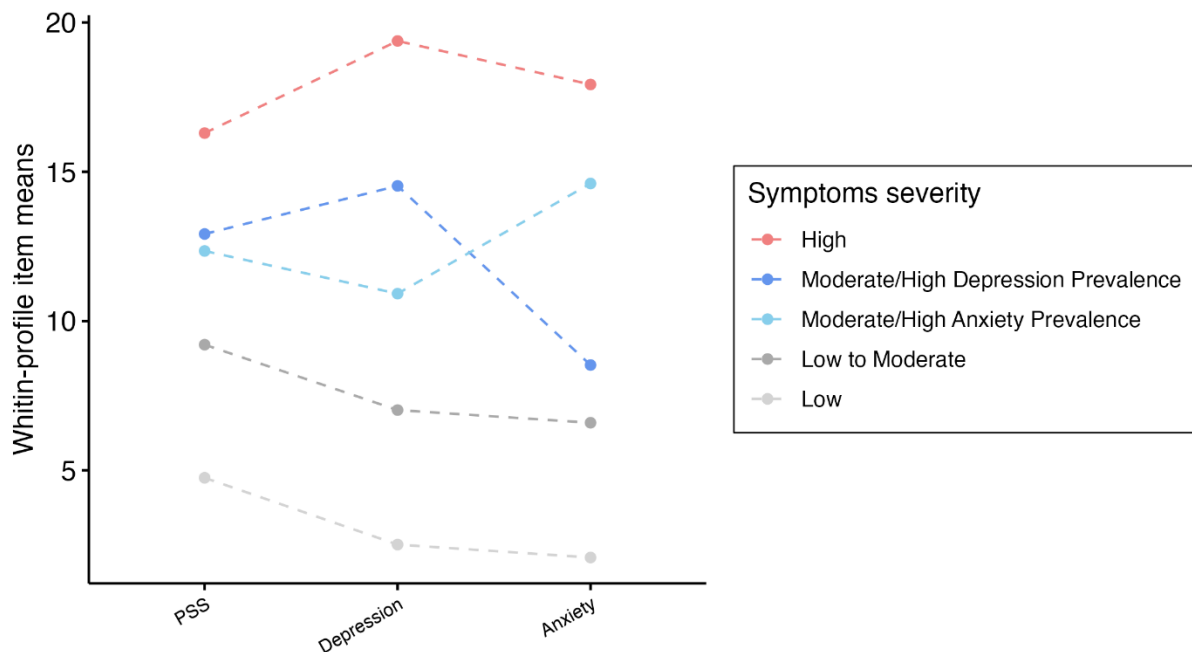
Note: AIC is Akaike Information Criterion; BIC is Bayesian Information Criterion; SSABIC is Sample-Size Adjusted BIC; BLRT is Bootstrapped Likelihood Ratio Test. Bolded rows indicate the optimal model.

Participants from class-1 (n = 173, 20.88%) were characterised by the lowest scores of anxiety and depression and by scores of SS there were close to the ≥ 5 cut-off score used to identify a low level of somatisation ($M = 4.75, SD = 3.01$). Thus, the 1-class model was labelled as the “Low Symptoms Severity Group” (L). Instead, the 2-class model (n = 306, 36.99%), was labelled “Low to Moderate Symptom Severity” (LM) as it showed a similar pattern of the first: lower levels of anxiety and depression and higher level of SS, which were close ($M = 9.21, SD$

= 3.73) to the cut-off of ≥ 10 used to identify moderate and clinically relevant scores of somatisation. The 3-class and 4-class model, which were respectively names “Moderate to High Symptoms Severity with Anxiety Prevalence” (MHA: $n = 135$, 16.33%) and “Moderate to High Symptoms Severity with Depression Prevalence” (MHD: $n = 108$, 13.04%), showed an inverted pattern. In fact, both profiles had a similar level of SS (Depression Prevalence: $M = 12.9$, $SD = 3.94$, Anxiety Prevalence: $M = 12.3$, $SD = 4.01$) but presented opposite scores of anxiety and depression. Finally, the 5th class, “High Symptom Severity” (H) presented clinically relevant levels of SS ($M = 16.3$, $SD = 4.73$), anxiety ($M = 19.4$, $SD = 2.72$) and depression ($M = 17.9$, $SD = 2.31$).

Figure 11

Latent profile analysis (LPA) for SSAD co-occurrence



7.3.3 Class Comparisons

Table 17 provides the results of class comparisons of the theoretically meaningful and comorbidity-related variables. There existed a notable age disparity among the groups ($F(822) = 15.87$, $p < 0.001$), indicating that individuals in the L group were older than those in the H group. Also, a significant association with gender was found ($F(822) = 5.86$, $p < 0.01$) with higher proportions of females in groups L compared to the MHA, MHD and H group. Significant

differences were observed in the monthly personal income ($F(805)= 4.738, p < 0.001$) with people in the L group reporting the highest income of all groups.

Regarding psychological variables, most of differences between groups showed statistic significance, except for the adaptive cognitive emotion regulation strategies acceptance and refocus on planning. However, adaptive emotion regulation strategies demonstrate minimal to small but significant impact (η^2 ranging between 0.0043 and 0.05) on group difference (CERQ Adaptive: $F(822)= 5.672, \eta^2 = 0.03, p < 0.001$). In contrast, maladaptive emotion regulation strategies consistently show significant differences, indicating a substantial impact on individuals across different symptom severity groups (CERQ Maladaptive: $F(822) = 69.1, \eta^2 = 0.25, p < 0.001$), indicating differences across groups. Specifically, self-blame showed a linear increase between symptom severity groups with individuals in the H group exhibiting the highest mean score ($M = 11.5, SD = 4.29$), indicating a prevalent tendency to blame themselves in distressing situations compared with non-clinical symptoms severity groups. Interestingly, the MHA group had significant higher levels of Rumination ($M = 14.3, SD = 3.63$) compared to the MHD group ($p = 0.007$), highlighting a persistent pattern of dwelling on repetitive negative thinking. Catastrophising and other-blame tendencies were notably prominent in the H group, as evidenced by their mean score of 8.19, indicating a propensity to magnify possible outcomes. Additionally, individuals in the same group exhibited the highest mean score (Catastrophising: $M = 9.80, SD = 3.72$; Other-blame: $M = 9.02, SD = 3.86$).

Table 17. Descriptive statistics and class comparisons

	Low (L) (N= 173)	Low to Moderate (LM) (N= 306)	Moderate/High Anxiety Prevalence (MHA) (N= 135)	Moderate/High Depression Prevalence (MHD) (N= 108)	High (H) (N= 105)	Total (N= 827)	F	η ²	Post hoc test (Tukey)
Age									
Mean (SD)	46.2 (15.2)	38.6 (14.1)	35.8 (12.4)	38.4 (14.0)	34.8 (12.7)	39.2 (14.4)	15.87 ***	0.07	L>H; L>MHD; L>MHA; L>LM
Median [Min, Max]	44.0 [21.0, 89.0]	36.0 [18.0, 73.0]	34.0 [18.0, 70.0]	36.0 [18.0, 75.0]	34.0 [18.0, 69.0]	37.0 [18.0, 89.0]			
Gender									
Female	136 (78.6%)	252 (82.4%)	127 (94.1%)	96 (88.9%)	95 (90.5%)	706 (85.4%)	5.866***	0.02	L>MHD; L>MHA; L>H;
Male	37 (21.4%)	52 (17.0%)	8 (5.9%)	9 (8.3%)	10 (9.5%)	116 (14.0%)			LM>MHA; LM>MHD
Other	0 (0%)	2 (0.7%)	0 (0%)	3 (2.8%)	0 (0%)	5 (0.6%)			
Monthly personal income									
Mean (SD)	2030 (1310)	1630 (1510)	1540 (1510)	1710 (1520)	1300 (1210)	1660 (1450)	9.15***	0.04	L>H ; L>MHA; L> LM
Median [Min, Max]	2000 [0, 8000]	1500 [0, 12000]	1450 [0, 8900]	1600 [0, 8000]	1050 [0, 6000]	1570 [0, 12000]			
Psychological problems	11 (6.4%)	29 (9.5%)	26 (19.3%)	23 (21.3%)	27 (25.7%)	116 (14.0%)	4.71***	0.04	H>L; MHA>L; MHD>L; LM>L;
Chronic Illness	34 (19.7%)	73 (23.9%)	17 (12.6%)	32 (29.6%)	28 (26.7%)	184 (22.2%)	3.22 *	0.01	LM>MHA; LM>MHD; H<LM
PHQ-15	4.75 (3.01)	9.21 (3.73)	12.3 (4.01)	12.9 (3.94)	16.3 (4.73)	10.2 (5.24)	185***	0.47	MHD>MHA
PHQ-8	2.51 (1.74)	7.02 (2.28)	10.9 (2.36)	14.5 (2.21)	19.4 (2.72)	9.26 (5.79)	1166***	0.85	All except MHA-MHD
GAD-7	2.08 (1.72)	6.59 (2.50)	14.6 (2.62)	8.53 (2.37)	17.9 (2.31)	8.65 (5.73)	1031***	0.83	All
SSAD	0 (0%)	35 (32.4%)	74 (54.8%)	97 (92.4%)	0 (0%)	206 (24.9%)	287.5***	0.58	All
TAS-TOT	41.4 (11.2)	48.8 (12.1)	54.2 (12.1)	55.8 (11.5)	61.3 (12.6)	50.6 (13.4)	56.7***	0.22	All except MHA-MHD
TAS-DIF	13.1 (5.06)	17.9 (5.85)	21.5 (6.34)	21.8 (5.51)	25.5 (5.79)	18.9 (6.92)	95.66***	0.32	All except MHA-MHD
TAS-DDF	11.4 (4.58)	13.4 (4.75)	15.1 (4.80)	15.5 (4.84)	17.0 (5.07)	14.0 (5.09)	28.66***	0.12	All except MHA-MHD and MHD - H
TAS-EOT	16.9 (4.56)	17.5 (4.65)	17.6 (4.48)	18.5 (4.40)	18.8 (4.70)	17.7 (4.61)	3.664*	0.02	H>L
CERQ Adaptive Acceptance	63.9 (14.8)	61.2 (13.7)	60.7 (14.1)	60.5 (13.4)	55.7 (14.4)	60.9 (14.2)	5.672***	0.03	L>H; LM>H; MHA>H
	12.5 (3.58)	12.6 (3.30)	12.9 (3.42)	13.2 (3.14)	12.7 (3.36)	12.7 (3.37)	0.93	0.004	-
Positive refocusing	11.0 (4.07)	9.92 (3.63)	9.64 (3.94)	9.32 (3.69)	8.64 (3.65)	9.85 (3.84)	7.169***	0.03	L>H; L>LM; L>MHA; L>MHD;
Refocus on planning	13.0 (3.82)	13.0 (3.58)	13.4 (3.60)	13.0 (3.70)	12.2 (4.09)	13.0 (3.73)	1.604	0.007	LM>H
Positive appraisal	13.7 (3.83)	12.6 (3.91)	12.2 (3.91)	11.9 (3.90)	10.5 (4.22)	12.4 (4.03)	11.89***	0.05	-
Prospective	13.7 (3.83)	13.1 (3.82)	12.5 (3.59)	13.1 (3.65)	11.6 (3.80)	12.4 (4.03)	5.674***	0.03	L>H; L>LM; L>MHA; L>MHD;
CERQ Maladaptive	29.6 (7.48)	35.4 (8.93)	42.6 (9.90)	39.2 (8.17)	45.1 (10.3)	37.1 (10.3)	69.1***	0.25	MHA>H
Self-blame	7.44 (2.52)	9.00 (3.17)	10.7 (3.88)	10.3 (3.48)	11.5 (4.29)	9.43 (3.63)	32.47***	0.14	All except MHA-H, MHD-H, MHA-MHD
Rumination	9.71 (3.54)	11.6 (3.71)	14.3 (3.63)	12.8 (3.46)	14.8 (3.26)	12.2 (3.97)	49.34***	0.19	All except MHA-H
Catastrophising	5.88 (2.07)	7.25 (2.90)	8.87 (3.40)	8.19 (3.33)	9.80 (3.72)	7.67 (3.26)	35.83***	0.15	All except MHA-H and MHA-MHD
Other blame	6.57 (2.33)	7.50 (2.72)	8.70 (3.78)	8.01 (2.97)	9.02 (3.86)	7.76 (3.14)	15.04***	0.07	H>L; LM>L; MHA>L; MHD>L;
									H>LM; MHA>LM

L = Low, LM =Low to Moderate, MHA = Moderate/High Anxiety prevalence, MHD = Moderate/High Depression prevalence, H = High. *p < 0.05; **p < 0.01; ***p < 0.001

7.3.4 Multinomial regressions and comparisons

Two multinomial comparison models (Table 18) were constructed to explore different patterns of emotion regulation between different profiles using likelihood ratio tests. The first model examined the impact of TAS subscales (including TAS-DIF, TAS-DDF, and TAS-EOT) on different profiles. The second model extended the analysis by incorporating additional emotional regulation strategies (Acceptance, Positive Refocus, Refocusing on Planning, Positive Reappraisal, Prospective, Self-blame, Rumination, Catastrophising, and Other-blame) into the study. The number of residual degrees of freedom for Model 1 was 3292, and the corresponding residual deviance was 2193.761. For Model 2, the number of residual degrees of freedom was reduced to 3256, and the residual deviance was 2013.588. The likelihood ratio test was used to compare the goodness of fit between the two models. The test statistic was calculated as 180.1725 with 36 degrees of freedom. The associated p-value was found to be extremely low ($p < 0.001$), indicating strong evidence against the null hypothesis of no difference in the models.

Table 18

Multinomial regression models predicting Profile membership (standardised coefficients with Low Symptoms Severity being the reference group)

Dependent Variable	Low to Moderate	Moderate/High Anxiety Prevalence	Moderate/High Depression Prevalence	High
Model 1				
TAS-DIF	1.174***	1.921***	1.894***	2.777***
TAS-DDF	-0.073	-0.074	-0.044	-0.130
TAS-EOT	-0.128	-0.334**	-0.143	-0.228
Constant	1.151*** (0.136)	0.248 (0.155)	0.014 (0.163)	-0.569*** (0.202)
Akaike Inf. Crit.	2,225.761	2,225.761	2,225.761	2,225.761
Model 2				
TAS-DIF	1.025***	1.682***	1.705***	2.515***
TAS-DDF	-0.101	-0.143	-0.125	-0.246
TAS-EOT	-0.063	-0.117	0.004	-0.114
Acceptance	0.033	-0.056	0.218	0.050
Positive refocusing	-0.187	-0.135	-0.300*	-0.120
Refocus on planning	0.199	0.335	0.405*	0.292
Positive reappraisal	-0.336*	-0.530**	-0.717***	-1.036***
Prospective	0.094	0.018	0.253	0.063

Self-blame	0.282*	0.453**	0.496***	0.557***
Rumination	0.225	0.858***	0.313	0.959***
Catastrophising	0.435**	0.525***	0.540**	0.560**
Other-blame	0.127	0.328*	0.215	0.378**
Constant	1.519***	0.447**	0.334*	-0.590**
Akaike Inf. Crit.	2,117.588	2,117.588	2,117.588	2,117.588

Overall, the likelihood ratio test results suggest that Model 2, which includes additional variables related to emotion regulation strategies (CERQ), provides a significantly better fit to the data compared to Model 1, which includes only TAS-DIF, TAS-DDF, and TAS-EOT variables. This implies that the inclusion of the CERQ variables enhances the explanatory power of the model in predicting profile membership.

In both models, the DIF subscale of alexithymia emerged as a noteworthy predictor of class membership, displaying a consistent linear progression across the severity levels of SSAD comorbidity. Specifically, as the severity of SSAD comorbidity increased, the coefficients for DIF escalated, indicating a stronger association with higher levels of comorbidity. Notably, in the initial model, the MHA group demonstrated a significantly elevated DIF score compared to the MHD group ($\beta = 1.921, p < 0.001$). However, with the integration of CERQ strategies in Model 2, the dynamics changed and the two groups showed similar levels of DIF. Also, the first model indicated significantly lower levels of EOT in the MHA group. However, this effect dissipated in Model 2, revealing the complexity of how emotion regulation strategies interplay with different manifestations of SSAD comorbidity.

In Model 2, which integrated both alexithymia and emotion regulation strategies, several strategies exhibited significant effects. Positive reappraisal exhibited a uniform reduction in intensity in alignment with the severity levels of SSAD comorbidity. In contrast, self-blame and catastrophising displayed an escalation in intensity corresponding to the severity levels of SSAD comorbidity. Interestingly, Rumination and Other-blame predicted the membership in only MHA and H groups of SSAD symptom severity.

7.4 Discussion

This study comprehensively explored the intricate relationship between SSAD and their comorbidity, shedding light on the nuanced interplay that alexithymia, and emotion regulation

strategies can have on the severity of these symptoms. To our best knowledge this is the first study exploring emotion regulation processes in SSAD comorbidity using a person centred-approach.

The study proposed hypotheses to understand SSAD comorbidity, anticipating the presence of at least a three-class solution based on symptom severity and the existence of a unique anxiety-focused profile. Moreover, we predicted a linear link between the DIF subscale of alexithymia and SSAD symptom severity. However, the study deliberately refrained from speculating upon variations in cognitive emotion regulation strategies among different symptom severity profiles as certain strategies like self-blame, rumination, and catastrophising are commonly associated with these conditions (Garnefski et al., 2017; Garnefski & Kraaij, 2007; Joormann & Quinn, 2014; R. C. Martin & Dahlen, 2005; Omran, 2011; Schnabel, Petzke, et al., 2022).

In contrast to prior studies that identified a 3-class solution in SSAD symptom severity (Jongedijk et al., 2020; Kim et al., 2022), our Latent Profile Analysis (LPA) unveiled five distinct comorbidity profiles, each characterised by a distinct combination of symptoms. This outcome underscores the complexity of SSAD symptomatology. However, while our hypothesis was based on the expectation of a minimum three-class solution, the presence of five distinct profiles emphasises the need for a more comprehensive understanding of SSAD and its varied manifestations (H1).

Profiles in the current study ranged from the "Low Symptoms Severity Group" (L) characterised by minimal symptom severity in the co-occurrence of SSAD to the "High Symptom Severity" (H) group, marked by clinically relevant high levels of SSAD. The "Low to Moderate Symptom Severity" (LM) profile exhibited low levels of anxiety and depression along with SS just below the threshold of ≥ 10 , indicating subclinical levels close to the moderate and clinically significant somatisation score. The upper-intermediate profiles (Moderate to High Symptoms Severity with Anxiety Prevalence and Moderate to High Symptoms Severity with Depression Prevalence) illuminated the complexity of SSAD comorbidity, showcasing diverse patterns of symptom presentation. The presence of the MHA profile, characterised by clinically high levels of anxiety and lower depression, partially validated our second hypothesis about the existence of a unique profile primarily characterised by anxiety without concurrent depression (H2). In fact, in the MHA profile levels of the depression were still above the ≥ 10 cut-off, indicating moderate but clinically relevant

depression. Unexpectedly, the LPA analysis also showed the presence of the MHD group, presenting moderate to high levels of depression, but with anxiety levels lower than the ≥ 10 cut-off of clinically relevant anxiety. These results align with previous research on the comorbidity between depression and anxiety, finding two stable and qualitatively distinct clusters of depression: one characterised by severe anxiety and another displaying little to no anxiety (Maes et al., 2010). Notably, individuals in the MHD group displayed a higher prevalence of chronic illnesses, while those in the MHA group exhibited notable distinctions in ER. Specifically, the utilisation of maladaptive cognitive emotion regulation strategies was more pronounced in the group characterised by higher levels of anxiety than depression. Within this group, rumination and other-blame emerged as significant predictors of MHA membership.

As expected, alexithymia as a tridimensional construct, exhibited a linear increase with higher SSAD symptom severity, showing the highest scores. Group differences indicated significant increases in Difficulty in Identifying Feelings (DIF) and Difficulty Describing Feelings (DDF) between the low, low to moderate, and high symptom severity groups, with DIF also being a strong predictor of worse class membership than the lower SSAD symptom severity group. However, MHA and MHD did not show any group differences in terms of alexithymia subscales. Additionally, variations in Externally Oriented Thinking (EOT) reached significance solely when comparing individuals in the highest symptom severity group with those in the lowest, indicating that elevated EOT levels correlate with more severe symptomatology. Furthermore, the initial regression model revealed significantly lower EOT levels in MHA, suggesting that individuals with moderate to high SSAD comorbidity, predominantly characterised by anxiety, might exhibit heightened self-focus compared to others. However, with the inclusion of CERQ maladaptive strategies in this group, the influence of EOT dissipated, highlighting the intricate interplay between the perception and appraisal of emotions and the selection of regulatory strategies in shaping symptom profiles.

While we deliberately avoided making specific hypotheses about emotion regulation strategies across symptom severity profiles in SSAD, intriguing patterns did emerge. Consistent with existing literature, difficulties in identifying feelings, diminished positive reappraisal, and a higher tendency to employ maladaptive emotion regulation strategies were observed in the higher SSAD comorbidity group (Martínez et al., 2015; Schnabel, Petzke, et al., 2022). Adaptive cognitive emotion regulation strategies demonstrated minimal impact on group differences. In contrast, maladaptive strategies, particularly self-blame, rumination,

catastrophising, and other-blame, significantly intensified with symptom severity, indicating their detrimental influence. These findings echo existing literature, emphasising the importance of targeting maladaptive emotion regulation strategies in clinical interventions. Furthermore, results also uncovered distinct patterns associated with the prevalence of depression and anxiety within the moderate to high symptom severity groups. Specifically, the CERQ strategies predictive of membership in the depression prevalence group were more inclined towards refocusing on planning, self-blame, and catastrophising, and less towards positive reappraisal and positive refocusing. Conversely, the CERQ strategies associated with anxiety prevalence featured diminished positive reappraisal and a heightened use of all maladaptive CERQ strategies. This nuanced distinction suggests that ruminative thinking and other-blame might be more specific markers of anxiety prevalence rather than depression, shedding light on the intricate nuances within these symptom profiles.

A final interesting finding worth discussing is the impact of two important sociodemographic variables in our results: age and gender. In fact, demographic factors played a significant role in shaping these profiles. Age disparities indicated that older individuals were more likely to belong to the lower severity groups, suggesting a potential age-related resilience or coping mechanism. However, research examining the evolution of somatic symptom reporting in various populations demonstrated a consistent association between SS and higher age (Beutel et al., 2020; Garrusi et al., 2019) and some authors hypothesised that depressive symptoms might tend to shift with age from being predominantly mood-related to being more somatic/vegetative, making the recognition of late-life depression challenging, as individual may exhibit less mood and motivational symptoms compared with younger old persons (Schaakxs et al., 2017; Hegeman et al., 2015). Our study challenges this vision and aligns with studying suggesting that older individuals might cope better with SS and related psychological distress than younger individuals (Hilderink et al., 2015). Furthermore, gender differences were noted. While female gender has consistently being associated with worst mental health, in our sample there were higher proportions of females in the lower severity groups, possibly reflecting gender-specific influences. Interestingly, income disparities further underscored the multifaceted nature of SSAD, hinting at socioeconomic influences on symptom severity.

The multinomial regression models delved deeper into the predictors of comorbidity profiles. The inclusion of alexithymia subscales and additional emotion regulation strategies enhanced the model's explanatory power. The DIF subscale of alexithymia emerged as a

consistent predictor, displaying a linear progression across SSAD comorbidity severity. Notably, the integration of emotion regulation strategies in Model 2 revealed intricate dynamics. Positive reappraisal exhibited a uniform decrease in intensity, signifying its potential protective effect. Conversely, self-blame and catastrophising escalated in intensity with increasing symptom severity, underscoring their detrimental impact on emotional well-being. Remarkably, rumination and other-blame specifically predicted membership in certain severity groups, highlighting their nuanced role in symptom exacerbation.

7.1 Conclusions, limitations and future directions

The present study utilised a person-centred approach to extend research on the interconnections among coexisting SSAD, highlighting the roles of alexithymia and emotion regulation strategies in the interplay between their comorbidity. Unlike prior research, our analysis uncovered five distinct comorbidity profiles, emphasising the complexity of SSAD symptomatology. These profiles ranged from minimal symptom severity to clinically significant levels, revealing varied manifestations of SSAD. Notably, the study identified unique profiles characterised primarily by anxiety or depression, highlighting the subtle differences within these conditions. Alexithymia, particularly the Difficulty in Identifying Feelings (DIF) subscale, exhibited a linear relationship with symptom severity, with higher scores correlating with greater SSAD severity. Emotion regulation strategies played a significant role, with maladaptive strategies like self-blame and catastrophising intensifying with symptom severity. Additionally, sociodemographic factors, such as age and gender, influenced these profiles, challenging conventional beliefs about age-related SS and revealing gender-specific patterns. While the outcomes contribute to the existing literature concerning challenges in emotional regulation in SSAD comorbidity, it is crucial to interpret the findings considering the inherent limitations. These limitations encompass the utilisation of a cross-sectional design, dependence on self-reported measures, and the examination of a specific sample comprising mainly women. The findings underscore the multifaceted nature of SSAD and emphasise the importance of tailored interventions addressing both symptom severity and specific strategies to improve outcomes for individuals with SSAD comorbidity. The findings emphasise the need for personalised interventions targeting specific emotion regulation mechanisms tailored to the individual's symptom profile. This nuanced approach can

significantly improve the efficacy of therapeutic strategies, leading to more tailored and effective treatments for individuals grappling with the challenges of SSAD comorbidity.

KEY POINTS

- **The objective of this study** was to investigate the intricate relationship between somatic symptoms, anxiety, and depression (SSAD) and their comorbidity, shedding light on how alexithymia and emotion regulation strategies influence the severity of these symptoms.
- We used a person-centered approach, and through a Latent Profile Analysis, identified five distinct comorbidity profiles, ranging from minimal symptom severity to clinically significant levels.
- Two profile exhibited in the moderate to high symptom severity range, exhibited similar somatic symptoms but contrasting anxiety and depression scores.
- **Role of Alexithymia:** The study reveals a linear relationship between alexithymia, particularly the Difficulty in Identifying Feelings (DIF) subscale, and SSAD symptom severity. Higher alexithymia scores correlate with greater SSAD severity.
- **Emotion Regulation Strategies:** Maladaptive strategies like self-blame and catastrophizing intensify with symptom severity.
- Age and gender play significant roles in shaping symptom profiles. Older individuals tend to belong to lower severity groups, challenging conventional beliefs about age-related somatic symptoms

PART II

Questioning the pertinence of Mindfulness for Somatic Symptoms

8. The Therapeutic effects of Mindfulness in Alleviating Somatic Symptoms

8.1 Management and Treatment of Somatic Symptoms

While many SS naturally fluctuate, a quarter of individuals develop persistent symptoms that follow a chronic course (Kroenke, 2014; olde Hartman et al., 2009). Prognosis is influenced by factors like fewer symptoms, early psychological interventions, and better baseline functioning (Berezowski et al., 2022; Creed & Barsky, 2004; olde Hartman et al., 2009). However, targeting SS at an early stage poses significant challenges due to complexities in identification, compounded by the fact that SS often present comorbidities with conditions such as depression and anxiety (see Chapter 2, section 2.3), leading to high healthcare costs (Konopka et al., 2013; Wortman et al., 2018), fragmented treatments and disjointed healthcare experiences (L. Aaron, 2001).

Treatment options include the use of pharmaceutical treatments as well as psychological interventions such as cognitive-behavioural therapy, hypnotherapy, and mindfulness. Also the use of St. John's wort, a botanical plant often prescribed for the treatment of depression, has demonstrated both effectiveness over placebo and safety in treating SSD (Kurlansik & Maffei, 2016; Linde et al., 2005). Pharmaceutical interventions frequently involve the early use of opioids upon the onset of symptoms. However, existing literature suggests that these medications offer only temporary relief, rather than long-term benefits for chronic conditions (Braunstein et al., 2017; Ibeziako et al., 2021; Martell et al., 2007). Pharmaceutical treatment for persistent SS with tricyclic antidepressants and selective serotonin reuptake inhibitors have moderate efficacy, especially in pain reduction and sleep improvement (Kurlansik & Maffei, 2016; O'Malley et al., 1999). Instead, medications such as monoamine oxidase inhibitors and antipsychotics not only exhibit limited effectiveness but also entail significant adverse effects (Kurlansik & Maffei, 2016; O'Malley et al., 1999). Therefore, due to ambiguous boundaries and overlaps with other syndromes, the effectiveness of pharmacological treatments for SS remains uncertain (Kurlansik & Maffei, 2016). Placebo-controlled trials indicate short-term efficacy, but the lack of specificity in drug selection and long-term benefits undermines

clinician confidence (Somashekar et al., 2013). Further research is essential to explore optimal dosages, long-term effects, and differentiated drug selection for improved treatment.

Psychological interventions for SS have demonstrated varying degrees of effectiveness (Henningsen, 2018; Kurlansik & Maffei, 2016; Maass et al., 2020; Roenneberg et al., 2019). However, one of the main challenge regarding these approaches is that in the initial phase “patients very often find it difficult to accept that a ‘*talking cure*’ might help with their primarily bodily symptoms and concerns” (Henningsen, 2018, p. 28). Within psychological interventions, Mindfulness-Based-Interventions (MBI) have been embraced as viable adjunctive treatments for patients presenting SS (for a summary of MBIs see Table 19)(Roenneberg et al., 2019). These interventions, based on mindfulness meditation practices rooted in Buddhist psychology, were developed as adaptations of the initial program (Mindfulness based stress reduction) introduced by Jon Kabat-Zinn in 1979 to help patients with chronic pain and multiple comorbidities, complementing medical treatment (Kabat-Zinn, 2003).

Table 19

Summary of Mindfulness-Based-Interventions, adapted from Billones, Lukkahatai and Saligan (2020)

Mindfulness based intervention	Similarities	Differences
Cognitive behavioural therapy (CBT)	<ul style="list-style-type: none"> ▪ The umbrella term that refers to a conceptual model of treatment that target emotional awareness and regulation, cognitive flexibility, and goal-based behaviours. ▪ Mindfulness principles integrated in the therapy. 	<ul style="list-style-type: none"> ▪ Mindfulness is merely a component of this intervention.
Acceptance and commitment therapy (ACT)	<ul style="list-style-type: none"> ▪ Therapeutic strategies are similar to mindfulness where its core principle is to observe self by cultivating the ability to simply observe internal phenomena, without attaching to, evaluating, or attempting to change them. 	<ul style="list-style-type: none"> ▪ An outpatient psychotherapy based in behaviour-analytical principles
Mindfulness based stress reduction (MBSR)	<ul style="list-style-type: none"> ▪ Standardised incorporation of Eastern mindfulness practices into Western cognitive-behavioural practice. ▪ 8-week program for 2–2.5-hour group-based meditation classes. ▪ Focused on learning on how to mindfully attend to body sensation using various mind-body meditative practices such as sitting meditation, body scan, gentle stretching, and yoga. 	<ul style="list-style-type: none"> ▪ Mindfulness practices is a core skill taught in mindfulness-based treatment. Originally designed to treat patients with chronic pain. ▪ The ultimate effect of being able to handle stressors in a more adaptive way.

Mindfulness based cognitive therapy (MBCT)	<ul style="list-style-type: none"> ▪ Standardised incorporation of Eastern mindfulness practices into Western cognitive-behavioural practice. ▪ Follows the structure of MBSR. 	<ul style="list-style-type: none"> ▪ Mindfulness practice is a core skill taught in treatment. ▪ Originally designed as relapse prevention for depression.
Mindful socioemotional regulation (MSER)	<ul style="list-style-type: none"> ▪ Mindful practices applied in group setting. ▪ Regulation of emotions via enhancing awareness and acceptance of full range of emotions via mindfulness meditation. ▪ 12 modules, 15 minutes 	<ul style="list-style-type: none"> ▪ For emotional regulation for chronic pain patients. ▪ Focused to address social engagement deficits evident in fibromyalgia and pain patients.
Mindfulness-based pain management (MBPM)	<ul style="list-style-type: none"> ▪ Group sessions of two and a half hours (20 training hours in total), held weekly for eight weeks 	<ul style="list-style-type: none"> ▪ Specifically designed to manage chronic pain

A first systematic review and meta-analysis on MBIs for the treatment of SS was published in 2013 by Lakhan and Schofield, showing a moderate effect compared to control groups. MBI demonstrated effectiveness in reducing pain, symptom severity, depression, and anxiety, while also improving overall quality of life. However, their impact varied based on the condition diagnosed, with clearer improvements seen in symptom severity for fibromyalgia and positive outcomes in quality of life, pain reduction, and symptom severity for irritable bowel syndrome. Structured interventions like Mindfulness-Based-Stress Reduction (MBSR) and Mindfulness-Based-Cognitive-Therapy (MBCT) appeared to be particularly effective (Lakhan & Schofield, 2013). A more recent meta-analysis of 30 randomised controlled trials found that MBIs exhibited a small yet positive impact on improving chronic pain symptoms when compared to treatment as usual, passive control groups, and education/support groups (Hilton et al., 2017). However, studies display significant heterogeneity and potential publication bias, leading to a low quality of evidence. The effectiveness of mindfulness meditation in addressing pain did not display systematic variations based on the type of intervention, medical condition, or the duration and frequency of the intervention. Instead, MBI demonstrated significant enhancements in depression, mental health-related quality of life, and physical health-related quality of life. However, the level of evidence was rated as high for depression, moderate for mental health-related quality of life, and low for physical health-related quality of life (Hilton et al., 2017).

8.2 Definition and Measurement of Mindfulness: from Ancient Origins to Western Perspectives

In recent decades, the concept of mindfulness has been defined in various ways, from a theoretical concept that can be measured (Brown & Ryan, 2003a) to a form of meditation practice (Kabat-Zinn, 1994). Defining mindfulness has been a challenging task, and “one of the most salient issues in mindfulness research is how to operationally define it in a meaningful, quantifiable and consensual way” (Shapiro, 2009, p. 559).

'*Mindfulness*' is the translation of '*sati*' in Pali and '*smṛti*' in Sanskrit, signifying “being in the process of becoming aware” (Nhat Hanh, 1995). The term '*sati*' also carries the meaning of "remembering" and maintaining awareness (Batchelor, 1997) and it is best translated as "to be mindful", which involves a dynamism in contrast to the term "mindfulness," which is a noun and implies a fixed trait (Grossman & Van Dam, 2011). Thus, within Buddhist scriptures, mindfulness is not perceived as a mental function or a fixed trait; instead, it is understood as a process that encompasses various stages, spanning from bodily sensations to more complex mental aspects like self-awareness (Nanamoli & Bodhi, 1995). This process involves purposeful and open-hearted attention to current experiences, supported by virtues such as kindness, patience, and courage. It also entails a form of investigation that is not reliant on a continuous inner dialogue and distinguishes itself from routine modes of attention (Grossman & Van Dam, 2011; Kabat-Zinn, 2005).

The landmark definition of mindfulness in modern science is based on Jon Kabat-Zinn's articulation as “paying attention in a particular way: on purpose, in the present moment, and nonjudgmentally” (Kabat-Zinn, 1994). Expanding on this, Western psychology has had a tendency to define mindfulness as a stable trait, overlooking its evolving aspect (Brown & Ryan, 2003b). Bishop et al. (2004) provided a fairly consensual model of trait mindfulness describing it as a relatively stable disposition that can be trained. This trait fosters a spectrum of mental processes that enable an understanding of how thoughts, emotions, and functional or dysfunctional behaviours emerge, enhancing the former and reducing the latter. This model of trait mindfulness comprises two components:

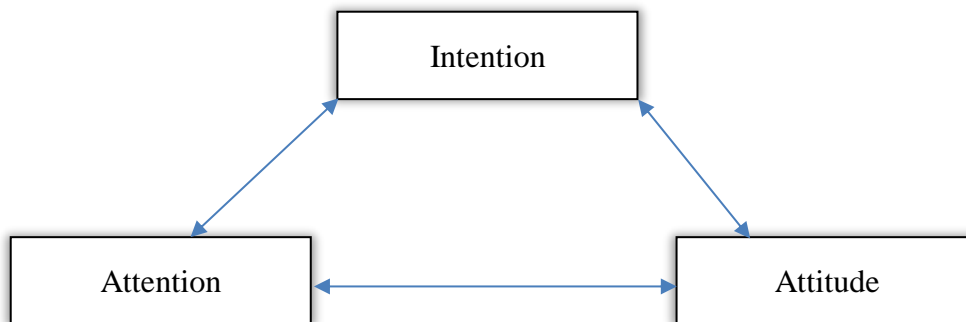
- **Attentional Self-Regulation:** intentionally directing attention to immediate sensory and mental experiences, fostering non-judgmental observation of internal and external stimuli as they arise.

- **Experiential Orientation:** openly accepting the entirety of the ongoing experience. This mindset is characterised by curiosity toward new experiences, which Bishop labels as cognitive curiosity. This behaviour contrasts with the usual avoidance tendency, particularly of negative aspects of experience.

Expanding on Bishop's work, Shapiro and colleagues introduced a pivotal third dimension: intention, referring to the personal motivations underlying meditation practice (Shapiro et al., 2006). This comprehensive model illustrates mindfulness as a dynamic and interconnected process, engaging attentional control, experiential acceptance, and personal intention (Figure 12). It's crucial to note that intention can be dynamic and evolve as the practice continues (R. J. Davidson & Kaszniak, 2015).

Figure 12

The three fundamental axioms of mindfulness – Intention, Attention, and Attitude – as interconnected elements within a continuous cyclical process that unfolds simultaneously (adapted from Shapiro et al., 2006)



The emphasis on cognitive aspects of mindfulness, such as attention and awareness, and the divergence from some of the key Buddhist teachings have received some critics (Gethin, 2011; Shonin et al., 2015). However, it has been recognised that Kabat-Zinn and Bishop et al. (2004) definitions of mindfulness “capture several of the qualities of mindfulness in early Buddhism”, and that it's important to consider that these are working definitions meant for practical guidance, and should be distinguished from a comprehensive theory outlining attributes and functions of mindfulness (Anālayo, 2019).

In 2003, a series of studies dedicated to psychometric development yielded an initial measure of dispositional mindfulness, known as the Mindful Attention Awareness Scale

(MAAS) (Brown & Ryan, 2003a). Subsequently other measures of mindfulness have also been validated. These measures encompass the Kentucky Inventory of Mindfulness Skills (KIMS)(Baer et al., 2004), Cognitive and Affective Mindfulness Scale (CAMS)(Feldman et al., 2007), Five Facet Mindfulness Questionnaire (FFMQ)(Baer et al., 2006), Freiburg Mindfulness Inventory (FMI)(Walach et al., 2006), and the Philadelphia Mindfulness Scale (PHLMS)(Cardaciotto et al., 2008). Collectively, these measures have enhanced the scientific exploration of mindfulness as a trait (Gethin, 2011). However, different authors have pointed out that in previous research a differentiation has not always been made between mindfulness as a state, as a disposition (or trait mindfulness) and as an intentional practice of meditation (Tang et al., 2017; Wheeler et al., 2016). A trait refers to a relatively stable characteristic of an individual, while a state represents a characteristic displayed in a specific situation or at a particular point in time (Hamaker et al., 2007). Essentially, a state is manifested through the interaction between an individual and a specific situation. It represents the distinctive manner in which the person adapts to the present moment and environment (Truong et al., 2020). The questionnaires mentioned above represent measures of mindfulness as a trait (or disposition). Instead, questionnaires such as the Toronto Mindfulness Scale (TMS)(Lau et al., 2006) have been specifically designed to capture mindfulness as a state.

Intentional mindfulness meditation can lead individuals to experience temporary mindful states and result in changes in personality traits with consistent, long-term practice (Shapiro et al., 2011; Tang et al., 2017). Indeed, a study on the evolution of mindfulness from state into trait, using latent growth and path analyses, revealed notable differences among individuals in how their state mindfulness changed during the meditation intervention (Kiken et al., 2015). These individual patterns of change were linked to shifts in trait mindfulness and distress before and after the intervention, implying that enhancing state mindfulness across multiple meditation sessions could lead to a more mindful and less distressed mindset. In fact, extended meditation experience is linked to increased dispositional mindfulness (Josefsson et al., 2011; Tomlinson et al., 2018), as well as a decrease in the use of maladaptive emotion regulation strategies (Schlosser et al., 2020). However, it's essential to acknowledge that these trajectories of change can vary from person to person.

8.3 Mindfulness emotion regulation in patients presenting Somatic Symptoms

Current research suggests that mindfulness, by enhancing neural processing linked to attention and body awareness, supports emotion regulation and cognitive control processes. This, in turn, helps mitigate problems associated with both emotional under-engagement, like alexithymia, and over-engagement, such as emotional dysregulation (Chambers et al., 2009; Grecucci et al., 2015; Norman et al., 2019). However, the application of attention and focus on bodily sensations in mindfulness practice becomes a topic of concern for individuals experiencing SS. In fact, this population tends to show heightened attention to bodily sensations (Mehling, 2016; Mirams et al., 2013). At the same time, attentional processes play a crucial role in mindfulness processes, serving as a vital link between mindfulness practice and psychological well-being. Previous studies have identified two distinct patterns of body awareness: one viewed as maladaptive, involving hypervigilance and catastrophic thinking, and the other seen as beneficial, involving regulated attention and acceptance (Gibson, 2019; Hanley et al., 2017; Mehling, 2016). The key distinction between these modes of awareness is the cognitive appraisal of bodily states (Farb et al., 2015).

Beside the mechanism already mentioned in the previous paragraph, mindfulness has also been associated with several processes that could contribute with its relationship with ER, such as a modification of the perception of self and body ownership (Dambrun & Ricard, 2011; Droit-Volet & Dambrun, 2019), as well as with the development of a decentred perspective (Hanley, Bernstein, et al., 2020; Hanley, Dorjee, et al., 2020). Decentering, allows a full present-moment attention coupled with a non-judgmental and open attitude and a sense of distance from distressing experiences. “In other words the attentional strategy implies a direct experience of events in the mind and body without being captured by them” (Grecucci et al., 2020, p. 2). Decentering plays a pivotal role in the emotion regulation mechanisms associated with mindfulness practice: it is a process through which positive reappraisal is promoted (Grecucci et al., 2015). Moreover, decentering exhibits a positive correlation with acceptance of pain and general psychological acceptance, as well as emotional and social functioning (McCracken et al., 2013, 2014).

Furthermore, previous studies have established a connection between dispositional mindfulness and lower levels of alexithymia (Baer et al., 2006; Teixeira & Pereira, 2013). Also,

a comprehensive review and meta-analysis on four randomised controlled trials, involving a total of 460 participants, has confirmed a significant impact of MBI on alexithymia when compared to control groups (mean difference = -5.28, 95% CI -9.28 to -1.28, $p = 0.010$). However, the duration of this effect beyond 9 months (matching the longest intervention period in the trials) remains uncertain (Norman et al., 2019). Analysing the insights from Bornemann and Singer (Bornemann & Singer, 2017), the review further suggests that mindfulness-based training may indeed possess the potential to mitigate alexithymia, potentially by augmenting neural processes associated with the recognition of bodily sensations (i.e., interoception; Norman et al., 2019). Additionally, investigations have shown a correlation between reduced alexithymia and an increase in the thickness of the right insula, a region of the brain implicated in both emotional and bodily awareness (Santarnecchi et al., 2014).

Collectively, these results indicate that different processes of mindfulness have the potential to alleviate somatic symptoms and associated alexithymia. Mindfulness practices enable individuals to engage with present-moment experiences (Baer & Krietemeyer, 2006) and facilitate positive reappraisal of stressful life events, thereby reducing maladaptive coping strategies that often prolong psychological distress (Gaylord et al., 2011; Jain et al., 2007; Nolen-Hoeksema, 2000). However, a distinction has to be made between anxiety and hypervigilance-driven attention style versus a more mindful attention style towards interoceptive cues (Mehling, 2016). Indeed, recent literature on Mindfulness-Related Adverse Effects (MRAE) highlights that, while in the minority, several studies have reported undesirable somatic experiences associated with meditation practice (Farias et al., 2020a).

8.4 Mindfulness-Related-Adverse Effects

A recent review on the adverse effects of mindfulness meditation revealed that out of the 83 studies on meditation practice or intervention included, 30% reported undesirable somatic experiences such as gastrointestinal or muscular pain, increased heart rate or physical tension (Farias et al., 2020a). In recent years concerns have been raised about the lack of knowledge regarding MBI potential risks and adverse effects (G. B. Taylor et al., 2022). In fact, if in Western cultures the practice of meditation is often described as “unequivocally beneficial” (Anderson et al., 2019), both contemplative Buddhist teachings and scientific research have mentioned many challenging perceptual, affective, epistemic and behavioural experiences that could arise from these practices (Lindahl et al., 2017; Sayadaw, 2016).

Early difficulties in the practice of mindfulness meditation are common and, in contemplative traditions, these challenges are often interpreted as a sign of progression (Compson, 2018). Therefore, practitioners are often guided to continue meditating to overcome such difficulties (Lindahl et al., 2017, 2020). Even outside the spiritual framework, transient experiences and initial deterioration may inherently be part of the therapeutic path of cultivating mindfulness and are not necessarily prognostic indicators of later adverse effects (Lilienfeld, 2007; Linden, 2013). Cebolla et al. (2017), in a large online survey of 342 meditation practitioners, documented that although one in four practitioners reported some unwanted experiences (e.g., hypersensitivity, greater self-criticism and emotional pain, restlessness/anxiety when not practising meditation), 39% of these were transient and passed with time and more meditation. Instead, 10% of participants reported sustained unwanted effects and 1% discontinued meditation practice as a result of adverse experience. More recently, Harel et al. (2019) found that, in early phases of mindfulness meditation training, elevations in negative affect and deterioration of positive affect were not linked to an iatrogenic effect of the intervention nor to a higher risk of dropout. Thus, “it is important to recognise that any person may have multiple narratives for making meaning and sense out of their experiences” and that the contextualised perception of the meditator is part of what can be defined as an adverse effect (Compson, 2018).

Meditation-related adverse effects (MRAE) are defined as unpleasant or distressing psychological, behavioural or physical meditation experiences with negative valence or negative impact that are not life or function-threatening (Britton et al., 2021). Even though the degree of severity and impact of these experiences may vary, MRAE are less severe changes than “serious adverse event” (SAE), which are function-threatening episodes requiring high-intensity treatment (Britton et al., 2021; Peterson et al., 2013; World Health Organization & Safety, 2010). SAE of meditation practice include mania, psychosis and suicidal behaviour and are sometimes reported in the context of intensive meditation retreats (>5 hrs. /day) or in conjunction with pre-existing psychopathology (Hanssen et al., 2021; Kuijpers et al., 2007; Kuyken et al., 2012; Pauly et al., 2022; Yorston, 2001).

Overall, the prevalence of MRAE among clinical and non-clinical samples ranges from 3.7% in experimental studies to 22.2% in observational studies (Farias et al., 2020a). However, these results need further investigation, as studies generally rely on passive monitoring based on the assumption that mindfulness meditation is safe and that participants would

spontaneously report difficulties (Britton et al., 2021; Wong et al., 2018). In fact, within 44 meta-analyses examining the effects of MBI, only 34.1% discuss adverse effects (S. B. Goldberg, Riordan, et al., 2021). Furthermore, recent systematic reviews show that the nature of MRAE is most commonly emotional, but that meditators often also report somatic and cognitive experiences (Cebolla et al., 2017; Farias et al., 2020a; Lindahl et al., 2020; Pauly et al., 2022; G. B. Taylor et al., 2022). However, in an extensive qualitative study of 60 experienced Western practitioners, 59 different categories and 7 domains of MRAE were identified, reflecting the heterogeneity of difficult experiences that can result from meditation practice (Lindahl et al., 2017). These included affective, cognitive, perceptual, somatic, conative, of the sense of self and social experiences. For each domain at least 25 practitioners reported the presence of MRAE. Most (73%) reported moderate to severe difficulty in at least one domain and 34% of the sample reported experiencing SAE (17% had suicidal tendencies and 17% required hospitalisation).

8.4.1 The relationship between MRAE, mindfulness experience, intensity of practice and inadequate delivery

Multiple hypotheses have been raised about the development of MRAE. A possible explanation for adverse responses to mindfulness meditation could be linked to the use of immature emotion regulation strategies in relation to early experience of the practice (Aizik-Reebs et al., 2021; Micheli et al., 2022). In this sense, meditating, naïve practitioners might become more aware of unwanted mental and bodily internal states, but continue to use maladaptive forms of regulation instead of new non-reactive and non-judgmental forms of mindful awareness, becoming more exposed to adverse experiences (Aizik-Reebs et al., 2021; Compson, 2018; Grabovac et al., 2011; Micheli et al., 2022). This transition effect could explain the high prevalence of MRAE in naïve participants during MBI (Aizik-Reebs et al., 2021; Britton et al., 2021). Indeed, in a study assessing 96 naïve practitioners during an 8-week mindfulness intervention, more than half (58%) experienced MRAE with negative valences and 37% had an impact on functioning. In 6–14% of the sample, adverse effects were lasting for one day to several months and were associated with a greater frequency of informal mindfulness practice and with signs of dysregulated arousal (hyperarousal and dissociation) (Britton et al., 2021). In the study of Aizik-Reebs, Shoham and Bernstein (2021), among 82 meditation-naïve participants following a 21-day MBI, 87% presented at least one momentary MRAE (most

commonly anxiety), and 25% reported MRAE post-intervention (Aizik-Reebs et al., 2021). Yet, if the combination between lack of experience and immature maladaptive emotion regulation strategies could be accounted as a possible explanation of MRAE in naïve practitioners, it does not explain the prevalence of adverse events in regular/experienced practitioners, who have supposedly mastered non-reactive and non-judgmental forms of emotion regulation (Lindahl et al., 2017; Lomas et al., 2015; G. B. Taylor et al., 2022). Thus, the most recent systematic review on the topic, assessing results from 61 studies, concluded that experience cannot be considered a predictor of MRAE (G. B. Taylor et al., 2022).

Another hypothesis has been proposed by Britton (Britton, 2019) who investigated the possibility that mindfulness processes could follow a non-monotonic logic. With this “too much of a good thing” effect, the intensity of mindfulness practice would play a central role in the development of MRAE. Thus, a positive mindfulness process such as body awareness, may reach an inflection point where its effect become negative. Indeed, while attention to bodily cues may be characterised by non-judgment and acceptance (i.e., adaptive body awareness), an excessive attention to the same cues may be maladaptive and actually increase anxiety. Thus, patients with anxiety disorders typically exhibit high levels of body awareness, but characterised by an exaggerated focus on physical symptoms, rumination and catastrophic thoughts (Mehling et al., 2009). Preliminary evidence supports the fact that greater exposure to meditation could lead to higher incidence of MRAE (Britton, 2019; Britton et al., 2021; S. B. Goldberg, Lam, et al., 2021; Schlosser et al., 2019). However, this dose-response relationship reported in the literature could also be influenced by the attempt of meditation practitioners to overcome difficult and distressing experiences with more meditation (Lindahl et al., 2017, 2020). Nevertheless, the implication of maladaptive emotion regulation strategies can only be supposed as, to date, no study has looked at the full range of emotion regulation processes involved in MRAE.

Finally, it has to be noted that an inadequate delivery of the MBI could also be accounted for MRAE. There is indeed an important distinction between adverse reactions (i.e., undesirable effects caused by correct treatment) and malpractice reactions (i.e., undesirable effects caused by incorrect or improperly applied treatment)(Linden, 2013). Lomas et al. (2015) found that Buddhist practitioners who used advanced practices before being ready could encountered difficult experiences. Similarly, Lindahl et al. (2017, p. 23) referred to “incorrect ways of practising meditation”, including over-seeking specific states and misunderstanding or not

following instructions. Therefore, besides the inherent therapeutic risks of mindfulness meditation, program-related factors and teacher/instructors-related factors could also be potential sources of MRAE (Baer et al., 2019; Canby et al., 2021; Crane et al., 2010).

8.5 Rationale on the necessity for further studies on the effect of Mindfulness Meditation on Somatic Symptoms

In recent years numerous studies have associated mindfulness meditation to an enhancement of various emotion regulation skills (Chambers et al., 2009; Guendelman et al., 2017; Wheeler et al., 2017). Consequently, mindfulness meditation has become a prevalent element in mental health interventions, and its associated theoretical concepts have influenced fundamental research on psychopathology (Wielgosz et al., 2019).

The literature highlights positive effects of mindfulness meditation on somatisation-related aspects like symptom severity, pain intensity, and comorbid anxiety and depression (Hoge et al., 2013; Lakhan and Schofield, 2013; Aucoin et al., 2014; Hilton et al., 2017; Hazlett-Stevens, 2018; Billones et al., 2020). However, while none of the reviews evaluating the impact of mindfulness meditation on SS indicate complete inefficacy, they also do not report substantial strong effects (Henningsen, 2018).

Several challenges hinder the attainment of conclusive findings in this field, including:

- Research has primarily focused on Mindfulness-Based-interventions (MBIs) rather than on mindfulness meditation itself.
- In the literature, there is often a lack of clear differentiation between mindfulness as a dispositional trait, an outcome of mindfulness training and the practice of mindfulness meditation itself.
- Research on MBIs has predominantly utilised a variable-centred approach, overlooking individual variability and relying solely on passive monitoring to assess potential challenges faced by participants during these programs, assuming the safety of mindfulness meditation practices (Britton et al., 2021; Wong et al., 2018).

The focus of studies on MBIs raises questions about the impact of common therapeutic factors (instructor and group related), as opposed to the specific effects of mindfulness practice, in contributing to patient improvements (Canby et al., 2021). Indeed, a recent study found that

social factors like the relationship with the instructor and group members could play a more significant role in enhancing depression, stress, and self-reported dispositional mindfulness than specific meditation practices, challenging the misconception that MBIs outcomes are solely due to the effect of mindfulness practice (Canby et al., 2021). Interestingly, in the study, informal mindfulness practice was not associated with any improvements, suggesting that the impact of MBIs might be significantly influenced by social factors. Additionally, the distinction between intentional mindfulness meditation and dispositional mindfulness is often blurred in the available evidence (Rau & Williams, 2016; Tang et al., 2017; Wheeler et al., 2016). In fact, if intentional mindfulness meditation induces temporary mindful states that can lead to personality trait changes with regular practice (Nyklíček et al., 2013; Shapiro et al., 2011; Tang et al., 2015, 2017), individuals can also present varying levels of dispositional mindfulness irrespective of mindfulness practice (Brown et al., 2007).

Research conducted assessing the practice of mindfulness meditation during COVID-19 pandemic yielded favourable outcomes, indicating its potential as an effective intervention to alleviate the mental health challenges associated to the crisis (Bursky et al., 2021; Zhu et al., 2021). To our best knowledge, no other study has looked at the effect of intentional mindfulness meditation on somatisation and psychological distress during COVID-19 pandemic. Therefore, the **fifth objective** of this thesis was to **assess the effect of mindfulness on SS, clearly distinguishing dispositional mindfulness from mindfulness practice (Study V)**. Specifically, the aim of the corresponding study was to document the effect of mindfulness practice on SS and psychological distress in the context of COVID-19 pandemic.

Furthermore, most of the studies assessing the effects of MBIs have neglected individual variability, using only passive monitoring to assess possible mindfulness-related adverse effects (MRAE) (Britton et al., 2021). In fact, while Western cultures often depict meditation as unequivocally beneficial, both contemplative Buddhist teachings and scientific studies acknowledge that mindfulness practitioners can encounter difficulties during their practices (Lindahl et al., 2017; Sayadaw, 2016). To summarise, the literature published in recent years has shown that MRAE are common (Farias et al., 2020a) and that they can be of different nature (Lindahl et al., 2017), with somatic experiences reported in approximately 30% of studies (Farias et al., 2020a). Individual vulnerabilities, such as depression, trauma or Adverse Childhood Experiences (ACE), may be risk factors increasing the likelihood of MRAE occurrence (Aizik-Reebs et al., 2021; Baer et al., 2019; S. B. Goldberg, Lam, et al., 2021).

MRAE also appear to be more frequent in male compared to female meditators and in non-religious practitioners (S. B. Goldberg, Lam, et al., 2021; Schlosser et al., 2019). Despite these progresses, an in-depth understanding of the underlying causes and factors triggering MRAE is still lacking. In fact, results from case studies presented in a systemic review, show that the majority of individuals presenting MRAE does not have a history of mental health problems (Farias et al., 2020a). Similarly, Aizik-Reebs, Shoham and Bernstein (2021) found that neither emotional and cognitive vulnerabilities nor mental health problems (negative affect, rumination, distress tolerance, worry, depression, anxiety, trauma history), individually or together, predicted momentary adverse effects experienced during meditation session (Aizik-Reebs et al., 2021).

Considering that “turning towards the difficult” and reducing emotional avoidance, are ways through which mindfulness is thought to exert its transdiagnostic benefits, it seems important to further investigate how participants experiencing MRAE deal with their emotions (Brake et al., 2016; Britton, 2019). Given these initial finding regarding somatic aspects of potential MRAE compared to research showing improvements in emotion regulation among individuals participating in MBI (Schlosser et al., 2020), and acknowledging the significant role that these interventions play in mental health, we assert the imperative need for further exploration into emotion regulation processes within MBIs. Therefore, **the sixth and last objective** of this thesis is to **discuss associations between MRAE of different nature and patterns of emotion flexibility deficits**. We present in chapter 10 a study protocol that has been submitted for approbation to the research ethics committees in France in 2023 [Comité de protection des personnes (CPP)]. This protocol extends beyond SS, encompassing a broad spectrum of psychological, behavioural, and somatic experiences. It reflects our interest in pursuing the research on ER, taking into consideration the complexity of these factors in further research aiming to establish mindfulness as a thoroughly evidence-based therapy (Farias et al., 2016).

KEY POINTS

In recent years, research has indicated the potential of mindfulness meditation in enhancing various emotion regulation skills, making it a prevalent element in mental health interventions. However, studies on its effectiveness in managing somatic symptoms (SS) have shown varied results. Several challenges hinder conclusive findings in this area, including:

- **Focus on Mindfulness-Based Interventions (MBIs):** Research primarily concentrates on MBIs rather than mindfulness meditation itself, raising questions about the specific effects of mindfulness practice versus general therapeutic factors.
- **Blurred Definitions of Mindfulness:** Differentiating between mindfulness as a dispositional trait, an outcome of mindfulness training, and the practice of mindfulness meditation is often unclear in the literature, leading to ambiguity in research outcomes.
- **Neglect of Individual Variability:** Studies assessing MBIs often overlook individual differences, ignoring potential adverse effects and difficulties encountered during mindfulness practices. These difficulties, including somatic experiences, are common but not well-studied.
- **Lack of Emotion Regulation Focus:** While mindfulness meditation is associated with improvements in emotion regulation, the relationship between mindfulness-related adverse experiences (MRAE) and emotion regulation processes, especially somatic aspects, remains understudied.
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Table 20

Summary of the objectives of the second part of the thesis and corresponding studies

Objectives	Study I	Study II	Study III	Study V	Study VI	Study Protocol
5 - Assessing the effect of mindfulness on somatic symptoms, clearly distinguishing dispositional mindfulness from mindfulness practice					X	
6 – Inscribing somatic symptoms in the literature of mindfulness-related-adverse effects						X

9. Study V - Does the practice of mindfulness reduce somatic symptoms and COVID-19-related anxiety? A community-based survey (published article)

In this chapter we present a study published in a recent article of *Frontiers of Psychology* (Micheli et al., 2022). The abstract and the introduction of the article have been omitted as the concept there explained are integrated in the theoretical part of this thesis. The full article is presented in the Appendix D (p. 247). The main objective of the study was to document the effect of mindfulness practice on SS and psychological distress in the context of COVID-19 pandemic.

We formulated three hypotheses for the current study, as detailed below:

H1: Dispositional mindfulness would be associated with lower somatic symptom, psychological distress, and COVID-19-related anxiety.

H2: A longer experience in mindfulness meditation, enhancing dispositional mindfulness and ER, would be associated with less SS and psychological distress.

H3: Practitioners with less experience would report more SS and a greater use of maladaptive emotion regulation strategies than those with more experience.

9.1 Materials and methods

Section 4.2.2 (Chapter 4, p. 75) and Appendix D (p. 247) present a full description of the sample and of the measurements used in this study. Data were collected during the worldwide second wave of pandemic, from November 24 2020 to January 29 2021 in France, in an online survey about the impact of COVID-19 on emotions and physical health. Participants were recruited through free social network advertisement.

Participants

569 (53.48%) subjects provided at least 50% of data and were included in the study. The mean age of the total sample was 39.8 years ($SD = 14.5$, range = 18–89). Most of the participants were female ($n = 512$, 90%), with a high level of education or university degrees (54.3%),

employed (60.5%), and living with their families or partners (78.4%). A quarter of the sample were infected by the SARS-CoV-2 ($n = 139$, 24.4%), and half of the participants reported COVID-19 infections among close friends or relatives. Finally, 17.6% of the population self-reported the presence of psychological problems, and 25% declared having a chronic illness.

Measures

The study collected sociodemographic and COVID-19-related data (e.g., having contracted the virus and the presence/absence of positive cases among relatives or friends). COVID-19-related anxiety was assessed using a visual analog scale, while SS were assessed using the Patient Health Questionnaire (PHQ-15; Kroenke et al., 2001), and psychological distress was evaluated with the Generalized Anxiety Disorder 7-item Scale (GAD-7; Spitzer et al., 2006) and the Patient Health Questionnaire-8 (PHQ-8; Kroenke et al., 2009). Emotion regulation strategies were explored through the Cognitive Emotion Regulation Questionnaire (CERQ; Garnefski et al., 2001), which categorised responses into adaptive and maladaptive strategies. Furthermore, the questionnaire included the assessment of mindfulness practice and experience and dispositional mindfulness.

Mindfulness practice was determined through six questions asking participants if they had a regular mindfulness practice, years of practice, weekly frequency, usual practice length, and amount of practice in the last month compared to usual and type of mindfulness exercise. The variable years of practice was used to determine mindfulness experience as it was judged to be less subject to recall bias and measurement error than frequency and session length (Schlosser et al., 2020). Subjects practising for less than 2 years were categorised as “beginners,” while people reporting a longer meditation experience (more than 2 years) have been classified as “advanced” (Haimerl & Valentine, 2001).

Dispositional mindfulness was assessed with the Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003a), a 15 items scale to measure mindfulness as a trait. Each item is scored using a six-point Likert scale ranging from 1 (“almost always”) to 6 (“almost never”). The total score is calculated by the mean of the 15 items, with higher scores indicating greater dispositional mindfulness. The total score reliability in the current sample was high ($\alpha = 0.89$).

9.2 Statistical analyses

Analyses were performed using R version 3.0 (R Core Team, 2013). The R code used for statistical analyses is available in the Supplementary material. Multiple imputation by chained equations (MICE) using a predictive mean matching method has been performed on the 3.8% of data, representing missing values in the mandatory questions of the survey. Descriptive statistics were used to describe the sociodemographic characteristics of the respondents. Measurement data were expressed as the mean \pm SD, while independent sample t-tests were used for group comparisons (practitioners vs. non-practitioners). Pearson's correlations were used to assess the association between COVID-19 related anxiety, generalised anxiety, depression, somatisation, ER, and dispositional mindfulness. Given that the relationship between meditation experience and the variables of interest was not assumed to be linear, meditation experience was categorised into three groups: non-practitioners, beginners (mindfulness practice \leq 2 years) and advanced (mindfulness practice $>$ 2 years). For the group comparisons between non-practitioners, beginner, and advanced practitioners, one-way ANOVA was used. The values of $p < 0.05$ were considered statistically significant. Multiple comparisons were performed by Tukey–Kramer Test for post hoc analysis to locate the significant group-by-group differences.

9.3 Results

Descriptive statistics of responders' sociodemographic characteristics and comparisons between practitioners and non-practitioners are available in the Supplementary Table 28 (Appendix E, p. 260). Overall, there were no main sociodemographic differences between the group of practitioners and non-practitioners except for age and educational level (practitioners were younger and more educated than non-practitioners).

Dispositional mindfulness, somatic, and psychological distress

Table 21 shows zero-order associations between COVID-19- related variables, somatic and psychological symptoms. As expected, large associations ($r > -0.50$) were found between psychological distress (i.e., anxiety and depression scores) and SS. Dispositional mindfulness showed strong and negative correlations with psychological distress [$r(567) = -0.56, p < 0.001$ for both anxiety and depression], SS [$r(567) = -0.46, p < 0.001$], and a small and negative

correlation with COVID-19 related anxiety [$r(567) = -0.13, p < 0.001$]. Moreover, dispositional mindfulness was negatively associated with maladaptive ER [$r(567) = -0.37, p < 0.001$].

Table 21

Associations between COVID-19-related factors, somatic and psychological variables

	COVID-19 anxiety	1	2	3	4	5	6	7	8	9
1. Chronic Illness	0.004 (0.931)									
2. Psychological problems	0.089 (0.033)	-0.001 (0.975)								
3. Coronavirus infection	0.134 (0.001)	0.015 (0.723)	-0.046 (0.270)							
4. Covid proxy	-0.048 (0.255)	0.001 (0.981)	-0.126 (0.003)	0.050 (0.229)						
5. PHQ-15	0.234 (<0.001)	0.136 (0.001)	0.093 (0.027)	0.230 (<0.001)	-0.040 (0.338)					
6. CERQ Maladaptive	0.181 (<0.001)	0.015 (0.715)	0.200 (<0.001)	0.089 (0.033)	-0.028 (0.512)	0.296 (<0.001)				
7. CERQ Adaptive	-0.066 (0.118)	-0.035 (0.410)	-0.121 (0.004)	-0.025 (0.544)	0.047 (0.267)	-0.073 (0.081)	0.028 (0.503)			
8. PHQ-8	0.232 (<0.001)	0.036 (0.386)	0.222 (<0.001)	0.155 (<0.001)	-0.047 (0.265)	0.589 (<0.001)	0.468 (<0.001)	-0.121 (0.004)		
9. GAD-7	0.316 (<0.001)	0.006 (0.895)	0.160 (<0.001)	0.096 (0.023)	-0.063 (0.133)	0.575 (<0.001)	0.473 (<0.001)	-0.114 (0.007)	0.731 (<0.001)	
MAAS	-0.138 (0.001)	-0.039 (0.358)	-0.118 (0.005)	-0.039 (0.357)	0.019 (0.649)	-0.462 (<0.001)	-0.378 (<0.001)	0.069 (0.101)	-0.565 (<0.001)	-0.567 (<0.001)

Note: Computed correlation used Pearson-method with list wise-deletion. PHQ-15, Patient Health Questionnaire—Somatic Symptom Severity Scale; CERQ, Cognitive Emotion Regulation Questionnaire; PHQ-8, Patient Health Questionnaire for Depression; GAD-7, Generalized Anxiety Disorder; and MAAS, Mindful Attention Awareness Scale.

The effect of mindfulness practice and experience on somatic symptoms and psychological distress

Mindfulness meditation was practised by 28.8% of the population ($n = 164$). The years of experience in mindfulness practice as well as the amount of practice were quite homogenous in the sample of practitioners. Most practitioners practised either for 10 min ($n = 67$) or between 10 and 30 min ($n = 67$), but a smaller part had a length of practice of more than 30 min for each session ($n = 30$). In total, 87 (15.3%) subjects were categorised as beginners (≤ 2 years of practice) and 77 people (13.5%) as advanced (> 2 years of practice). A significant difference was found in the type of practice ($p = 0.003$; Table 22).

One-way ANOVA comparison showed no differences between non-practitioners, beginners, and advanced practitioners concerning dispositional mindfulness (Table 23). Moreover, no differences were found among the three groups concerning depression, anxiety, and COVID-19 related anxiety. However, a significant difference was found between groups in the levels of SS [$F(2, 566) = 4.50, p = 0.01, \eta^2 = 0.01$]. Tukey–Kramer post hoc tests showed that beginners reported significantly more SS ($M = 12.2$) than non-practitioners ($M = 10.3, p = 0.008$).

Table 22

Descriptive statistics of mindfulness practice

	Overall (N = 569)	Beginners (N = 87)	Advanced (N = 77)	χ^2	Value of p	V
Years of practice						
Less than 1 year	40 (7%)	40 (46%)	-			
Between 1 and 2 years	47 (8.3%)	47 (54%)	-			
Between 3 and 4 years	35 (6.2%)	-	35 (45.5%)			
More than 4 years	42 (7.4%)	-	42 (54.5%)			
Practice per week						
Less than once a week	40 (7.0%)	21 (24.1%)	19 (24.7%)	7.597	0.1	0.215
Once a week	36 (6.3%)	25 (28.7%)	11 (14.3%)			
Between 2 and 3 times	55 (9.7%)	29 (33.3%)	26 (33.8%)			
Between 4 and 5 times	16 (2.8%)	6 (6.9%)	10 (13.0%)			
More than six times	17 (3.0%)	6 (6.9%)	11 (14.3%)			
Length of practice						
10 min	67 (11.8%)	39 (44.8%)	28 (36.4%)	1.215	0.5	0.086
Between 10 and 30 min	67 (11.8%)	33 (37.9%)	34 (44.2%)			
More than 30 min	30 (5.3%)	15 (17.2%)	15 (19.5%)			
Type of practice						
Yoga	27 (4.7%)	21 (24.1%)	6 (7.8%)	17.67	0.003	0.328
Mindfulness meditation	26 (4.6%)	12 (13.8%)	14 (18.2%)			
Breathing exercises	48 (8.4%)	29 (33.3%)	19 (24.7%)			
Yoga and meditation	31 (5.4%)	11 (12.6%)	20 (26%)			
Meditation and breathing exercises	27 (4.7%)	14 (16.1%)	13 (16.9%)			
Other practices	5 (0.9%)	0 (0%)	5 (6.5%)			

Mindfulness practice and emotion regulation

A one-way ANOVA revealed that there was a significant difference between groups for total adaptive regulation score (CERQ Adaptive), $F(2, 566) = 9.81, p < 0.001, \eta^2 = 0.02$ (Table 23). Post hoc tests showed that participants in the advanced practitioners group reported significantly higher use of adaptive emotion regulation ($M = 66.9$) than non-practitioners ($M =$

59.9; $p = 0.004$). This result was similar for each adaptive emotion regulation sub-dimension (Table 24).

Table 23

Descriptive statistics of somatic and psychological variables in the population and according to practice group

	Total (N=569)	Non-practitioners (NP) (N=405)	Practitioners		F	Value of p	η^2	Post hoc test (Tukey)
			Beginners (BE) (N=87)	Advanced (AD) (N=77)				
COVID-19 anxiety								
Mean±SD [Min, Max]	4.24±2.86 [0, 10]	4.20±2.87	4.77±2.68	3.87±2.97	2.19	0.11	0.007	-
Somatic symptoms (PHQ-15)								
Mean±SD [Min, Max]	10.7±5.37 [0, 30]	10.3±5.32	12.2±4.69	10.9±6.09	4.50	0.01	0.015	NP<BE
Score 0–4	74 (13%)	57 (14%)	3 (3%)	14 (18%)				
Score 5–9 (mild)	177 (31%)	136 (34%)	22 (25%)	19 (25%)				
Score 10–14 (moderate)	183 (32%)	124 (31%)	36 (41%)	23 (30%)				
Score ≥ 15 (severe)	135 (24%)	88 (22%)	26 (30%)	21 (27%)				
PHQ-15 score ≥ 10	318 (56%)	212 (52%)	62 (71%)	44 (57%)				
Depression (PHQ-8)								
Mean±SD [Min, Max]	9.51±6.14 [0, 24]	9.34±6.10	10.3±6.02	9.48±6.47	0.91	0.40	0.003	-
Score 0–4 (none)	137 (24%)	99 (24%)	16 (18%)	22 (29%)				
Score 5–9 (mild)	173 (30%)	126 (31%)	27 (31%)	20 (26%)				
Score 10–14 (moderate)	136 (24%)	97 (24%)	22 (25%)	17 (22%)				
Score 15–19 (moderate severe)	81 (14%)	55 (14%)	13 (15%)	13 (17%)				
Score 20–24 (severe)	42 (7%)	28 (7%)	9 (10%)	5 (6%)				
PHQ-8 score ≥ 10	259 (46%)	180 (44%)	44 (51%)	35 (45%)				
Anxiety (GAD-7)								
Mean±SD [Min, Max]	8.42±6.05 [0, 21]	8.40±6.09	8.75±5.63	8.14±6.32	0.21	0.80	0.000	-
GAD-7 score ≥ 10	205 (36%)	143 (35%)	33 (38%)	29 (38%)				
Depression and anxiety	173 (30%)	120 (30%)	27 (31%)	26 (34%)				
CERQ adaptive								
Mean±SD [Min, Max]	61.2±14.8 [20, 100]	59.9±14.7	61.8±14.4	66.9±14.3	7.32	<0.001	0.025	NP<AD
CERQ maladaptive								
Mean±SD [Min, Max]	36.8±10.4 [16, 76]	36.8±10.8	38.4±9.47	34.9±9.13	2.27	0.10	0.007	-
Dispositional mindfulness (MAAS)								
Mean ± SD [Min, Max]	3.75±0.87 [1, 5.93]	3.77±0.85	3.74±0.86	3.68±0.93	0.35	0.70	0.001	-

No difference among the three groups was found in the total score of maladaptive emotion regulation (CERQ Maladaptive), $F(2,566) = 2.27$, $p = 0.10$ (Table 23). Interestingly, there was only a significant difference between the three groups when looking at rumination sub-scale [$F(2, 566) = 5.74$, $p = 0.003$, $\eta^2 = 0.019$; Table 24]. The total score of the subscale Rumination was significantly higher in the group of beginners ($M = 13.5$) than in non-practitioners ($M =$

11.9; $p = 0.006$) and advanced practitioners ($M = 11.8$; $p = 0.02$). No differences have been found for other maladaptive subscales.

Table 24

Comparison of emotion regulation strategies according to mindfulness experience group

	NP-Non practitioners (N=405)	BE-Beginners (N=87)	AD-Advanced (N=77)	F	p value	η^2	Post hoc test (Tukey)
	Mean \pm SD	Mean \pm SD	Mean \pm SD				
CERQ adaptive							
Acceptance	12.7 \pm 3.81	13.1 \pm 3.32	14.0 \pm 3.34	4.02	0.018	0.014	NP < AD
Positive refocusing	9.60 \pm 4.06	10.1 \pm 3.50	11.1 \pm 4.56	4.84	0.008	0.016	NP < AD
Refocus on planning	12.6 \pm 3.94	13.3 \pm 3.55	14.1 \pm 3.60	5.97	0.002	0.020	NP < AD
Positive reappraisal	11.9 \pm 4.06	12.6 \pm 4.01	13.8 \pm 4.19	7.04	<0.001	0.024	NP < AD
Putting into prospective	12.8 \pm 3.81	13.1 \pm 3.82	14.3 \pm 3.46	5.13	0.006	0.017	NP < AD
CERQ maladaptive							
Self-blame	9.41 \pm 3.92	9.85 \pm 3.78	8.99 \pm 3.24	1.05	0.35	0.003	
Rumination	11.9 \pm 4.19	13.5 \pm 4.12	11.8 \pm 3.68	5.74	0.003	0.019	BE > NP, BE > AD
Catastrophising	7.52 \pm 3.40	7.54 \pm 3.00	6.95 \pm 2.85	1.04	0.35	0.003	
Other-blame	7.66 \pm 3.59	7.49 \pm 2.79	7.31 \pm 2.66	0.42	0.65	0.001	

9.4 Discussion

To our knowledge this is the first study investigating the effects of mindfulness practice on SS and psychological distress during COVID-19 pandemic. Based on previous literature on the positive effects of mindfulness on mental health, it was assumed that dispositional mindfulness would have a buffering effect against somatic complaints and the distressing mental health outcomes of COVID-19. In particular, we hypothesised that a longer experience in mindfulness practice, enhancing dispositional mindfulness, and ER, would be associated with less SS and psychological distress. On the contrary, a lack of mindfulness experience, would bring subjects to experience more SS and a greater use of maladaptive emotion regulation strategies than those with more experience.

Dispositional mindfulness, somatic symptoms, and psychological distress during COVID-19 pandemic

As expected, dispositional mindfulness was associated with lower levels of somatisation and psychological distress, confirming the positive relationship between this personality trait and psychological health (Tomlinson et al., 2018). A negative association has also been found with the use of maladaptive emotion regulation and with more specific COVID-19-related anxiety, suggesting that dispositional mindfulness may have afforded protective buffering against the distress caused by the pandemic. These results are in line with other studies assessing dispositional mindfulness in different populations during COVID-19 and provide new and strong evidence for the protective role of this personality trait during the pandemic (Conversano et al., 2020; O'Connor et al., 2022; Roemer et al., 2021).

The relationship between dispositional mindfulness and mindfulness experience

In the present study, no relationships were found between dispositional mindfulness measured with MAAS (Brown & Ryan, 2003a) and any of the mindfulness meditation practice factors investigated (e.g., practitioners vs. non-practitioners, years of mindfulness experience, frequency and length of practice, and type of practice). These results provide further evidence in the discrepancy between studies linking mindfulness meditation experience to higher dispositional mindfulness (Cordon & Finney, 2008; Josefsson et al., 2011; Schlosser et al., 2020), and those finding no significant associations (MacKillop & Anderson, 2007). As discussed in the study of MacKillop and Anderson (2007), in which 65% of the experienced group had practised for 1 year or less, this might be due to the fact that the original validation of the MAAS used a sample of extensively experienced and committed Zen Buddhist practitioners (Brown and Ryan, 2003). In our population, advanced practitioners had more than 2 years of experience and cannot, therefore, be categorised as novice practitioner. However, beginner and advanced practitioner did not differ in terms of number of times practising per week and length of practice per session. Moreover, advanced practitioners deeply involved in practising meditation were the minority (27.3% of advanced practitioner meditated more than three times per week and only 19.5% for more than 30 min). As such, these data suggest that there are no clear differences in dispositional mindfulness (as measured by the MAAS) between beginners and advanced practitioners and also suggest that caution is needed when assessing how “regular” mindfulness meditation training has to be to modify the trait of dispositional mindfulness.

The effect of mindfulness practice experience on somatic symptoms and psychological distress

The second hypothesis of this study, which assumed that a longer mindfulness meditation experience, enhancing dispositional mindfulness and ER, would positively affect somatic complaints and psychological distress, was only partially validated. In fact, as previously noted, advanced practitioners did not show higher levels of dispositional mindfulness. Moreover, the means of SS, COVID-19-related anxiety and psychological distress were not significantly smaller in advanced practitioners compared to the rest of the sample. However, advanced practitioners showed significantly higher use of adaptive emotion regulation strategies compared to non-practitioners, confirming the fact that emotion regulation can be considered as one of the processes facilitated by mindfulness meditation (Tang et al., 2015; Roemer et al., 2021).

The most interesting result of this study concerned the third hypothesis enunciated, for which less experienced practitioners would show more SS and a greater use of maladaptive emotion regulation than experienced practitioners. Subjects with less experience in mindfulness practices (mindfulness experience ≤ 2 years) showed worse somatic health than subject who never practised mindfulness meditation. Considering that the three groups did not differ in terms of anxiety, depression, and COVID-19-related anxiety, the higher levels of SS in beginners cannot be explained by psychological distress. A possible explanation for this result lies in the contribution of interoception in these practices and in the possible impact of rumination, which was significantly higher in the beginners' group. Most meditation practices, using the sensations of the body as an anchor to improve attention to the present moment, enhance interoceptive awareness and perceptual skills (Gibson, 2019). However, previous literature has highlighted the existence of two different styles of interoceptive awareness, one maladaptive and characterised by hypervigilance and catastrophising, and one beneficial and characterised by attention regulation and acceptance (Gibson, 2019; Hanley et al., 2017; Mehling, 2016). The main difference between these two styles of interoceptive awareness is the cognitive appraisal of body states (Farb et al., 2015). Mindfulness, through acceptance, changes the appraisal and the affective significance of body states and enhances the regulation of associated negative emotions (Kober et al., 2019; Lindsay & Creswell, 2017). However, in mindfulness meditation, practitioners use interoceptive awareness since the very beginning of their practice, and their perceptual skills may improve before the competences of acceptance (Lindsay & Creswell,

2017). Thus, in distressing contexts (such as COVID-19 pandemic), an augmented attention to the body in the absence of acceptance might narrow the focus on negative stimuli and sensations, and result in more ruminative thinking (Lindsay and Creswell, 2017). Consequently, the significantly higher report of SS in beginner practitioners could be interpreted as a consequence of the focus of attention on the body during mindfulness meditation, joined with the lack of mindful acceptance and an overuse of rumination.

9.5 Limitations

The current study had several limitations that merit discussion. First, the convenience sampling recruitment method used does not allow any generalisations. Even though we controlled sociodemographic differences between practitioners and non-practitioners, there is still the possibility of having under/over- represented the population. Women in the sample were overrepresented (90%) not allowing gender comparisons. Second, the prevalence of SS (56%), anxiety (36%), and depression (46%) in this sample were high compared to other studies done during the COVID-19 pandemic (Ran et al., 2020; Salari et al., 2020; Xiong et al., 2020). At the time of data collection for this study, the French population was slowly coming out of the second lockdown, which officially stopped on December 15, 2020. However, many public health measures and restrictions were put in place to continue limiting the spread of the virus. Thus, the high prevalence of SS and psychological distress could be either a bias of the convenience sampling used in this study or the manifestation of the distress for the uncertainty of COVID-19 pandemic. Third, several factors of mindfulness practice have been assessed and the data showed significant differences between beginners and advanced practitioners in the practice of yoga, mindfulness meditation, and breathing exercises. However, previous literature has categorised specific styles of meditation (e.g., attentional, constructive, and deconstructive) based on their primary cognitive mechanisms (Dahl et al., 2015). The use of these categories could have brought a deeper understanding of the processes between mindfulness practice and somatisation. Finally, we have concentrated on emotion regulation strategies to explain differences between groups as the study did not include a measure of interoceptive awareness. Therefore, we lack perspective on the possible effect of interoceptive awareness in the results, which can only be hypothesised.

9.6 Conclusion

In conclusion, the findings of this study suggest that mindfulness practice over time enhances the use of adaptive ER. However, these practices require adequate training. Inexperience, in distressing times such as COVID-19 pandemic, can bring people to focus on bodily sensations without having developed the necessary skills to handle emerging emotions and, as a result, develop more SS. A particular attention should be given on rumination tendencies during the initial period of mindfulness training, which is prevalent in subjects with lower mindfulness experience. Further studies are recommended to better understand the relationship between somatisation, mindfulness practice, and emotion regulation and to clarify the relationship between mindfulness practice and dispositional mindfulness.

KEY POINTS

- This study explored the impact of mindfulness practice on somatic symptoms and psychological distress during the COVID-19 pandemic, aiming to understand how mindfulness might buffer against pandemic-related mental health challenges.
- Dispositional Mindfulness: Individuals with higher dispositional mindfulness experienced lower somatization and psychological distress. Dispositional mindfulness appeared to protect against COVID-19-related anxiety, indicating its buffering effect during the pandemic, consistent with previous studies.
- Discrepancy in Mindfulness Experience: Surprisingly, no clear relationship was found between dispositional mindfulness (measured by MAAS) and mindfulness meditation practice factors. This contrasted with prior research, highlighting a discrepancy between studies linking mindfulness meditation experience to higher dispositional mindfulness.
- Effect of Mindfulness Practice Experience: Long-term mindfulness meditation experience didn't necessarily increase dispositional mindfulness. However, experienced practitioners exhibited higher use of adaptive emotion regulation strategies, emphasizing the role of mindfulness in enhancing emotional regulation skills.
- Impact of Inexperience: Beginners (≤ 2 years of mindfulness experience) exhibited worse somatic health compared to non-practitioners, possibly due to heightened interoception without adequate acceptance skills. This suggests that inexperienced individuals might focus intensely on bodily sensations, leading to increased somatic symptoms.
- Conclusion: Mindfulness practice, when developed over time, enhances adaptive emotion regulation. However, adequate training is crucial. Inexperienced individuals, especially during distressing periods like the COVID-19 pandemic, might struggle due to heightened bodily awareness without the necessary emotional regulation skills. Ruminative tendencies in early mindfulness training need special attention.

10. Study protocol - Meditation-related adverse effects and their relationship with emotion regulation flexibility and body awareness: a study protocol for an observational study in meditation-naïve participants.

10.1 Aims and objectives of the MRAE investigation

The primary aim of this protocol study is to examine the implication of emotion regulation flexibility and body awareness in the development of MRAE in Mindfulness-Based Interventions (MBI). Considering the heterogeneity in the way people regulate their emotions, instead of a more commonly used variable-centred approach, we adopt a person-centred perspective. Using a latent profile analysis (LPA), we aim to identify specific patterns of emotion regulation in order to observe how different flexibility profiles and possible flexibility deficits might be linked to adverse responses to mindfulness training. To do so we will address important factors that could moderate the relationship between flexibility profiles and MRAE, including: 1) contextual factors (i.e., type of MBI, amount of mindfulness meditation, perceived support from the group/instructor, and participant understanding of the instructions)(Farias et al., 2020b; S. B. Goldberg, Lam, et al., 2021); 2) and individual participant characteristics (depression, anxiety, persistent SS, adverse childhood experiences and alexithymia). The longitudinal design of the study will allow to observe clinical changes of these factors over time and determine the difference between momentary deterioration and more persistent MRAE. The clinical significance of these changes will be calculated using the reliable change index (Blampied, 2022; Maassen, 2000). Finally, the study's secondary aim is to examine the occurrence of MRAE in real-life contexts MBI, differentiating between transient and more persistent experiences.

10.2 Methods/Design

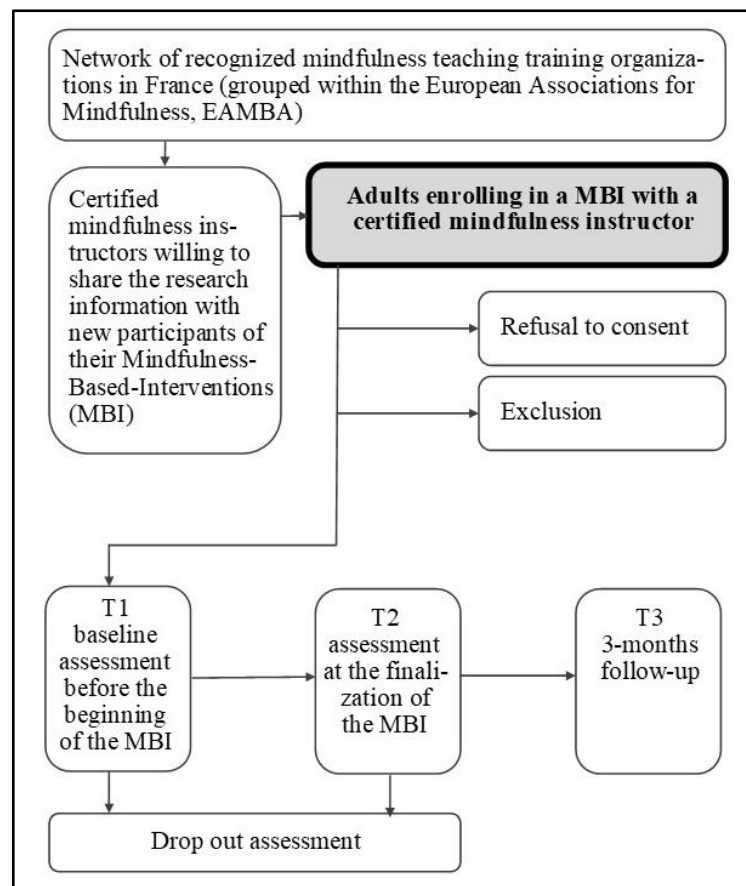
10.2.1 Design and recruitment

Figure 13 illustrates the overall design and subject flow for the study. This observational study has a prospective, longitudinal design involving three time points (baseline, post-

intervention, and 3-month follow-up). The longitudinal design will allow the evaluation of transient and persistent- adverse effects of the mindfulness intervention. Recruitment will be done throughout the networks of recognised mindfulness teaching training organisations in France (grouped within the European Associations for Mindfulness, EAMBA). These organisations offer certified courses in mindfulness programs and provide ongoing training for instructors. Mindfulness organisations will be asked to share information about the research within their networks of certified instructors. Instructors interested in participating can contact the research team via the official email of the study. An information sheet about the study will be sent to mindfulness instructors for them to share with participants who enrol in their mindfulness program. The information note will contain a link to the informed consent form (online on the platform Limesurvey). If participants give consent to participate in the study, they will be redirected to the study's baseline assessment. (T1). Participants who decide to drop out of MBI and/or the study after agreeing to participate will be asked to respond to a dropout assessment.

Figure 13

Flow chart of the meditation-related adverse effects study



10.2.2 Participants

The study sample will include adult meditation naïve participants enrolling in a MBI led by a certified instructor recognised by the EAMBA. Exclusion criteria will include: participants who do not speak or understand French language; participants with a diagnosis of severe mental illness and participants who have attended a MBI prior to the study.

10.2.3 Measures

The schedule of the different assessments is summarised in Table 25.

Table 25

Assessment schedule

Measures	Assessment time points for MBI participants			
	T1 Baseline	T2 Post intervention	T3 3-months follow-up	Dropout assessment
Demographic and medical characteristics	x			
PHQ-SSADS	x	x	x	x
ACE	x			
TAS-20	x			
MAIA-II	x	x	x	x
ERF	x	x	x	x
FFMQ	x	x	x	x
MRAE		x	x	x

Note: PHQ-SSADS, Patient Health Questionnaire; ACE, Adverse Childhood Experiences Questionnaire; MAIA-II, Multidimensional Assessment of Interoceptive Awareness; ERF, Emotion Regulation Flexibility (Context Sensitivity Index, Cognitive Emotion Regulation Questionnaire, Coping Flexibility Scale) ; FFMQ, Five Facets Mindfulness Questionnaire ; MRAE, Variety of Mindfulness Adverse Experiences.

Sociodemographic and medical variables: participants will be asked to indicate their age, gender identity and education level (i.e. highest degree). Also, they will be asked to report the presence of any medical condition.

Mindfulness training: participants will be asked to specify the characteristics of the MBI in which they are enrolled. Also, the frequency and duration of their formal and informal meditations training will be assessed.

Meditation-Related-Adverse-Effects: in the absence of a validated questionnaire to study MRAE, we will use a modified version of the Meditation-Related Adverse Effects Scale, Mindfulness-Based Program version (MRAES-MBP), created by Britton, Lindahl, and Cooper, in 2018. The MRAES-MBP scale includes the 10 items most common and/or most strongly associated with negative impact on functioning in the context of a MBI, including signs of hyperarousal (anxiety, perceptual hypersensitivity, traumatic re-experiencing, emotional lability, insomnia), hyperarousal/emotional blunting (anhedonia, depersonalisation), executive dysfunction and social disengagement (Britton et al., 2021; Lindahl et al., 2017). The items are derived from the NIH Patient-Reported Outcomes Management Information System (PROMIS) toolkit item bank (Cella et al., 2007) and Neuro-QOL (Cella et al., 2012) for anxiety, depression, emotional and behavioural control disorder and cognitive function, as well as other validated measures of clinically relevant symptoms (Dell, 2006; A. J. Lang & Stein, 2005; Mason et al., 2008; Schat et al., 2005). An eleventh item uses an optional free text format to inquire about other meditation-related experiences that were not surveyed. In the present study, will use a modified version of the original MRAES-MBP questionnaire, in which items were added selecting other common meditation adverse experiences from the "phenomenological codebook" issued from the study of Lindahl et al. (2017) and translated into French by Herbet, Wynen, and Neuman from the Mindfulness Institute in May 2019. Two mindfulness experts and three clinical mindfulness researchers (M.BC, C.D., and N.M.) selected the most relevant items for naive participants of mindfulness programs to include in the self-report questionnaire. The final questionnaire consists of 30 items representing all 7 domains of the study of Lindahl et al. (2017)(i.e., cognitive, perceptual, affective, somatic, conative, sense of self and social) and 3 additional questions assessing participants' understanding of instructions and participants' perceived support from the group and the mindfulness instructor. The questionnaire instruction ask: *"Since the start of the mindfulness program, have you experienced one or more of the experiences described below which, in your opinion, were caused by or related to the practice*

of meditation?”, and items response options are: never, rarely (once per week), sometimes (2-3 times per week), often (once a day), very often (several times a day).

Body Awareness: the awareness of bodily sensations will be measured with the Multidimensional Assessment of Interoceptive Awareness Version 2 (MAIA-II) questionnaire (Mehling et al., 2018). The MAIA-II uses 37 items rated on a 6- point scale of “never” to “always” to measure 8 different aspects of interoceptive awareness: (1) Noticing: awareness of uncomfortable, comfortable, and neutral body sensations; (2) Not-distracting: tendency not to be distracted by oneself from sensations of pain or discomfort; (3) Not-worrying: tendency not to worry with sensations of pain or discomfort; (4) Attention regulation: ability to sustain and control attention to body sensation; (5) Emotional Awareness: awareness of the connection between body sensations and emotional states; (6) Self-regulation: ability to regulate psychological distress by attention to body sensations; (7) Body listening: actively listens to the body for insight; and (8) Trusting: experiences one own body as safe and trustworthy. After reverse coding the negatively-worded items, the mean of all items together made the total score, ranging between 8 and 48. Higher score reflects greater interoceptive awareness. The French translation of the first version of the questionnaire has shown to have a satisfactory internal consistency and Cronbach’s alphas for the eight subscales ranged from 0.71 to 0.89 (Willem et al., 2021). The MAIA-2 has five more items compared to the first version, which have been added for improving internal consistency and reliability (Mehling et al., 2018).

Emotion Regulation Flexibility: all three components of emotion regulation flexibility will be assessed. **Context sensitivity** will be measured with the Context Sensitivity Index (CSI), a 20-item self-report and scenario-based questionnaire assessing the ability to capture sensitivity to the presence of contextual cues (CSI Cue Presence index) and sensitivity to the relative absence of cues (Cue Absence index) (Bonanno et al., 2020). The items are rated on a 7-point Likert scale ranging from 1 (not at all) to 7 (very much). An overall CSI score (CSI Overall index) is calculated by averaging the Cue Presence and Cue Absence indices. The degree of reliability of the questionnaire factors in a recent study was good, with a Cronbach’s alphas of 0.74 for the Cue Presence index and 0.72 for the Cue Absence index (Lenzo et al., 2020). Additionally, evidence for convergent and discriminant validity of indices against other relevant measures has been provided (Bonanno et al., 2020). **Repertoire** will be assessed with the Cognitive Emotion Regulation Questionnaire (CERQ) (Jermann et al., 2006), which is designed to measure the cognitive emotion regulation strategies used by individuals in response

to the experience of stressful life events (Garnefski, Van Den Kommer, et al., 2002). The CERQ consists of 36 items and 9 subscales: self-blame, other-blame, rumination, catastrophising, perspective taking, positive refocusing, positive reappraisal, acceptance and planning. The items are measured on a 5-point Likert scale ranging from 1 (almost never) to 5 (almost always). The individual subscale scores are obtained by summing the scores belonging to the particular subscale (ranging from 4 to 20). The internal reliability scores for each strategy range from 0.68 to 0.87 (Jermann et al., 2006). Finally, **Feedback responsiveness** will be measured by the Coping Flexibility Scale-Revised (CFS-R), a twelve-item self-report questionnaire comprising three scales, namely abandonment, re-coping, and meta-coping, with four items each (T. Kato, 2020). Participants are asked to indicate how the statements apply to them (1 = not applicable, 4 = very applicable). The total score ranges from 12 to 48 and higher scores indicate richer coping flexibility. Cronbach's alphas of the three subscales calculated in a large sample (N = 6,752) ranged between 0.86 and 0.92 (T. Kato, 2020). Overall, the psychometric properties of the CFS-R showed good internal reliability, acceptable test-retest reliability coefficients, and appropriate validity of the CFS-R scores (T. Kato, 2020).

Mindfulness: the Five Facets Mindfulness Questionnaire (FFMQ) (Baer et al., 2006) will be used in its French version (Heeren et al., 2011) to assesses dispositional mindfulness by means of its 24 items using a Likert scale ranging from 1 ("never true") to 5 ("always true"). A previous study showed that the FFMQ is reliable and valid with a Cronbach's alpha of 0.88 (Heeren et al., 2011).

Patient Health Questionnaire-SSADS (PHQ-SSADS): the PHQ-SSADS includes the PHQ-9, GAD-7 and PHQ-15 as well as panic symptoms for the PHQ and it will be used to measure the co-occurrence of somatic, anxiety and depressive symptoms (the SSADS triad)(Kroenke et al., 2010).

- The PHQ-9 is a 9-item measure assessing the severity of depression over the previous 2 weeks. Items are scored on a 4-point Likert-type scale (0 = "not at all" to 3 = "almost every day"). Scores can range from 0 to 27; scores of 20 and above are considered clinically significant. The questionnaire has shown adequate internal validity and high internal consistency reliability (Cronbach's $\alpha=0.87$)(Arthurs et al., 2012).
- The General Anxiety Disorder (GAD-7) is a 7-item scale assessing levels of anxiety over the past 2 weeks. Items are scored on a 4-point Likert-type scale (0

= "not at all" to 3 = "almost every day"). Scores can range from 0 to 21; scores of 15 and above are considered clinically significant. The French GAD-7 has been shown a good internal homogeneity, with satisfactory item-internal consistency and high internal consistency reliability (Cronbach's $\alpha > 0.70$) (Micoulaud-Franchi et al., 2016).

- The PHQ-15 is a 15-item questionnaire assessing SS over the past 4 weeks. Subjects are asked to rate the severity of symptoms as 0 ("not bothered at all"), 1 ("bothered a little"), or 2 ("bothered a lot"). Two additional physical symptoms - feeling tired or having little energy, and trouble sleeping - are coded as 0 ("not at all"), 1 ("several days"), or 2 ("more than half the days" or "nearly every day"). The total PHQ-15 score ranges from 0 to 30 and scores of ≥ 5 , ≥ 10 , and ≥ 15 represent mild, moderate, and severe levels of somatisation. Cronbach's alpha in a recent study translating the English version to French showed a PHQ-15 confidence interval of 0.91 (0.88–0.93).

Adverse childhood experiences: Adverse childhood experiences will be measured using a French translation of the 11-item Adverse Childhood Experiences Questionnaire (Felitti et al., 2019). This questionnaire assesses the occurrence of adverse experiences, including home dysfunction and the occurrence of physical, emotional and sexual abuse. Response options are dichotomous (i.e. yes/no, never/one or more times) and a total score is calculated by adding up all items. The total score, ranging between 0 and 10, is a severity index suggesting how many types of adversities someone has experienced in their childhood. A recent study, using a translation of this scale, has found an acceptable internal consistency ($\rho = 0.86$, $\alpha = 0.64$) and adequate internal validity (Kovács-Tóth et al., 2023).

Alexithymia: the 20-Item Toronto Alexithymia Scale (TAS-20) (Bagby et al., 1994) will be used in its French version (Watters, Taylor, Ayearst, et al., 2016). The 20 items measure three subscales: difficulty identifying emotions (DIF), difficulty describing emotions (DDF), and externally oriented thinking (EOT). Each item consists of a statement that respondents rate on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). All items are summed into a scale total as a marker of overall alexithymia. The total score of the TAS20 ranges from 20 to 100. The TAS-20 has sufficient construct validity and has acceptable internal consistency of the DIF ($\alpha = 0.66$) and DDF ($\alpha = 0.71$) factors. In contrast, the internal consistency of the EOT factor is low ($\alpha = 0.43$) (Zimmermann et al., 2007).

10.2.4 Simple Size and Statistical Analyses

To have enough accuracy in identifying a correct number of latent profiles in LPA, a minimum sample size of about 500 has been suggested (Nylund et al., 2007; Spurk et al., 2020). A similar study, aiming to establish latent profiles based on emotion regulation flexibility and to investigate their potential relationships with depressive and anxious symptoms, used a simple size of 802 participants.

Data analysis will be carried out by Bordeaux Population Health, Inserm (U1219), according to the defined analysis plan. The software used will be MPLUS and R. In order to explore the relationship between flexibility profiles and MRAE we will perform a Latent Profile Analysis, a person-centred statistical method for identifying latent classes from multivariate continuous data (Gana et al., 2022; Lanza & Cooper, 2016). Latent profile analysis is conceptually similar to cluster analysis, as it identifies latent profiles from observed response patterns (Lanza et al., 2013). It is carried out in stages: an initial analysis checks the fit of a model to a profile and subsequent analyses examine the fit of models to an increasing number of profiles. Models will be based on the measures of emotion regulation flexibility and body awareness. All variables will be standardised so that the results are not biased by differences in variance. Established recommendations regarding pre-analyses and missing data treatment will be applied (Spurk et al., 2020). To identify the best fitting model, we will compare the information criteria (IC), including the Bayesian Information Criteria (BIC), Akaike Information Criteria (AIC) and SABIC (Sample-size Adjusted BIC) indexes. Lower values on IC indicate better model fit. We also will take entropy into account. Additionally, for the model comparison verification we will use the statistical model comparison likelihood ratio (Lo-Mendell-Rubin test [LMR]) and the Bootstrap Likelihood Ratio Test (BLRT) to determine if there is a statistically significant improvement in fit for the inclusion of one more class. To ensure that the profiles are clearly differentiated, we will conduct Multivariate analysis of variance (MANOVA), one-way ANOVAs and Duncan's post-hoc tests using profile membership as the independent variable.

In the second phase of the analysis, after the best-fitting LPA model will be selected, we will examine between-group differences in MRAE, and look at possible mediating factor such as contextual factors (i.e., type of MBI, amount of mindfulness meditation, perceived support from the group/instructor, and participant understanding of the instructions)(Farias et al., 2020b; S. B. Goldberg, Lam, et al., 2021), 2) and individual participant characteristics

(depression, anxiety, persistent SS, adverse childhood experiences and alexithymia). After performing our preliminary LPAs, we will conduct an LTA to estimate latent transition probabilities for the two groups across the two time points. The latent transition probabilities will represent the probabilities of patterns of class change across time points (Collins & Lanza, 2009). Finally, multiple regressions will be performed to predict profile differences in MRAE. In addition, clinical significance of longitudinal changes over the course of the MBI will be calculated using the reliable change index (RCI)(Blampied, 2022; Maassen, 2000).

10.3 Discussion

The overarching purpose of this study protocol is to investigate associations between MRAE and patterns of emotion flexibility deficits, using self-report measures of body awareness and emotion regulation flexibility. Flexibility in emotional response and the ability to correctly perceive or not perceive contextual cues could explain differences in the prevalence of adverse responses to mindfulness training. As Farias, Wikholm and Delmonte have stated, “the only way to establish mindfulness as a truly evidence-based therapy is to temper enthusiasm and focus on understanding how it works and when it should (or should not) be used” (Farias et al., 2016, p. 4). Accounting for individual variability in the study of mindfulness adverse experiences would provide a better understanding of the specific subgroups of individuals for whom meditation training is most or least appropriate. This is a crucial step, leading to improved treatment methods and supported systematic implementations of screening procedures. Mindfulness interventions are nowadays widely used and instructors need to be aware of how to monitor, identify and respond optimally to meditation-related difficulties and adverse effects.

KEY POINTS

- Existing studies on Meditation-Related Adverse Effects (MRAE) lack depth in understanding their causes and triggers, especially in Mindfulness-Based Interventions (MBI).
- The primary aim of the research protocol is to examine how emotion regulation flexibility and body awareness contribute to MRAE in MBIs. A person-centered perspective is adopted, focusing on different flexibility profiles and their link to adverse responses.
- Longitudinal Study Design: The study is prospective and longitudinal, with assessments at baseline, post-intervention, and a 3-month follow-up. Clinical changes are assessed over time, distinguishing between transient and persistent adverse effects, ensuring a comprehensive understanding.
- Participant Recruitment: Participants are recruited from certified MBIs conducted by recognized mindfulness instructors in France, ensuring a real-life context.
- Emotion Regulation and Body Awareness: Latent Profile Analysis (LPA) is used to identify emotion regulation patterns. Individual and contextual factors, such as depression, anxiety, program characteristics, and perceived support, are considered.
- Moderating Factors: Factors like program characteristics, participant characteristics, and contextual elements are explored to understand how they influence the relationship between flexibility profiles and MRAE.
- Contextual Understanding: By studying MRAE in real-life MBIs, the research aims to provide specific insights into which individuals might find mindfulness training suitable or challenging.
- Importance for Instructors: The study results will be invaluable for mindfulness instructors, helping them monitor, identify, and respond effectively to participants facing difficulties during meditation practice.
- Enhanced Treatment Approaches: This research contributes to establishing evidence-based mindfulness therapy, emphasizing the need for a nuanced understanding of when and how mindfulness interventions should be used.

General Discussion

The main objective of this thesis was to explore emotional regulation mechanisms in individuals with SS and to critically evaluate the relevance of mindfulness meditation for this specific population. Additionally, considering that the data for both samples were collected during the COVID-19 pandemic, we have also investigated the influence of COVID-19 related anxiety and interpersonal closeness on SS. Throughout the manuscript, we have considered diverse important aspects of SS, ranging from their definition and the methodologies employed for their measurement to an in-depth analysis of the multifaceted construct of alexithymia, elucidating its pivotal role in the emotional processing of individuals dealing with somatic symptomatology. Additionally, adopting a person-centred approach, we have unravelled latent profiles within the intricate fabric of SSAD co-occurrence. Finally, in the second part, we have raised questions about some of the processes that could contribute to the benefits that mindfulness could have on SS, also discussing some difficulties that might arise from these practices. In this final discussion, we bring together all our findings and theoretical considerations carefully exploring what they mean, and suggesting important paths for future research and practical applications in the field.

Reconceptualising Somatic Symptoms and their measurement: a critical perspective

Our research journey initiated with a critical re-examination of terminologies related to SS, moving away from outdated distinctions between organic and functional conditions. As discussed in the first chapter, the understanding of somatisation has evolved through time, shaped by a growing insight into the experiences of individuals exhibiting SS. The latest classification of SSD or BDD marked a significant departure from the previous definition of somatoform disorders (Dimsdale et al., 2013), in which the “unexplainedness” of symptoms had a central role. Instead, new categorisations are focused on the perceived distress experienced by patients and on the fact that SS could entrain excessive and disproportionate thoughts, emotions, and behaviours. However, despite the passage of a decade since the publication of the new diagnosis in the DSM-5, a cursory search on PubMed reveals that, despite its diminishing use, between 2020 and 2023, 61 articles have been published with "medically unexplained symptoms" in their titles, indicating a continued use of this terminology. We argue that keeping a distinction between explained and unexplained symptoms not only perpetuates a division in the conceptualisation and research of this phenomenon but also further divides patients from clinical care (Creed et al., 2010). While we acknowledge the necessity of a term to refer to this phenomenon beyond the confines of SSD

or BDD diagnostic categories (especially in regards to the 6 months delay for diagnosis), we argued that "Persistent Somatic Symptoms" might best capture the enduring nature of this symptomatology, emphasising the prolonged presence of these symptoms and the sufferance of individuals grappling with these conditions. Nevertheless, employing this term necessitates a careful assessment of the persistence of symptoms over time, either with longitudinal studies or with questionnaires capable of capturing the full process of somatisation. In fact, the lasting presence of SS is a dimension overlooked by widely used questionnaires such as the PHQ-15 and the SCL-90. Therefore, in the studies included in this thesis, we have opted to use the term SS, acknowledging the limitation posed by our exclusive reliance on these scales. Thus, these questionnaires only enquire the Criterion A of SSD diagnosis (Toussaint et al., 2020), questioning the level to which individuals have been bothered by symptoms in the past weeks, and therefore capturing symptom severity. Yet, an individual might experience significant distress from one or more symptoms but only for a brief duration, perhaps just for a day. What these questionnaires miss is the crucial temporal gap between the perception of an interoceptive sensation and the phase in which these sensations are attributed to a symptom significant enough to entrain worrying and to look for a doctor's attention. It is imperative to recognise and account for this temporal aspect in shaping the distress experience of SS when evaluating these patients. Although some new scales have introduced this temporal component (e.g., Neuro-11 which also integrates some questions on negative affect; Zeng et al., 2023), they still fail to take into consideration the attribution part of the somatisation process. Instead, the Somatic Symptom Disorder - B Criteria Scale has been developed with the purpose of assessing the psychological aspect of patients' symptom burden (Toussaint et al., 2017). Authors suggest the use of this scale accompanied by scales such as the PHQ-15 (Toussaint et al., 2020). Still, we argue that with the conjunction of these two questionnaires further studies should also employ questions related to the impact of this symptoms on functioning, such as those included in the interference subscale of the Brief Pain Inventory (Cleeland & Ryan, 1994).

A second important aspect to consider is that different questionnaire enquire about different symptoms and only most common symptoms are included, not acknowledging the heterogeneity of possible symptoms individuals could experience (Appendix C). Therefore, for future research we also advise on the inclusion of an extra item questioning other possible SS that participant might experience (Zeng et al., 2023). By broadening the scope of inquiry and considering the multifaceted nature of SS, future research can foster a more accurate understanding, ensuring a more comprehensive approach to research of SS.

Somatic symptoms as emotion regulation flexibility dysfunctions

In Chapter 3, following an exploration of well-known models of emotion regulation, we introduced an integrated framework of emotion regulation flexibility operating at a "meso level". This framework encompasses a wide array of emotion regulation strategies and abilities, integrating theories of allostasis proposed by McEwen and Stellar (1993). To construct this synthesis, we melded Gross's process model of emotion regulation and Bonanno and Burton's model of regulatory flexibility (Bonanno & Burton, 2013; Gross, 1998a, 2015b) with key elements from Panayiotou, Panteli, and Vlemincx's dynamic-phasic model of emotion processing (2018). In alignment with these authors, we contend that incorporating an anticipation phase, along with stages such as recovery, habituation, and resting state, could offer a more nuanced comprehension of emotion regulation processes in individuals with SS, emphasising the circular nature of these processes (Panayiotou et al., 2021). While our thesis primarily focused on the phases of identification and strategy selection in emotion regulation, we posit that integrating these crucial stages with the processes of identification, strategy selection, and feedback could substantially enhance our insight into how individuals manage their emotions when experiencing SS. This holistic approach could not only capture the multifaceted nature of emotion regulation but also offer a nuanced perspective on context-dependent and culture-specific strategies, providing a comprehensive framework for real-life emotional situations.

How did COVID-19-related anxiety affect Somatic Symptoms during the pandemic?

The COVID-19 pandemic has added complexity to the understanding of SS and the blurred line in between medically explained and unexplained symptoms. Examining the relationship between COVID-19-related anxiety and SS, a nuanced picture emerged from two separate studies conducted across different time frames. In the initial stage, a connection between COVID-19-related anxiety and SS was evident, consistent with prior research (Bruno et al., 2020; Shevlin, Nolan, et al., 2020). However, in the second study, which occurred eight months later and incorporated depression alongside anxiety, results from regression analyses did not demonstrate statistical significance, highlighting the evolving nature of this association. Consequently, we have hypothesised that the findings of study I might have showed a habituation effect to the evolving landscape of the COVID-19 pandemic in study II. In fact, changing public health guidelines, the introduction of vaccines, and differing levels of exposure to pandemic-related information might have shaped the dynamics of COVID-19-related anxiety

and SS. The observed disparities between the two studies serve as a reminder of the multifaceted dynamics at play and the importance of considering the evolving context when interpreting psychological and somatic associations.

Furthermore, the second objective of this thesis was to observe the influence of perceived interpersonal closeness on SS and COVID-19 related anxiety. Surprisingly, there was a lack of a substantial correlation between COVID-19-related anxiety and interpersonal closeness in both studies. However, in line with previous studies (Vos et al., 2023; Werner et al., 2021; Xu et al., 2021) a consistent pattern emerged regarding mental health: both anxiety and depression displayed negative correlations, indicating that individuals with higher levels of these conditions reported lower interpersonal closeness. Additionally, our analysis of SS revealed a similar trend, albeit with relatively small effect sizes. These findings underscore the complex interplay between psychological well-being and the perception of interpersonal closeness, emphasising the need to take interpersonal relationships and interpersonal emotion regulation in account in further exploration for better understanding how they may contribute to psychopathology (Dixon-Gordon et al., 2015).

The role of alexithymia as an emotional process deficit in Somatic Symptoms

Our exploration into alexithymia provided profound insights into its intricate relationship with SS. As expected and consistent with existing literature, our findings highlighted the robust predictive power of the Difficulty Identifying Feelings (DIF) dimension, underscoring the crucial significance of emotional awareness on somatic manifestations and psychological distress (De Gucht & Heiser, 2003; Mattila et al., 2008). Notably in our sample, the predictive strength of DIF on SS, together with the one of Difficulty to Describe Feelings (DDF), persisted even after controlling for negative affectivity (Porcelli & Taylor, 2018), diverging from studies in which the relationship between SS and alexithymia became statistically insignificant after considering psychological distress (Bailey & Henry, 2007; De Gucht & Heiser, 2003; Mattila et al., 2008). However, in the sequential mediation presented in Study III, while both DDF and DIF showed a direct impact on SS, only DIF showed an indirect impact through emotion regulation strategies (i.e., rumination and catastrophising) and psychological distress (i.e., anxiety and depression). These results align with a previous study demonstrating that the influence of DIF on somatisation might occur both directly and through the mediation of psychological distress (Lanzara et al., 2020). Furthermore, this understanding is enriched by

integrating emotion regulation strategies like rumination and catastrophising into this relationship.

Furthermore, it's crucial to highlight that DIF and DDF demonstrated a stronger predictive power for SS compared to cognitive emotion regulation strategies. In the hierarchical regression of Study III, adding all strategies from the Cognitive Emotion Regulation Questionnaire (CERQ) after considering the alexithymia subscales, did not result in a significant increase in variance (from $R^2 = 0.28$ to $R^2 = 0.30$), and none of the strategies yielded significant results. If in accordance with the attention-appraisal model of alexithymia (Preece et al., 2017), we hypothesise that DIF and DDF might impact the appraisal phase of emotions, this findings would suggest a greater implication of emotion awareness on SS than the use of maladaptive emotion regulation strategies.

Another important aspect of our research has been the assessment of the relationship between Externally Oriented Thinking (EOT) and SS. As discussed the significance of the influence of this subscale of alexithymia on SS has often been negligible (De Gucht & Heiser, 2003; Mattila et al., 2008). However, drawing from the attention-appraisal model of alexithymia (Preece et al., 2017), our study examined the sequential impact of EOT, DIF, and DDF on SS, incorporating relevant emotion regulation strategies (rumination and catastrophising) and psychological distress. EOT showed no direct association with SS and the full sequential mediation model, including the sums of all direct and indirect effects, only explained 9.23% of the variance in SS scores. However, the results revealed several significant indirect effects of EOT on SS, mediated by both DIF and/or DDF. These findings are crucial as they suggest that previous studies that reported no direct relationships between EOT and SS might have overlooked this underlying mediation effect.

However, it's crucial to address a key consideration concerning the concept of EOT. As discussed previously, the model proposed by Preece et al. (2017) has faced substantial criticism for limiting EOT to mere inattention to emotions, overlooking the complexity of the original *pensée opératoire* concept clinically observed in patients with SS (G. J. Taylor et al., 2023; G. J. Taylor & Bagby, 2021). It is crucial to highlight that, for constructing our sequential model, we specifically utilised the EOT sub-dimension of the TAS-20, designed to assess this operational thinking style. Consequently, we assert that this sub-dimension could still be interpreted as a departure point in the emotional processing connecting alexithymia to SS. This

interpretation aligns with Nemiah et al.'s (1976) vision of *pensée opératoire*, as closely associated with impairments in affect awareness.

The interplay between somatic symptoms and co-occurring anxiety and depression

In the studies of this thesis, we adopted a mixed methodological approach, using both variable-centred and person-centred methods. Unlike variable-centred approaches, which focus on individual variables, person-centred methods (e.g., latent class analysis and cluster analysis) aim to identify meaningful subpopulations while recognising the broader population's heterogeneity (Howard & Hoffman, 2018; Laursen & Hoff, 2006). Employing a person-centred approach, we discerned five distinct profiles marked by different levels of symptom severity in the co-occurrence of SSAD, which contrasts with prior research finding only a 3-class solution in SSAD symptom severity (Jongedijk et al., 2020; Kim et al., 2022). However, in line with previous studies adopting similar methodological approaches, the study revealed a consistent association between SS, anxiety, and depression across all profiles, without any specific profile predominantly displaying exclusively somatic symptoms or anxiety and depression (Bekhuis et al., 2015; Burri et al., 2017; Jongedijk et al., 2020; Kim et al., 2022). However, within the moderate to high symptom severity range, two distinct profiles emerged: one primarily marked by anxiety and the other by depression. These two profiles differed for the presence of chronic medical conditions (higher in the moderate to high profile characterised by depression) and by the use or more maladaptive emotion regulation strategies (higher in the moderate to high profile characterised by anxiety). Although the relationship between SS and negative affect is well known in the literature, as it is known that negative emotions are not only a consequence of SS, but modulates the somatosensory experience (De Gucht et al., 2004; Lundh & Wångby, 2002; Rief & Broadbent, 2007; Van Den Houte et al., 2017), these findings add depth to the understanding of SSAD co-occurrence and can offer valuable insights for enhancing clinical care practices.

The relationship between Somatic Symptoms and emotion regulation strategies

Differences in emotion regulation strategies between SSAD symptom severity groups were noted. Positive reappraisal consistently diminished in intensity with increasing SSAD comorbidity severity, while self-blame and catastrophising intensified in proportion to the severity levels. Most importantly, rumination and other-blame specifically predicted membership in the moderate to high symptom severity profile characterised by anxiety and in

the highest symptoms severity group, but not in the moderate to high symptom severity profile characterised by depression. However, this group was characterised by a lower use of positive refocusing and higher refocusing on planning. Thus, these findings suggest specific vulnerabilities in the emotion regulation strategy selection phase of different SSAD symptom severity groups, emphasising that a one-size-fits-all approach to treatment might be inadequate.

In this thesis we also explored the impact of rumination and catastrophising on SS, two maladaptive emotion regulation strategies widely discussed in prior literature on SS (Kwon et al., 2021; Le Borgne et al., 2017; Mewes, 2022). Additionally, rumination, recognised as a transdiagnostic process, plays a central role in multiple disorders such as depression and anxiety, and is identified as a risk factor for chronic pain (Aldao & Nolen-Hoeksema, 2010b). While previous studies have emphasised the importance of these strategies, we proposed a potential link between rumination and catastrophising. Our hypothesis was based on the idea that rumination constitutes one aspect of the multifaceted concept of catastrophising, encompassing elements like magnification and feelings of helplessness (Sullivan et al., 1995). Furthermore, a conceptualisation of catastrophising by Flink, Boersma, and Linton views it as a repetitive negative thinking pattern that also includes worry and rumination. This cognitive process involves abstract thoughts, intrusiveness, and challenges in disengaging from these thoughts (Flink et al., 2013). According to the authors, this repetitive and abstract cognitive activity serves as a dysfunctional avoidance strategy, aiming to regulate negative emotions. Addressing emotions on a superficial level temporarily inhibits intense emotional reactions, but in the long term, hinders the treatment and integration of emotional and somatic responses. Consequently, patients struggle to cope with symptoms in an adaptive manner.

Our research identified a robust positive association between rumination and catastrophising. However, in the presented sequential mediation model, neither rumination nor catastrophising directly influenced SS. Instead, their effects consistently appeared to be mediated by psychological distress. This implies that while these strategies might impact psychological distress, it is the latter that could act as the mediator in the intricate relationship between emotional regulation difficulties and somatic symptomatology.

Mindfulness processes and mindfulness practice for SS

In the second part of this thesis we have questioned the pertinence of mindfulness for individuals struggling with SS. Indeed, Mindfulness-Based-Interventions (MBI) have been embraced as viable adjunctive treatments for patients presenting SS (Roenneberg et al., 2019). These approaches are particularly intriguing, considering that patients often struggle to believe that a 'talking cure' could alleviate their predominantly physical symptoms and concerns (Henningsen, 2018). However, as previously explained, in the literature a definition is not always made between mindfulness as a state, as a disposition (or trait mindfulness) and as an intentional practice of meditation (Tang et al., 2017; Wheeler et al., 2016).

The study presented in this part (Study V) aimed to enhance our understanding of how SS have been influenced by mindfulness practice, dispositional mindfulness and psychological distress during the COVID-19 pandemic. Additionally, delving into the role of practice experience, the study differentiated between non-practitioners, beginners, and advanced practitioners. As expected, dispositional mindfulness was found to be strongly associated with less somatic complaints and psychological distress, indicating its protective role. Unexpectedly, we found no direct correlation between dispositional mindfulness and mindfulness meditation experience, challenging conventional beliefs that intentional mindfulness meditation can induce temporary mindful states and lead to lasting changes in personality traits through consistent, long-term practice (Shapiro et al., 2011; Tang et al., 2017). Moreover, if advanced practitioners showed superior adaptive emotion regulation skills, less experienced practitioners displayed heightened SS, possibly stemming from increased body awareness without the development of emotion regulation skills nurtured by mindfulness practices. Thus, given that the three groups showed no disparities in terms of anxiety, depression, and COVID-19-related anxiety, the elevated SS in beginners could not be attributed to psychological distress alone. These findings bring to the necessity of a crucial re-evaluation of the pertinence of mindfulness meditation as a therapeutic approach for individuals with SS, urging for a deeper understanding of its intricate relationship with emotional regulation and the unique challenges faced by individuals at different stages of their mindfulness journey. In fact, the recent literature on Mindfulness-Related-Adverse-Effects (MRAE), shows how practitioners can encounter several difficulties during their practice and could interpret symptoms arising from the practice as a secondary effect rather than a normal sign of progression (Britton et al., 2021; Lindahl et al., 2017, 2020).

Considering the tight relationship that SS have with alexithymic trait, we need to take into consideration clinical advices that have been given in treating these patients. As reminded

by Taylor, Bagby and Porcelli (2023) in their recent article on the concept of *pensée opératoire*, cautionary advice has been provided by several psychoanalysts regarding pushing patients to access their emotions (Barth, 1998; Krystal, 1979; McDougall, 1989). In fact, there might be an adaptive function of keeping emotions out of awareness, indicating that some patients face challenges not in experiencing emotions but in containing and reflecting upon an excess of emotional experiences, creating what McDougall called a "defensive prison" (McDougall, 1982, 1989). Aisenstein (2022) reinforced this notion, proposing that *pensée opératoire* and *vie opératoire* serve as complex defences against the risk of psychic collapse or internal chaos. These insights underscore the delicate balance therapists must maintain when addressing their patients' emotional experiences. We posit that recognising and managing intense emotions must be considered when working with patients experiencing SS and that this challenge can be effectively addressed within a therapeutic relationship guided by an informed therapist.

Examining minor sociodemographic factors, an intriguing discovery emerges concerning the impact of age on somatic symptoms

One of the minor findings we want to discuss regards the effect of age on SS. While previous research has often pointed to an increase in SS with age (Beutel et al., 2020; Bohman et al., 2012; Nummi et al., 2017), our thesis presents a contrasting pattern. In both samples analysed, we consistently observed that older age was associated with lower levels of psychopathology. Remarkably, this negative correlation was significant not only for anxiety but also for depression and overall SS in the second sample. Additionally, older individuals displayed a reduced reliance on maladaptive emotion regulation strategies, further supporting the notion that they may exhibit more effective coping mechanisms than younger individuals when faced with somatic symptoms (Hilderink et al., 2015). Considering that the ranges of ages included in our studies were quite wide (Study I: 18–84; Study II: 18–89), these findings challenge conventional beliefs on higher symptomatology in older age and align with existing theories, such as theory of Socioemotional Selectivity, suggesting that when individuals perceive constraints on their time, their motivations shift towards emotionally significant objectives. This heightened focus on emotional goals leads to improved regulation of emotions in daily life binging older individuals to exhibit superior coping abilities in the face of general psychological distress.

Limits and future directions:

The findings of this thesis hold important implications for both research and clinical practice. Firstly, our work highlights the necessity for a multidimensional assessment of SS. Secondly, the recognition of distinct profiles within SSAD as well as the variations in the use of cognitive emotion regulation strategies, underscores the need for personalised interventions. Tailoring treatments based on individual profiles could lead to more effective therapeutic outcomes. Moreover, our research emphasises the critical role of emotional awareness and regulation in somatic expressions, urging researchers to further investigate these aspects and clinicians to consider these factors in their therapeutic approaches.

The thesis's findings are not without limitations, necessitating a careful interpretation. One notable concern is the reliance on self-report measures and on the online assessment of the cross-sectional studies presented, which inherently introduce the possibility of biases. The subjective nature of these assessments raises questions about the accuracy and depth of the data, highlighting the need for a more comprehensive multi-method approach. For instance, for the assessment of alexithymia, Bagby et al. (2006) recommended the use of structured interviews, which could provide a more nuanced understanding and evaluation beyond self-reported responses. Integrating these interviews into future investigations would enhance the accuracy and validity of the assessments, providing a more robust foundation for the research findings.

Secondly, the study's use of community samples, although common, limits the generalisability of the findings. While efforts were made to control sociodemographic differences in the population, there remains a risk of underrepresentation or overrepresentation within the sample, potentially skewing the results. In fact, both samples did not present an equal gender distribution and women were significantly overrepresented (90%). This imbalance prevents meaningful gender comparisons and raises questions about the generalisability of the findings. Furthermore, the study's prevalence rates of SS (56%), anxiety (36%), and depression (46%), were notably higher than those reported in the literature during the COVID-19 pandemic (Ran et al., 2020; Salari et al., 2020; Xiong et al., 2020). While this discrepancy could be attributed to the ongoing uncertainties related to the pandemic, it is essential to acknowledge the potential influence of the study's sampling method on these elevated rates. The inherent biases linked to sampling might have contributed to the exaggerated psychological distress observed. Moreover, we did not include a discussion on cultural comparison between the Italian and French population included in Study III. In fact, these two populations exhibited significant differences in the variables of interest: PHQ15 (France: $M (SD) = 10.6 (5.27)$; Italy:

$M (SD) = 9.17 (4.81)$, $p < 0.001$); TAS-20 (France: $M (SD) = 51.8 (12.7)$; Italy: $M (SD) = 47.3 (14.0)$, $p < 0.001$); PHQ-8 (France: $M (SD) = 9.50 (6.04)$; Italy: $M (SD) = 8.58 (4.85)$, $p = 0.03$). These cultural nuances should be taken into account when interpreting the study's findings and considering their broader applicability.

These findings serve as a foundation for reflection. However, longitudinal studies or experimental approaches are needed to unravel the temporal dynamics between mindfulness practice, emotional regulation, and somatic symptoms. These methods are crucial for gaining a deeper understanding of the underlying processes involved. Although the first sample presented in the thesis comes from a short-longitudinal design, the low response rate at the second measurement point of the study ($N = 284$ without accounting for outliers) did not allow the use of longitudinal person-centred approaches such as longitudinal latent class (LCA) or latent transition analysis (LTA) (Lanza et al., 2013; Nylund-Gibson et al., 2023). In LCA, suggestions for the minimum sample size vary, spanning from 300 to 1000, with some researchers advocating for a minimum of 500 (Nylund-Gibson et al., 2023). Simulations also highlight the need for larger sample sizes in LTA, underlining the necessity for samples exceeding 500 (Nylund-Gibson et al., 2023). Future longitudinal investigations could capture the changes in these variables over time, elucidating the causal pathways and shedding light on the mechanisms underlying the observed associations. Moreover, experimental methodologies, such as intervention studies with control groups, could explore the effects of specific mindfulness interventions on somatic symptoms, offering valuable insights into the potential therapeutic applications of mindfulness practices.

In the first sample we omitted the inclusion of a mindfulness scale and assessment of mindfulness practice, which could have allowed for the replication of some of the presented findings. Additionally, we did not include the exploration of specific meditation styles within mindfulness practices. Mindfulness practices encompass diverse techniques, including attentional, constructive, and deconstructive meditations, each engaging distinct cognitive mechanisms (Dahl et al., 2015). Understanding how these specific styles influence somatic symptomatology and emotional regulation could offer valuable insights into the differential effects of mindfulness interventions. Future research could delve deeper into these specific meditation styles, unravelling their unique contributions to emotional regulation and somatic symptomatology. The study lacked a measure of some important emotion regulation strategies (i.e., suppression), which could have influenced results, as well as a measure of decentering and

interoceptive awareness. Interoception, the perception of internal bodily sensations, plays a pivotal role in mindfulness practices, influencing individuals' ability to regulate emotions and respond to somatic cues effectively. The absence of this measure limits the depth of understanding, as interoceptive awareness could potentially mediate the relationship between mindfulness practice and SS. Including this dimension in future studies would provide a more holistic perspective on the intricate interplay between mindfulness, interoception, and somatic symptomatology.

In summary, while the studies presented offer valuable insights into the intricate relationships among somatic symptomatology, emotional regulation processes, and mindfulness, these findings should be interpreted within the context of their limitations. The reliance on self-report measures, the sampling method, the gender imbalance, the absence of interoceptive awareness assessment, the lack of differentiation between specific meditation styles, and the cross-sectional design necessitate caution in drawing definitive conclusions. Many of these limitations will be addressed in our upcoming study, the detailed protocol of which is presented in Chapter 10. This study will provide a unique opportunity for observing unwanted and distressing somatic experiences in the real-life setting of MBI. Accounting for inter-individual variability in the study of meditation adverse experiences will contribute to a better understanding of the specific subgroups of individuals for whom meditation practice is most or least appropriate, particularly shedding light on the processes relevant to individuals dealing with SS. Moreover these study will also take into account past traumatic childhood experiences, making a connection between emotion regulation and trauma. These findings may have important implications for the delivery of mindfulness training and for the safety of MBI participants, raising awareness on the possible risks of mindfulness practice and helping instructors to better monitor and support participants encountering difficulties. These findings will enrich the depth and applicability of the current studies, paving the way for more nuanced understandings of the complex interplay between emotional regulation, mindfulness processes and SS.

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Appendices

Appendix A. Questionnaires included in the studies presented

Title: The Body and Its Emotions: Research on the Impact of Covid-19 on the General Population

Welcome to the research by the Psychology Laboratory of the University of G. D'Annunzio on the impact of COVID-19 on our emotions and somatic symptoms. In this research, we seek to understand the emotional consequences of COVID-19 on our daily lives. Your participation will take approximately 15 to 20 minutes. There are no right or wrong answers. Your responses are free, confidential, and anonymous. You can stop your participation at any time without providing any justifications. It is important that you complete the questionnaires in their entirety. Some questions may appear repetitive or peculiar, but we ask you to respond with the first thing that comes to mind, even if it contradicts previous answers. At the end of the study, you may be contacted to participate in the second part, which will take place in two months. For any additional information or if you wish to receive information about the results of this research, you can contact us at the following email address: noemi.micheli@u-bordeaux.fr. Thank you for your participation.

Creating an anonymous and personal code

To ensure your anonymity, please create your personal code. Include:

The first letter of your mother's name (example: Mother = Laura);

The first letter of your father's name (example: Father = Paolo);

The last two digits of your mobile number (No. = 338 ***** 75);

Your date of birth (June 2nd).

Example of the code → LP7502

Please do not add characters other than those requested to the personal code.

Sociodemographic questions

Gender: Male, Female, Other

Age: (Free response, integer format, max length: 10)

Region of Residence: (Free response, integer format, length: 5)

Highest Education Level: None, Middle School, Technical/Professional High School, High School, Bachelor's Degree, Master's Degree/Specialist, Doctorate

Occupation: Farmer, Craftsman/Shopkeeper/Entrepreneur, Liberal Profession/Manager, Intermediate Occupation, Employee, Worker, Retired, Not Working or Seeking Work, Student, Other (with a contingent question for specification)

Current Employment Status: Working from Home, Partial Unemployment, Continuing Work On-site, Lost Job, Other (with a contingent question for specification)

Monthly Gross Income: (Free response, long text format, max length: 24)

Living Arrangement: Alone, Only with Children, Only with Children in Joint Custody, Only with Spouse, With Family, With Friends or Roommates, Other (with a contingent question for specification)

Health-related questions

Do you suffer from a psychological disorder? (Yes/No)

Do you have a chronic illness (this does not include COVID-19)?

A chronic illness is a condition that permanently affects a person, for their entire life or for a significant part of their life.

(Yes/No)

Do you think you have had COVID-19? (Yes/No)

Do you have a loved one (family or friends) who has been diagnosed with Covid-19? (Yes/No)

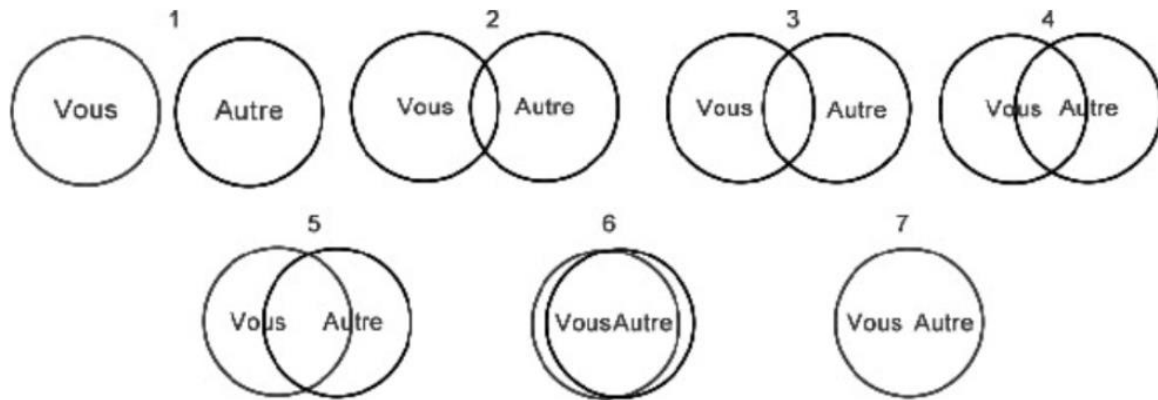
Do you practice mindfulness (yoga, meditation, or breathing exercises)? (Yes/No)

COVID-19-related anxiety

From 0 to 10, how anxious do you feel about Coronavirus? (Scale: 0 = Not Worried at All, 10 = Extremely Worried)

Perceived interpersonal closeness: Other in the Self, adapted from Aron, Aron and Smollan (1992).

Below are 7 figures that express varying degrees of connection to others. Which figure expresses how you have feel surrounded by those closest to you?



Somatic Symptoms

PHQ-15

During the past two weeks, how much have you been bothered by any of the following problems?	Not bothered at all	Botherd a little	Bothered a lot	Not bothered at all
a. Stomach pain				
b. Back pain				
c. Pain in your arms, legs, or joints (knees, hips, etc.)				
d. Menstrual cramps or other problems with your periods WOMEN ONLY				
e. Headaches				
f. Chest pain				
g. Dizziness				
h. Fainting spells				

i. <i>Feeling your heart pound or race</i>				
j. <i>Shortness of breath</i>				
k. <i>Pain or problems during sexual intercourse</i>				
l. <i>Constipation, loose bowels, or diarrhea</i>				
m. <i>Nausea, gas, or indigestion</i>				
n. <i>Feeling tired or having low energy</i>				
o. <i>Trouble sleeping</i>				

Psychological distress

Generalized Anxiety Disorder 7-item Scale (GAD-7; Spitzer et al., 2006)

Over the last two weeks, how often have you been bothered by the following problems?	Not at all	Several days	More than half the days	Nearly every day
1. <i>Feeling nervous, anxious, or on edge</i>	0	1	2	3
2. <i>Not being able to stop or control worrying</i>	0	1	2	3
3. <i>Worrying too much about different things</i>	0	1	2	3
4. <i>Trouble relaxing</i>	0	1	2	3
5. <i>Being so restless that it is hard to sit still</i>	0	1	2	3
6. <i>Becoming easily annoyed or irritable</i>	0	1	2	3
7. <i>Feeling afraid, as if something awful might happen</i>	0	1	2	3

Patient Health Questionnaire-8 (PHQ-8; Kroenke et al., 2009).

Over the last two weeks, how often have you been bothered by the following problems?	Not at all	Several days	More than half the days	Nearly every day
1. <i>Little interest or pleasure in doing things</i>	0	1	2	3
2. <i>Feeling down, depressed, or hopeless</i>	0	1	2	3
3. <i>Trouble falling or staying asleep, or sleeping too much</i>	0	1	2	3

<i>4. Feeling tired or having little energy</i>	0	1	2	3
<i>5. Poor appetite or overeating</i>	0	1	2	3
<i>6. Feeling bad about yourself — or that you are a failure or have let yourself or your family down</i>	0	1	2	3
<i>7. Trouble concentrating on things, such as reading the newspaper or watching television</i>	0	1	2	3
<i>8. Moving or speaking so slowly that other people could have noticed? Or the opposite — being so fidgety or restless that you have been moving around a lot more than usual</i>	0	1	2	3

The Toronto Alexithymia Scale (TAS-20)

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
<i>1. I am often confused about what emotion I am feeling</i>					
<i>2. It is difficult for me to find the right words for my feelings</i>					
<i>3. I have physical sensations that even doctors don't understand</i>					
<i>4. I am able to describe my feelings easily(R)</i>					
<i>5. I prefer to analyze problems rather than just describe them (R)</i>					
<i>6. When I am upset, I don't know if I am sad, frightened, or angry</i>					
<i>7. I am often puzzled by sensations in my body</i>					
<i>8. I prefer to just let things happen rather than to understand why they turned out that way</i>					
<i>9. I have feelings that I can't quite identify</i>					
<i>10. Being in touch with emotions is essential (R)</i>					
<i>11. I find it hard to describe how I feel about people</i>					

12. <i>People tell me to describe my feelings more</i>					
13. <i>I don't know what's going on inside me</i>					
14. <i>I often don't know why I am angry</i>					
15. <i>I prefer talking to people about their daily activities rather than their feelings</i>					
16. <i>I prefer to watch "light" entertainment shows rather than psychological dramas</i>					
17. <i>It's difficult for me to reveal my innermost feelings, even to close friends</i>					
18. <i>I can feel close to someone, even in moments of silence (R)</i>					
19. <i>I find examination of my feelings useful in solving personal problems (R)</i>					
20. <i>Looking for hidden meanings in movies or plays distracts from their enjoyment</i>					

Cognitive Emotion Regulation Questionnaire (CERQ) (Garnefski et al., 2001)

	Almost never	Rarely	Occasionally	Frequently	Almost always
1. <i>I feel that I am the one to blame for it.</i>					
2. <i>I feel that I am the one who is responsible for what has happened.</i>					
3. <i>I think about the mistakes I have made in this matter.</i>					
4. <i>I think that basically the cause my lie within myself.</i>					
5. <i>I think that I have to accept that this has happened.</i>					
6. <i>I think that I have to accept the situation.</i>					
7. <i>I think that I cannot change anything about it.</i>					
8. <i>I think I must learn to live with it.</i>					
9. <i>I often think about how I feel about what I have experienced.</i>					
10. <i>I am preoccupied with what I think and feel about what I have experienced.</i>					
11. <i>I want to understand why I feel the way I do about what I have experienced.</i>					
12. <i>I dwell upon the feelings the situation has evoked in me.</i>					
13. <i>I think of nicer things that what I have experienced.</i>					
14. <i>I think of pleasant things that have nothing to do with it.</i>					
15. <i>I think of something nice instead of what has happened.</i>					
16. <i>I think about pleasant experiences.</i>					

17. I think about what I can do best.						
18. I think about how I can best cope with the situation.						
19. I think about how to change the situation.						
20. I think about a plan of what I can do best.						
21. I think I can learn something from the situation.						
22. I think that I can become a stronger person as a result of what has happened.						
23. I think that the situation also has its positive sides.						
24. I look for the positive sides to the matter.						
25. I think that it could have all been much worse.						
26. I think that other people go through much worse experiences.						
27. I think that it hasn't been too bad compared to other things.						
28. I tell myself that there are worse things in life.						
29. I often think that what I have experienced is much worse than what others have experienced.						
30. I keep thinking about how terrible it is what I have experienced.						
31. I often think that what I have experienced is the worst that can happen to a person.						
32. I continually think how horrible the situation has been.						

Dispositional mindfulness - Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003a)

Please indicate the degree to which you agree with each of the following items using the scale below.	Almost always	Very frequently	Somewhat frequently	Somewhat frequently	Very infrequently	Almost never
1. I could be experiencing some emotion and not be conscious of it until some time later.						
2. I break or spill things because of carelessness, not paying attention, or thinking of something else.						
3. I find it difficult to stay focused on what's happening in the present.						
4. I tend to walk quickly to get where I'm going without paying attention to what I experience along the way.						
5. I tend not to notice feelings of physical tension or discomfort until they really grab my attention.						
6. I forget a person's name almost as soon as I've been told it for the first time.						
7. It seems I am "running on automatic" without much awareness of what I'm doing.						

8. <i>I rush through activities without being really attentive to them.</i>						
9. <i>I get so focused on the goal I want to achieve that I lose touch with what I am doing right now to get there.</i>						
10. <i>I do jobs or tasks automatically, without being aware of what I'm doing.</i>						
11. <i>I find myself listening to someone with one ear, doing something else at the same time.</i>						
12. <i>I drive places on "automatic pilot" and then wonder why I went there.</i>						
13. <i>I find myself preoccupied with the future or the past.</i>						
14. <i>I find myself doing things without paying attention.</i>						
15. <i>I snack without being aware that I'm eating.</i>						

Mindfulness practice

Do you practise mindfulness (yoga, meditation or breathing exercises)? (Yes/No)

How many times a week? (Less than once a week; 1 time per week; between 2 and 3 times a week; between 4 and 5 times a week; more than 6 times per week)

Per ogni sessione, quanto tempo? (10 minut

Da 10 a 30 minuti

Da 30 minuti a 2 ore

Più di 2 ore

Appendix B. Tables of models predicting PHQ-15 scale and subscale scores in UK (Shevlin et al., 2020) and Italy (Bruno et al., 2020).

Table 27

Unstandardised regression coefficients from models predicting PHQ-15 Scale and Subscales scores in Shevlin et al. (2020)

	Pain	Gastro	Cardio	Fatigue	Total scale
<i>Model 1</i>					
COVID-19 anxiety					
Quintile 1	–	–	–	–	–
Quintile 2	0.140	0.339**	0.231	0.178*	0.889**
Quintile 3	0.189*	0.340**	0.119	0.281***	0.931**
Quintile 4	0.181*	0.289**	0.064	0.267**	0.801*
Quintile 5	0.427***	0.594***	0.251*	0.590***	1.863***
R ²	.011*	.012**	.004	.027***	.015**
<i>Model 2</i>					
COVID-19 anxiety					
Quintile 1	–	–	–	–	–
Quintile 2	0.103	0.249*	0.164	0.122	0.637*
Quintile 3	0.141	0.251*	0.058	0.196**	0.647*
Quintile 4	0.121	0.230*	0.014	0.179*	0.544
Quintile 5	0.232*	0.327**	0.058	0.337***	0.954**
Control variables					
Age	–0.004*	–0.019***	–0.013***	–0.005**	–0.041***
Gender (female)	–0.074	0.021	–0.305***	0.123*	–0.234
Income	–0.065**	–0.052*	–0.022	–0.028	–0.167*
Health problem	0.262**	0.395***	0.360***	0.238**	1.255***
GAD-7 ≥ 10	0.858***	1.243***	1.059***	0.971***	4.131***
R ²	.103***	.172***	.152***	.169***	.198***

Note. * $p < .05$; ** $p < .01$; *** $p < .001$.

Table 26

Regression coefficients from models predicting PHQ-15 Scale and Subscales scores from Bruno et al.(2020)

	Pain	Gastro	Cardio	Fatigue	Total Score
<i>Model 1</i>					
COVID-19 anxiety					
Quintile 1	–	–	–	–	–
Quintile 2	0.18	0.61**	0.33*	0.23*	1.36**
Quintile 3	0.26*	0.91***	0.55***	0.30**	2.03***
Quintile 4	0.26*	0.89***	0.53***	0.47***	2.15***
Quintile 5	0.56***	1.20***	0.90***	0.72***	3.40***
R ²	0.02***	0.04***	0.03***	0.04***	0.05***
<i>Model 2</i>					
COVID-19 anxiety					
Quintile 1	–	–	–	–	–
Quintile 2	0.13	0.42*	0.22	0.14	0.92*
Quintile 3	0.12	0.46*	0.26	0.10	0.95*
Quintile 4	0.08	0.37	0.19	0.23	0.87
Quintile 5	0.25*	0.38	0.32	0.32*	1.27*
Control variables					
Age	0.006**	–0.01***	0.00	0.00	–0.02
Gender (Male)	–0.18*	–0.30*	–0.24*	–0.20*	–0.93**
Income (Max)	–0.12	0.08	0.10	0.00	0.04
Health Problem (Yes)	0.52***	0.63***	0.60***	0.50***	2.27***
GAD-7 ≥ 10	0.75***	1.82***	1.48***	0.87***	4.93***
Region					
Lazio	–0.19	–0.17	–0.12	–0.14	–0.63
Lombardia	–0.21*	–0.15	–0.09	–0.19	–0.64
Veneto	–0.26*	–0.38	–0.19	–0.18	–1.03*
Human Losses due to COVID-19					
Yes	0.30*	0.71***	0.37*	0.41***	1.80***
Not sure	0.43*	0.34	0.09	0.34*	1.21
R ²	0.14***	0.24***	0.22***	0.18***	0.27***

Note. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (adjusted controlling the false discovery rate [32]).

Appendix C. Correspondence between the Patient Health Questionnaire-15 (PHQ-15) and the Symptom Checklist-90 Somatization (SCL-90 SOM)

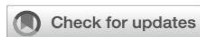
PHQ-15:

- Question: During the last 4 weeks, how much have you have been bothered by any of the following problems? Please place a check mark in the box to indicate your answer.
- Answer options: Not bothered at all (0); Bothered a little (1); Bothered a lot (2).

SCL-90 SOM:

- Question: Below is a list of problems and complaints that people sometimes have. Please read each one carefully. After you have done so, select one of the numbered descriptors that best describes **HOW MUCH THAT PROBLEM HAS BOTHERED OR DISTRESSED YOU DURING THE PAST WEEK, INCLUDING TODAY.**
- Answer options: Not at all (0); A little bit (1); Moderately (2); Quite a bit (3); Extremely (4).

Patient Health Questionnaire-15: Physical Symptoms (PHQ-15)	Symptom CheckList-90 Somatization (SCL-90 SOM)
Stomach pain	-
Back pain	27. Pains in lower back
Pain in your arms or legs or other joints	-
Menstrual cramps or other problems with your periods (women only)	-
Headaches	1. Headaches
Chest Pain	12. Pains in heart or chest
Dizziness	4. Faintness or dizziness
Fainting spells	4. Faintness or dizziness
Feeling your heart pound or race	-
Shortness of breath	48. Trouble getting your breath
Pain or problems during sexual intercourse	-
Constipation, loose bowels, or diarrhoea	-
Nausea, gas, or indigestion	40. Nausea or upset stomach
Feeling tired, or having low energy	-
Trouble sleeping	-
	42. Soreness of your muscles
	49. Hot or cold spells
	52. Numbness or tingling in parts of your body
	53. A lump in your throat
	56. Feeling weak in parts of your body
	58. Heavy feelings in your arms or legs



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Does the practice of mindfulness reduce somatic symptoms and COVID-19-related anxiety? A community-based survey

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Objective: Since the beginning of COVID-19 pandemic, several studies have shown an increase of psychological distress in the general population. Previous research demonstrated that high levels of anxiety are associated with reporting more somatic symptoms. The ability to adaptively regulate emotions is essential to deal with stressful situations, and it is one of the main components of mindfulness practice. The aim of the present study was to document the effect of mindfulness practice on somatic symptoms and psychological distress in the context of COVID-19 pandemic.

Methods: The study has a descriptive cross-sectional design. During the second wave of COVID-19 pandemic, between November 2020 and January 2021 participants living in France responded to an online survey on the impact of COVID-19 on psychological distress and physical health. The questionnaire included the assessment of COVID-19-related anxiety, mindfulness practice and experience, dispositional mindfulness, somatization, depression, generalized anxiety, and emotion regulation.

Results: A total of 569 people (mean age=39.8years, 90% women) were included in the study. COVID-19 related anxiety was associated with higher levels of somatic symptoms, generalized anxiety, and depression. About half of the sample ($n=318$, 56%) reported moderate to severe somatic symptoms that were associated with higher levels of depression and anxiety, lower levels of dispositional mindfulness and to the use of maladaptive emotion regulation strategies. Overall, 164 subjects (28.8%) reported practicing meditation. No differences were found in dispositional mindfulness (MAAS score) between beginners and advanced practitioners, regardless of the type, years, frequency, and length of practice. Participants with less experience in mindfulness practice reported a significant higher number of somatic symptoms than non-practitioners and a higher use of rumination. Moreover, mindfulness experience was associated with the use of more adaptive emotion regulation strategies.

Conclusion: Mindfulness meditation has been promoted as a practice enhancing well-being and helping to cope with the psychological impact of stressful events. However, in a distressing situation as COVID-19 pandemic, a

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limited experience in mindfulness practices might result in the development or endurance of somatic symptoms. Adequate training and a focus on mindful acceptance, may contribute to enhance the effectiveness of mindfulness practice.

KEYWORDS

mindfulness practice, dispositional mindfulness, COVID-19 anxiety, somatic symptoms, emotional regulation strategies

Introduction

In 2019, the World has been stroked by the spreading of the new SARS-CoV-2 coronavirus, bringing the World Health Organization to officially declare the COVID-19 outbreak as a pandemic on March 11, 2020. Population's daily life has been altered by unprecedented public health measures, causing people to experience social isolation, adverse media exposure, worry about significant others, and limited access to health services (Jernigan, 2020; Cruz et al., 2021; Talic et al., 2021). As a result, the pandemic has created not only the “perfect storm” for an augmentation of anxiety and depression (Barzilay et al., 2020; Lakhan et al., 2020; Prete et al., 2020; Salari et al., 2020; Boden et al., 2021), which increased through the two lockdown periods (Lu et al., 2022), but also of persistent somatic symptoms (Bruno et al., 2020; Shevlin et al., 2020; Willis and Chalder, 2021).

Persistent somatic symptoms, also defined as medically unexplained symptoms or functional somatic symptoms, can result from a tendency to experience and communicate psychological distress in the form of physical symptoms and to seek medical help for them (Lipowski, 1988; Roenneberg et al., 2019). Somatic Symptom Disorder (SSD) is the corresponding diagnosis in the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), and refers to persistent (6 months or more) and clinically significant somatic complaints accompanied with excessive health-related thoughts, feelings, and behaviors, regardless of the functional vs. organic nature of the symptoms (American Psychiatric Association, 2013). The most common symptoms include pain, fatigue, and disturbances in the organ functions (Witthöft et al., 2016). The underlying mechanisms of the development of somatic symptoms are still not fully understood (Groen et al., 2021), but research has shown that they are associated with at least a 2-fold increase in the likelihood of having a depressive and/or anxiety disorder (Kroenke et al., 1997; Janssens et al., 2010; van Boven et al., 2011; Groen et al., 2021). This might be due to the fact that high-state anxiety and depression can induce physiological changes, an intensified attention to the body and an alteration of the cognitive processing of physical sensations, representing important precipitating factors (Mayou and Farmer, 2002; Janssens et al., 2010; Mallorquí-bagué et al., 2016). Indeed, the attention to bodily sensations is usually high in subjects who report somatic symptoms (Mirams

et al., 2013; Mehling, 2016) and tend to interpret physical sensations as a sign of illness (Duddu et al., 2003; Rief et al., 2004). In a distressing situation such as COVID-19 pandemic, during which people had to be particularly attentive to any signs of virus infection, these attribution and regulation tendencies might have been heightened. In fact, while the prevalence of persistent somatic symptom in the general population ranges between 6.7 and 17.4%, it has been found to be 45.9% at the peak of the pandemic (Ran et al., 2020), which is similar to the one usually recorded in primary care patients (Löwe et al., 2022).

Studies assessing the practice of mindfulness meditation during COVID-19 showed positive results on the psychological distress of the population, suggesting that mindfulness meditation might be a viable intervention for the impact of the pandemic on mental health (Matiz et al., 2020; Bursky et al., 2021; Zhu et al., 2021). Mindfulness meditation, training the propensity to attend to and accept the present moment experiences (Brown and Ryan, 2003; Baer and Krietemeyer, 2006), facilitates the positive reappraisal of stressful life events, decreasing maladaptive coping cognitive processes known to prolong the experiences of psychological distress (Nolen-Hoeksema, 2000; Jain et al., 2007; Garland et al., 2011). This increase in emotion regulation is crucial in patients with somatic complaints as a lack of emotional awareness and an overuse of maladaptive emotion regulation strategies are considered basic psychological liabilities of Somatic Symptom Disorder (Waller and Scheidt, 2004; Garnefski et al., 2017; Okur Güney et al., 2019). Previous research has shown that mindfulness meditation can have a positive impact on some aspects of somatization, such as symptom severity and pain intensity, and on comorbid anxiety and depression (Hoge et al., 2013; Lakhan and Schofield, 2013; Aucoin et al., 2014; Hilton et al., 2017; Hazlett-Stevens, 2018; Billones et al., 2020). However, the body of evidence prevents strong conclusions, as available studies are mostly based on mindfulness interventions, in which social determinants, such as the relationship with the instructor and the group, have been found to be stronger predictors than specific mindfulness practice-related factors on psychological outcomes (Canby et al., 2021). Furthermore, mindfulness can be a state, a training, or a disposition that can be promoted through training, but in the evidence, a clear distinction is not always made between intentional mindfulness meditation and dispositional mindfulness (Rau and Williams, 2016; Wheeler et al., 2016; Tang

et al., 2017). Dispositional mindfulness has protective effects against psychological distress (Tomlinson et al., 2018). However, different levels of dispositional mindfulness have been observed in the population, independently of mindfulness practice (Brown et al., 2007). Intentional mindfulness meditation, instead, can induce subjects into temporary states of mindfulness and bring to modifications in personality traits following a longer period of regular practice (Shapiro et al., 2011; Nyklíček et al., 2013; Tang et al., 2015, 2017). In fact, a longer experience in meditation is associated with higher levels of dispositional mindfulness (Josefsson et al., 2011; Tomlinson et al., 2018), and with a reduction of maladaptive emotion regulation strategies (Schlosser et al., 2020).

To our best knowledge, no other study has looked at the effect of intentional mindfulness meditation on somatization and psychological distress during COVID-19 pandemic. The purpose of this observational study is to fill this gap, taking into account dispositional mindfulness, meditation experience, and emotion regulation. Three hypotheses were formulated. First, dispositional mindfulness would be associated with lower somatic symptom, psychological distress, and COVID-19-related anxiety. Second, a longer experience in mindfulness meditation, enhancing dispositional mindfulness and emotion regulation, would be associated with less somatic symptoms and psychological distress. Third, practitioners with less experience would report more somatic symptoms and a greater use of maladaptive emotion regulation strategies than those with more experience.

Materials and methods

During the worldwide second wave of pandemic, from November 24 2020 to January 29 2021, 790 participants living in France responded to an online survey about the impact of COVID-19 on emotions and physical health. Participants were recruited through free social network advertisement. To maximize ecological validity, the only inclusion criterion was being at least 18 years old. The study followed the local ethics protocol: all subjects provided informed consent, through an online form, in accordance with the Declaration of Helsinki.

Participants

569 (53.48%) subjects provided at least 50% of data and were included in the study. The mean age of the total sample was 39.8 years ($SD = 14.5$, range = 18–89). Most of the participants were female ($n = 512$, 90%), with a high level of education or university degrees (54.3%), employed (60.5%), and living with their families or partners (78.4%). A quarter of the sample were infected by the SARS-CoV-2 ($n = 139$, 24.4%), and half of the participants reported COVID-19 infections among close friends or relatives. Finally, 17.6% of the population self-reported the presence of psychological problems, and 25% declared having a chronic illness

(see [Supplementary Table 1](#) for detailed descriptive statistics in [Supplementary material](#)).

Measures

Socio-demographic and COVID-19-related information (e.g., having contracted the virus and the presence/absence of positive cases among relatives or friends) were among the data collected.

As in other studies, COVID-19-related anxiety was assessed through the question: “How anxious are you about the coronavirus COVID-19 pandemic?” (Bruno et al., 2020; Shevlin et al., 2020). Participants were provided with an electronic visual analog scale to indicate their degree of anxiety, ranging from 0 to 10, with higher scores reflecting higher levels of COVID-19-related anxiety.

Mindfulness practice was determined through six questions asking participants if they had a regular mindfulness practice, years of practice, weekly frequency, usual practice length, and amount of practice in the last month compared to usual and type of mindfulness exercise. The variable years of practice was used to determine mindfulness experience as it was judged to be less subject to recall bias and measurement error than frequency and session length (see Schlosser et al., 2020). Subjects practicing for less than 2 years were categorized as “beginners,” while people reporting a longer meditation experience (more than 2 years) have been classified as “advanced” (Haimerl and Valentine, 2001).

Dispositional mindfulness was assessed with the Mindful Attention Awareness Scale (MAAS; Brown and Ryan, 2003), a 15 items scale to measure mindfulness as a trait. Each item is scored using a six-point Likert scale ranging from 1 (“almost always”) to 6 (“almost never”). The total score is calculated by the mean of the 15 items, with higher scores indicating greater dispositional mindfulness. The total score reliability in the current sample was high ($\alpha = 0.89$).

Somatic symptoms were evaluated using the Patient Health Questionnaire (PHQ-15; Kroenke et al., 2001), a self-report measure that assessing physical health problems in the last 2 weeks. Items are rated on a three-point Likert scale ranging from 0 (“not bothered at all”) to 2 (“bothered a lot”). The total PHQ-15 score ranges from 0 to 30. Previous studies attest that PHQ-15 produces reliable and valid scores (Hinz et al., 2017). The total score reliability in the current sample was high ($\alpha = 0.80$).

Psychological distress was measured with the Generalized Anxiety Disorder 7-item Scale (GAD-7; Spitzer et al., 2006) and the Patient Health Questionnaire-8 (PHQ-8; Kroenke et al., 2009). The PHQ-8 includes eight of the nine criteria on which the DSM-IV diagnosis of depressive disorders is based (American Psychiatric Association, 1994). As in previous studies, the ninth criteria assessing suicidal and self-injurious thoughts was omitted as researchers would not be able to provide adequate intervention due to the online design of the study and its deletion has only a minor effect on scoring (Kroenke and Spitzer, 2002; Kroenke et al., 2009). Higher scores represent increased severity of anxiety and depressive

symptoms, and the cut-off score of ≥ 10 was used to identify a moderate level of anxiety and depressive symptoms (Kroenke et al., 2009, 2010; Williams, 2014). The reliability in the current sample for both scales was high (GAD-7: $\alpha = 0.91$; PHQ-8: $\alpha = 0.87$).

Emotion regulation was assessed with the Cognitive Emotion Regulation Questionnaire (CERQ; Garnefski et al., 2001). The CERQ is a 36-item questionnaire which uses a five-point Likert scale to assess emotion regulation strategies that subjects use in response to the experience of stressful events. The final scores are divided in nine strategy subscales, grouped into adaptive (CERQ_A: acceptance, positive refocusing, refocus on planning, positive reappraisal, and putting into perspective), and maladaptive strategies (CERQ_M: self-blame, rumination, catastrophizing, and blaming others; Garnefski et al., 2001; Aldao and Nolen-Hoeksema, 2010). In the current study, the Cronbach's alpha ranged from 0.66 to 0.87 for each strategy.

Statistical analyses

Analyses were performed using R version 3.0 (R Core Team, 2013). The R code used for statistical analyses is available in the [Supplementary material](#). Multiple imputation by chained equations (MICE) using a predictive mean matching method has been performed on the 3.8% of data, representing missing values in the mandatory questions of the survey. Descriptive statistics were used to describe the socio-demographic characteristics of the respondents. Measurement data were expressed as the mean \pm SD, while independent sample *t*-tests were used for group comparisons (practitioners vs. non-practitioners). Pearson's correlations were used to assess the association between COVID-19 related anxiety, generalized anxiety, depression, somatization, emotion regulation, and dispositional mindfulness. Given that the relationship between meditation experience and the variables of interest was not assumed to be linear, meditation experience was categorized into three groups: non-practitioners, beginners (mindfulness practice ≤ 2 years) and advanced (mindfulness practice > 2 years). For the group comparisons between non-practitioners, beginner, and advanced practitioners, one-way ANOVA was used. The values of $p < 0.05$ were considered statistically significant. Multiple comparisons were performed by Tukey–Kramer Test for *post hoc* analysis to locate the significant group-by-group differences.

Results

Descriptive statistics of responders' socio-demographic characteristics and comparisons between practitioners and non-practitioners are available in the [Supplementary Table 1](#). Overall, there were no main socio-demographic differences between the group of practitioners and non-practitioners except for age and educational level (practitioners were younger and more educated than non-practitioners).

Dispositional mindfulness, somatic, and psychological distress

Table 1 shows zero-order associations between COVID-19-related variables, somatic and psychological symptoms. As expected, large associations ($r > -0.50$) were found between psychological distress (i.e., anxiety and depression scores) and somatic symptoms. Dispositional mindfulness showed strong and negative correlations with psychological distress [$r(567) = -0.56$, $p < 0.001$ for both anxiety and depression], somatic symptoms [$r(567) = -0.46$, $p < 0.001$], and a small and negative correlation with COVID-19 related anxiety [$r(567) = -0.13$, $p < 0.001$]. Moreover, dispositional mindfulness was negatively associated with maladaptive emotion regulation, [$r(567) = -0.37$, $p < 0.001$].

The effect of mindfulness practice and experience on somatic symptoms and psychological distress

Mindfulness meditation was practiced by 28.8% of the population ($n = 164$). The years of experience in mindfulness practice as well as the amount of practice were quite homogenous in the sample of practitioners. Most practitioners practiced either for 10 min ($n = 67$) or between 10 and 30 min ($n = 67$), but a smaller part had a length of practice of more than 30 min for each session ($n = 30$). In total, 87 (15.3%) subjects were categorized as beginners (≤ 2 years of practice) and 77 people (13.5%) as advanced (> 2 years of practice). A significant difference was found in the type of practice ($p = 0.003$; **Table 2**).

One-way ANOVA comparison showed no differences between non-practitioners, beginners, and advanced practitioners concerning dispositional mindfulness (**Table 3**). Moreover, no differences were found among the three groups concerning depression, anxiety, and COVID-19 related anxiety. However, a significant difference was found between groups in the levels of somatic symptoms [$F(2, 566) = 4.50$, $p = 0.01$, $\eta^2 = 0.01$]. Tukey–Kramer *post hoc* tests showed that beginners reported significantly more somatic symptoms ($M = 12.2$) than non-practitioners ($M = 10.3$, $p = 0.008$).

Mindfulness practice and emotion regulation

A one-way ANOVA revealed that there was a significant difference between groups for total adaptive regulation score (CERQ Adaptive), $F(2, 566) = 9.81$, $p < 0.001$, $\eta^2 = 0.02$ (**Table 3**). *Post hoc* tests showed that participants in the advanced practitioners group reported significantly higher use of adaptive emotion regulation ($M = 66.9$) than non-practitioners ($M = 59.9$; $p = 0.004$). This result was similar for each adaptive emotion regulation sub-dimension (**Table 4**).

TABLE 1 Associations between COVID-19-related factors, somatic and psychological variables.

	COVID-19 anxiety	1	2	3	4	5	6	7	8	9
1. Chronic Illness	0.004 (0.931)									
2. Psychological problems	0.089 (0.033)	-0.001 (0.975)								
3. Coronavirus infection	0.134 (0.001)	0.015 (0.723)	-0.046 (0.270)							
4. Covid proxy	-0.048 (0.255)	0.001 (0.981)	-0.126 (0.003)	0.050 (0.229)						
5. PHQ-15	0.234 (<0.001)	0.136 (0.001)	0.093 (0.027)	0.230 (<0.001)	-0.040 (0.338)					
6. CERQ Maladaptive	0.181 (<0.001)	0.015 (0.715)	0.200 (<0.001)	0.089 (0.033)	-0.028 (0.512)	0.296 (<0.001)				
7. CERQ Adaptive	-0.066 (0.118)	-0.035 (0.410)	-0.121 (0.004)	-0.025 (0.544)	0.047 (0.267)	-0.073 (0.081)	0.028 (0.503)			
8. PHQ-8	0.232 (<0.001)	0.036 (0.386)	0.222 (<0.001)	0.155 (<0.001)	-0.047 (0.265)	0.589 (<0.001)	0.468 (<0.001)	-0.121 (0.004)		
9. GAD-7	0.316 (<0.001)	0.006 (0.895)	0.160 (<0.001)	0.096 (0.023)	-0.063 (0.133)	0.575 (<0.001)	0.473 (<0.001)	-0.114 (0.007)	0.731 (<0.001)	
MAAS	-0.138 (0.001)	-0.039 (0.358)	-0.118 (0.005)	-0.039 (0.357)	0.019 (0.649)	-0.462 (<0.001)	-0.378 (<0.001)	0.069 (0.101)	-0.565 (<0.001)	-0.567 (<0.001)

Computed correlation used Pearson-method with list wise-deletion. PHQ-15, Patient Health Questionnaire—Somatic Symptom Severity Scale; CERQ, Cognitive Emotion Regulation Questionnaire; PHQ-8, Patient Health Questionnaire for Depression; GAD-7, Generalized Anxiety Disorder; and MAAS, Mindful Attention Awareness Scale.

TABLE 2 Descriptive statistics of mindfulness practice.

	Overall (N=569)	Beginners (N=87)	Advanced (N=77)	X ²	Value of p	V
Years of practice						
Less than 1 year	40 (7%)	40 (46%)	-			
Between 1 and 2 years	47 (8.3%)	47 (54%)	-			
Between 3 and 4 years	35 (6.2%)	-	35 (45.5%)			
More than 4 years	42 (7.4%)	-	42 (54.5%)			
Practice per week						
Less than once a week	40 (7.0%)	21 (24.1%)	19 (24.7%)	7.597	0.1	0.215
Once a week	36 (6.3%)	25 (28.7%)	11 (14.3%)			
Between 2 and 3 times	55 (9.7%)	29 (33.3%)	26 (33.8%)			
Between 4 and 5 times	16 (2.8%)	6 (6.9%)	10 (13.0%)			
More than six times	17 (3.0%)	6 (6.9%)	11 (14.3%)			
Length of practice						
10 min	67 (11.8%)	39 (44.8%)	28 (36.4%)	1.215	0.5	0.086
Between 10 and 30 min	67 (11.8%)	33 (37.9%)	34 (44.2%)			
More than 30 min	30 (5.3%)	15 (17.2%)	15 (19.5%)			
Type of practice						
Yoga	27 (4.7%)	21 (24.1%)	6 (7.8%)	17.67	0.003	0.328
Mindfulness meditation	26 (4.6%)	12 (13.8%)	14 (18.2%)			
Breathing exercises	48 (8.4%)	29 (33.3%)	19 (24.7%)			
Yoga and meditation	31 (5.4%)	11 (12.6%)	20 (26%)			
Meditation and breathing exercises	27 (4.7%)	14 (16.1%)	13 (16.9%)			
Other practices	5 (0.9%)	0 (0%)	5 (6.5%)			

TABLE 3 Descriptive statistics of somatic and psychological variables in the population and according to practice group.

	Total (N=569)	Non-practitioners (NP) (N=405)	Practitioners		F	Value of p	η^2	Post hoc test (Tukey)
			Beginners (BE) (N=87)	Advanced (AD) (N=77)				
COVID-19 anxiety								
Mean ± SD [Min, Max]	4.24 ± 2.86 [0, 10]	4.20 ± 2.87	4.77 ± 2.68	3.87 ± 2.97	2.19	0.11	0.007	-
Somatic symptoms (PHQ-15)								
Mean ± SD [Min, Max]	10.7 ± 5.37 [0, 30]	10.3 ± 5.32	12.2 ± 4.69	10.9 ± 6.09	4.50	0.01	0.015	NP < BE
Score 0–4	74 (13%)	57 (14%)	3 (3%)	14 (18%)				
Score 5–9 (mild)	177 (31%)	136 (34%)	22 (25%)	19 (25%)				
Score 10–14 (moderate)	183 (32%)	124 (31%)	36 (41%)	23 (30%)				
Score ≥ 15 (severe)	135 (24%)	88 (22%)	26 (30%)	21 (27%)				
PHQ-15 score ≥ 10	318 (56%)	212 (52%)	62 (71%)	44 (57%)				
Depression (PHQ-8)								
Mean ± SD [Min, Max]	9.51 ± 6.14 [0, 24]	9.34 ± 6.10	10.3 ± 6.02	9.48 ± 6.47	0.91	0.40	0.003	-
Score 0–4 (none)	137 (24%)	99 (24%)	16 (18%)	22 (29%)				
Score 5–9 (mild)	173 (30%)	126 (31%)	27 (31%)	20 (26%)				
Score 10–14 (moderate)	136 (24%)	97 (24%)	22 (25%)	17 (22%)				
Score 15–19 (moderate severe)	81 (14%)	55 (14%)	13 (15%)	13 (17%)				
Score 20–24 (severe)	42 (7%)	28 (7%)	9 (10%)	5 (6%)				
PHQ-8 score ≥ 10	259 (46%)	180 (44%)	44 (51%)	35 (45%)				
Anxiety (GAD-7)								
Mean ± SD [Min, Max]	8.42 ± 6.05 [0, 21]	8.40 ± 6.09	8.75 ± 5.63	8.14 ± 6.32	0.21	0.80	0.000	-
GAD-7 score ≥ 10	205 (36%)	143 (35%)	33 (38%)	29 (38%)				
Depression and anxiety	173 (30%)	120 (30%)	27 (31%)	26 (34%)				
CERQ adaptive								
Mean ± SD [Min, Max]	61.2 ± 14.8 [20, 100]	59.9 ± 14.7	61.8 ± 14.4	66.9 ± 14.3	7.32	<0.001	0.025	NP < AD
CERQ maladaptive								
Mean ± SD [Min, Max]	36.8 ± 10.4 [16, 76]	36.8 ± 10.8	38.4 ± 9.47	34.9 ± 9.13	2.27	0.10	0.007	-
Dispositional mindfulness (MAAS)								
Mean ± SD [Min, Max]	3.75 ± 0.87 [1, 5.93]	3.77 ± 0.85	3.74 ± 0.86	3.68 ± 0.93	0.35	0.70	0.001	-

No difference among the three groups was found in the total score of maladaptive emotion regulation (CERQ Maladaptive), $F(2,566) = 2.27, p = 0.10$ (Table 3). Interestingly, there was only a significant difference between the three groups when looking at rumination sub-scale [$F(2, 566) = 5.74, p = 0.003, \eta^2 = 0.019$; Table 4]. The total score of the subscale Rumination was significantly higher in the group of beginners ($M = 13.5$) than in non-practitioners ($M = 11.9; p = 0.006$) and advanced practitioners ($M = 11.8; p = 0.02$). No differences have been found for other maladaptive subscales.

Discussion

To our knowledge this is the first study investigating the effects of mindfulness practice on somatic symptoms and psychological distress during COVID-19 pandemic. Based on previous literature on the positive effects of mindfulness on mental health, it was

assumed that dispositional mindfulness would have a buffering effect against somatic complaints and the distressing mental health outcomes of COVID-19. In particular, we hypothesized that a longer experience in mindfulness practice, enhancing dispositional mindfulness, and emotion regulation, would be associated with less somatic symptoms and psychological distress. On the contrary, a lack of mindfulness experience, would bring subjects to experience more somatic symptoms and a greater use of maladaptive emotion regulation strategies than those with more experience.

Dispositional mindfulness, somatic symptoms, and psychological distress during COVID-19 pandemic

As expected, dispositional mindfulness was associated with lower levels of somatization and psychological distress, confirming the positive relationship between this personality trait and

TABLE 4 Comparison of emotion regulation strategies according to mindfulness experience group.

	NP-Non practitioners (N=405)	BE-Beginners (N=87)	AD-Advanced (N=77)	F	p value	η^2	Post hoc test (Tukey)
	Mean \pm SD	Mean \pm SD	Mean \pm SD				
CERQ adaptive							
Acceptance	12.7 \pm 3.81	13.1 \pm 3.32	14.0 \pm 3.34	4.02	0.018	0.014	NP < AD
Positive refocusing	9.60 \pm 4.06	10.1 \pm 3.50	11.1 \pm 4.56	4.84	0.008	0.016	NP < AD
Refocus on planning	12.6 \pm 3.94	13.3 \pm 3.55	14.1 \pm 3.60	5.97	0.002	0.020	NP < AD
Positive reappraisal	11.9 \pm 4.06	12.6 \pm 4.01	13.8 \pm 4.19	7.04	<0.001	0.024	NP < AD
Putting into prospective	12.8 \pm 3.81	13.1 \pm 3.82	14.3 \pm 3.46	5.13	0.006	0.017	NP < AD
CERQ maladaptive							
Self-blame	9.41 \pm 3.92	9.85 \pm 3.78	8.99 \pm 3.24	1.05	0.35	0.003	
Rumination	11.9 \pm 4.19	13.5 \pm 4.12	11.8 \pm 3.68	5.74	0.003	0.019	BE > NP, BE > AD
Catastrophizing	7.52 \pm 3.40	7.54 \pm 3.00	6.95 \pm 2.85	1.04	0.35	0.003	
Other-blame	7.66 \pm 3.59	7.49 \pm 2.79	7.31 \pm 2.66	0.42	0.65	0.001	

psychological health (Tomlinson et al., 2018). A negative association has also been found with the use of maladaptive emotion regulation and with more specific COVID-19-related anxiety, suggesting that dispositional mindfulness may have afforded protective buffering against the distress caused by the pandemic. These results are in line with other studies assessing dispositional mindfulness in different populations during COVID-19 and provide new and strong evidence for the protective role of this personality trait during the pandemic (Conversano et al., 2020; Roemer et al., 2021; O'Connor et al., 2022).

The relationship between dispositional mindfulness and mindfulness experience

In the present study, no relationships were found between dispositional mindfulness measured with MAAS (Brown and Ryan, 2003) and any of the mindfulness meditation practice factors investigated (e.g., practitioners vs. non-practitioners, years of mindfulness experience, frequency and length of practice, and type of practice). These results provide further evidence in the discrepancy between studies linking mindfulness meditation experience to higher dispositional mindfulness (Cordon and Finney, 2008; Josefsson et al., 2011; Schlosser et al., 2020), and those finding no significant associations (MacKillop and Anderson, 2007). As discussed in the study of MacKillop and Anderson (2007), in which 65% of the experienced group had practiced for 1 year or less, this might be due to the fact that the original validation of the MAAS used a sample of extensively experienced and committed Zen Buddhist practitioners (Brown and Ryan, 2003). In our population, advanced practitioners had more than 2 years of experience and cannot, therefore, be categorized as novice practitioner. However, beginner and advanced practitioner did not differ in terms of number of times practicing per week and length of practice per session. Moreover,

advanced practitioners deeply involved in practicing meditation were the minority (27.3% of advanced practitioner meditated more than three times per week and only 19.5% for more than 30 min). As such, these data suggest that there are no clear differences in dispositional mindfulness (as measured by the MAAS) between beginners and advanced practitioners and also suggest that caution is needed when assessing how “regular” mindfulness meditation training has to be to modify the trait of dispositional mindfulness.

The effect of mindfulness practice experience on somatic symptoms and psychological distress

The second hypothesis of this study, which assumed that a longer mindfulness meditation experience, enhancing dispositional mindfulness and emotion regulation, would positively affect somatic complaints and psychological distress, was only partially validated. In fact, as previously noted, advanced practitioners did not show higher levels of dispositional mindfulness. Moreover, the means of somatic symptoms, COVID-19-related anxiety and psychological distress were not significantly smaller in advanced practitioners compared to the rest of the sample. However, advanced practitioners showed significantly higher use of adaptive emotion regulation strategies compared to non-practitioners, confirming the fact that emotion regulation can be considered as one of the processes facilitated by mindfulness meditation (Tang et al., 2015; Roemer et al., 2021).

The most interesting result of this study concerned the third hypothesis enunciated, for which less experienced practitioners would show more somatic symptoms and a greater use of maladaptive emotion regulation than experienced practitioners. Subjects with less experience in mindfulness practices (mindfulness experience ≤ 2 years) showed worse somatic health than subject who never practiced mindfulness meditation. Considering that the three

groups did not differ in terms of anxiety, depression, and COVID-19-related anxiety, the higher levels of somatic symptoms in beginners cannot be explained by psychological distress. A possible explanation for this result lies in the contribution of interoception in these practices and in the possible impact of rumination, which was significantly higher in the beginners' group. Most meditation practices, using the sensations of the body as an anchor to improve attention to the present moment, enhance interoceptive awareness and perceptual skills (Gibson, 2019). However, previous literature has highlighted the existence of two different styles of interoceptive awareness, one maladaptive and characterized by hypervigilance and catastrophizing, and one beneficial and characterized by attention regulation and acceptance (Mehling, 2016; Hanley et al., 2017; Gibson, 2019). The main difference between these two styles of interoceptive awareness is the cognitive appraisal of body states (Farb et al., 2015). Mindfulness, through acceptance, changes the appraisal and the affective significance of body states and enhances the regulation of associated negative emotions (Lindsay and Creswell, 2017; Kober et al., 2019). However, in mindfulness meditation, practitioners use interoceptive awareness since the very beginning of their practice, and their perceptual skills may improve before the competences of acceptance (Lindsay and Creswell, 2017). Thus, in distressing contexts (such as COVID-19 pandemic), an augmented attention to the body in the absence of acceptance might narrow the focus on negative stimuli and sensations, and result in more ruminative thinking (Lindsay and Creswell, 2017). Consequently, the significantly higher report of somatic symptoms in beginner practitioners could be interpreted as a consequence of the focus of attention on the body during mindfulness meditation, joined with the lack of mindful acceptance and an overuse of rumination.

Limitations

The current study had several limitations that merit discussion. First, the convenience sampling recruitment method used does not allow any generalizations. Even though we controlled sociodemographic differences between practitioners and non-practitioners, there is still the possibility of having under/over-represented the population. Women in the sample were overrepresented (90%) not allowing gender comparisons. Second, the prevalence of somatic symptoms (56%), anxiety (36%), and depression (46%) in this sample were high compared to other studies done during the COVID-19 pandemic (Ran et al., 2020; Salari et al., 2020; Xiong et al., 2020). At the time of data collection for this study, the French population was slowly coming out of the second lockdown, which officially stopped on December 15, 2020. However, many public health measures and restrictions were put in place to continue limiting the spread of the virus. Thus, the high prevalence of somatic symptoms and psychological distress could be either a bias of the convenience sampling used in this study or the manifestation of the distress for the uncertainty of COVID-19 pandemic. Third, several factors of mindfulness practice have been assessed and the data showed significant differences between

beginners and advanced practitioners in the practice of yoga, mindfulness meditation, and breathing exercises. However, previous literature has categorized specific styles of meditation (e.g., attentional, constructive, and deconstructive) based on their primary cognitive mechanisms (Dahl et al., 2015). The use of these categories could have brought a deeper understanding of the processes between mindfulness practice and somatization. Finally, we have concentrated on emotion regulation strategies to explain differences between groups as the study did not include a measure of interoceptive awareness. Therefore, we lack perspective on the possible effect of interoceptive awareness in the results, which can only be hypothesized.

Conclusion

In conclusion, the findings of this study suggest that mindfulness practice over time enhances the use of adaptive emotion regulation. However, these practices require adequate training. Inexperience, in distressing times such as COVID-19 pandemic, can bring people to focus on bodily sensations without having developed the necessary skills to handle emerging emotions and, as a result, develop more somatic symptoms. A particular attention should be given on rumination tendencies during the initial period of mindfulness training, which is prevalent in subjects with lower mindfulness experience. Further studies are recommended to better understand the relationship between somatization, mindfulness practice, and emotion regulation and to clarify the relationship between mindfulness practice and dispositional mindfulness.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The study involving human participants was reviewed and approved by Institutional Review Board of the Laboratory of Psychology (EA4139) of the University of Bordeaux, France (protocol code: 2022.03.CLE003). The participants provided their informed consent to participate in this study online.

Author contributions

NM, CD, and PP conceived the assessment. NM contributed to the data analysis. MB-C contributed to the data interpretation. NM, CD, MB-C, and PP participated in the concept and writing of this manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fpsyg.2022.996559/full#supplementary-material>

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Appendix E. Supplementary materials of the published article: Micheli, N., Porcelli, P., Barrault-Couchouron, M., & Dantzer, C. *Frontiers in Psychology*, 2022, vol. 13, p. 996559. <https://www.frontiersin.org/articles/10.3389/fpsyg.2022.996559/full#supplementary-material>

Table 28 - Descriptive statistics of respondents' sociodemographic characteristics and differences between practitioners and non-practitioners

	Overall (N= 569)	Non- practitioners (N= 405)	Practitioners (N= 164)	X ²	p-value	V
Gender						
Male	53 (9.3%)	42 (10.4%)	11 (6.7%)	2.667	0.26	0.068
Female	512 (90.0%)	361 (89.1%)	151 (92.1%)			
Other	4 (0.7%)	2 (0.5%)	2 (1.2%)			
Educational level						
Elementary or some secondary education	55 (9.7%)	48 (11.9%)	7 (4.3%)	8.205	0.01	0.120
High school	205 (36.0%)	146 (35.8%)	59 (36%)			
Higher level of education	309 (54.3%)	211 (52.1%)	98 (59.8%)			
Employment status						
Employed	344 (60.5%)	249 (61.5%)	95 (57.9%)	5.305	0.25	0.096
Retired	46 (8.1%)	28 (6.9%)	18 (11.0%)			
Not active or looking for a job	41 (7.2%)	27 (6.7%)	14 (8.5%)			
Student	98 (17.2%)	75 (18.5%)	23 (14.0%)			
Other	40 (7.0%)	26 (6.4%)	14 (8.5%)			
Working situation						
Working from home	90 (15.8%)	72 (17.8%)	18 (11.0%)	9.128	0.10	0.126
Partial unemployment	25 (4.4%)	17 (4.2%)	8 (4.9%)			
Going to the workplace	193 (33.9%)	133 (32.8%)	60 (36.6%)			
Lost the employment	39 (6.9%)	28 (6.9%)	11 (6.7%)			
Not working	12 (2.1%)	150 (37.0%)	60 (36.6%)			
Other	210 (36.9%)	5 (1.2%)	7 (4.3%)			
Living arrangements						
Alone	98 (17.2%)	66 (16.3%)	32 (19.5%)	2.135	0.54	0.061
Family or partner	446 (78.4%)	322 (79.5%)	124 (75.6%)			
Flatmates	23 (4.0%)	15 (3.7%)	8 (4.9%)			
Other	2 (0.4%)	2 (0.5%)	0 (0%)			
Contracted Covid						
Yes	139 (24.4%)	87 (21.5%)	41 (25.0%)	0.106	0.74	0.014
No	430 (75.6%)	287 (70.9%)	123 (75.0%)			
Positive Covid cases among relatives and close friends						
Yes	282 (49.6%)	183 (45.2%)	84 (51.2%)	0.156	0.69	0.017
No	287 (50.4%)	191 (47.2%)	80 (48.8%)			
Self-reported psychological symptoms						
Yes	100 (17.6%)	53 (13.1%)	34 (20.7%)	3.152	0.07	0.076
No	469 (82.4%)	321 (79.3%)	130 (79.3%)			
Chronic Illness						
Yes	142 (25.0%)	87 (21.5%)	50 (30.5%)	2.767	0.09	0.071
No	427 (75.0%)	287 (70.9%)	114 (69.5%)			
Age						
Mean (SD) [Min, Max]	39.8 (14.5) [18, 89]	38.8 (14.2) [18, 89]	42.3 (14.8) [18, 75]	-2.586	0.010	
Monthly personal income						
Mean (SD)	2310 (5060)	2180 (3630)	2650 (7520)	-0.767	0.44	