I Feel, Therefore I Am

An investigation on mindfulness, body awareness, and emotion regulation in youth

I Feel, Therefore I Am: An investigation on mindfulness, body awareness, and emotion regulation in youth

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Abstract

Adolescence and emerging adulthood are times of psychological vulnerability. Mindfulness-based interventions (MBIs) may help prevent and alleviate the mental health burden in this vulnerable population. However, there is inconclusive evidence on the impact and mechanisms of change of MBIs in youth. Therefore, the general purpose of this dissertation was to evaluate the impact of an MBI on two developmentally important and interconnected resilience factors, body awareness and emotion regulation. We hypothesized that an MBI would lead to improvements in body awareness which would in turn improve emotion regulation skills, and the two mechanisms in tandem would explain the reduction in emotional distress observed after an MBI. The research involved three general steps: (1) a proof-of-concept study in adults with emotional disorders, (2) the development and validation of measures of body awareness and emotion regulation for youth, and (3) a clinical trial assessing the impact of an MBI in adolescents in a school setting. Results supported our hypothesis in adults but not in adolescents in a school setting. Clinical, developmental, and measurement implications are discussed.

Résumé

L'adolescence et la transition vers l'âge adulte représentent des phases de vulnérabilité psychologique. Les interventions basées sur la pleine conscience (MBI) sont envisagées comme des moyens potentiels pour prévenir et atténuer les défis en matière de santé mentale au sein de cette population vulnérable. Cependant, les preuves concernant l'impact et les mécanismes de changement des interventions basées sur la pleine conscience chez les jeunes ne sont pas concluantes. Ainsi, l'objectif global de cette thèse était d'évaluer l'effet d'une MBI sur deux facteurs de résilience interconnectés et importants pour le développement, à savoir la conscience du corps et la régulation des émotions. Nous avons émis l'hypothèse qu'un MBI entraînerait une amélioration de la conscience corporelle, les compétences de régulation des émotions, et que les deux mécanismes en tandem expliqueraient la réduction de la détresse émotionnelle observée après un MBI. La recherche s'est déroulée en trois grandes étapes : (1) une étude de validation de ce concept chez des adultes souffrant de troubles émotionnels, (2) l'élaboration et la validation de mesures de conscience corporelle et de régulation des émotions chez les jeunes, et (3) un essai clinique évaluant l'impact d'une MBI chez des adolescents en milieu scolaire. Les résultats ont confirmé notre hypothèse chez les adultes, mais n'ont pas été concluants chez les adolescents en milieu scolaire. Les implications cliniques, développementales et liées à la mesure sont discutées.

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Chapter 1.
General Introduction

1.1 Psychological Vulnerability in Youth

Adolescence and emerging adulthood (from the onset of puberty to approximately 24 years of age) are stages of life fraught with change and instability (Arnett, 2000; World Health Organization [WHO], 2021). Physically, the body goes through a period of rapid transformation as it attains its adult form and sexual maturation (Dahl et al., 2018). Neurologically, the brain changes structurally and functionally making individuals more prone to emotional reactivity, sensation-seeking, and risk-taking (Ahmed et al., 2015; Dahl et al., 2018; Jaworska & MacQueen, 2015). Psychologically, individuals seek autonomy and take on the challenging task of forming an identity of their own (Arnett, 2000; Crone & Dahl, 2012). Contextually speaking, young people experience increased academic and employment pressures, changes in their educational context (e.g., from primary to secondary school to university in some cases), and an increased relational complexity (Ahmed et al., 2015; Arnett, 2000; Dahl et al., 2018). Given these multilevel changes, it is not surprising that adolescents and young adults (AYAs) have an increased vulnerability to developing psychological difficulties (Ahmed et al., 2015; Nobre et al., 2022).

This increased psychological vulnerability is confirmed by the latest statistics on the prevalence of mental health difficulties in AYAs. Up to 50% of mental health conditions begin before the age of 14 with lifelong consequences if left untreated (WHO, 2021). Youth account for 13% of the global burden of mental health disorders, with one in seven 10-19-year-olds experiencing a mental health condition that is for the most part left undetected and unmanaged (WHO, 2021). This is worrisome because mental health problems at a young age tend to predict psychopathology later in life (De Girolamo et al., 2012).

In Europe, the Global Burden of Disease (GBD) Study 2019 found that 19.5% of young people between the ages of 10 and 24 experienced mental health conditions in 2019. More specifically, there were 13.6 million young people in Europe with mental disorders, 3.2 million with substance use disorders, and 75,770 who self-harmed (Castelpietra et al., 2022). Overall, anxiety disorders were the most prevalent across age and gender groups. Additionally, a high prevalence of attention-deficit and hyperactivity disorders (ADHD) and conduct disorders was found in 10-14-year-old males as well as a high prevalence of drug and alcohol use disorders in 20-24-year-old males. Mental health conditions contributed to 1 million years lost to disability, making them the leading cause

of disability among European youth in 2019. Given the continuity of mental health problems into adulthood, the GBD study concludes by asserting that "mental health conditions should be considered a core health challenge of the 21st century" (Castelpietra et al., 2022; p. 15).

The above statistics have been affected by the recent COVID-19 pandemic. Not only did the pandemic pose a health risk, but the measures implemented to contain the spread of the virus (i.e., lockdowns, closing of schools and universities, and social distancing) profoundly impacted youth's daily life and mental well-being (Oliveira et al., 2022). A recent systematic review assessing the change in youth (aged 3 to 24 years) mental health before and during the COVID-19 pandemic, found increases in depression, anxiety, psychological distress, negative affect, and loneliness after the pandemic started (Kauhanen et al., 2023). Moreover, frequency of alcohol and cannabis use increased in adolescents globally (aged 13 to 17 years; Jones et al., 2021) and in young adults (aged 18 to 21) in the United States (Papp & Kouros, 2021). Overall, these results provide evidence for a generally negative impact of the pandemic on youth mental health, but will these effects persist? The longer-term effects of the COVID-19 pandemic on youth mental health have yet to be examined. However, there are reasons to expect long-term harm of the pandemic in young people's psychological functioning via three hypothesized pathways (Sonuga-Barke & Fearon, 2021): (1) affected brain development due to exposure to a prolonged adverse experience (e.g., lockdown); (2) the continuity of mental health disorders that had their onset in the context of the pandemic; and (3) the cascading consequences of increased contextual risk factors triggered and exacerbated by the pandemic (e.g., financial hardship, family break-up, impact on education, etc.). These pathways may be particularly pertinent for AYAs in high-risk situations.

Given the increasing prevalence of mental health conditions in young people and the prospect of this tendency continuing in the future, there are many calls for action. For instance, in their Comprehensive Mental Health Action Plan 2013-2030, the World Health Organization calls for the implementation of strategies to promote mental health and prevent mental health conditions, with a particular focus on young people (WHO, 2021). They stress the need to develop and implement universal, evidence-based programs in schools. These programs should teach skills and practices conducive to mental well-being, such as socioemotional life skills, meditation, yoga, among others. In their latest GBD study, the Institute for Health Metrics and Evaluation seconds the WHO's call by encouraging national policies to provide accessible, evidence-based treatment and preventive interventions for young people (Castelpietra et al., 2022).

From a psychological perspective, these calls for preventive action are warranted. Adolescence and emerging adulthood can be seen as a developmental crossroads in which the plethora of changes occurring can be stirred in a direction of well-being or in a direction of psychopathology (Nobre et al., 2022; Silvers, 2022). Furthermore, adolescence is often seen as a "window of opportunity" when it comes to learning, as the brain is particularly plastic during this time of life (Ahmed et al., 2015). Therefore,

implementing preventive evidence-based psychological programs may help stir AYAs in a direction of well-being, helping to establish a positive foundation for their future.

In order to address these calls for preventive action in an efficient and targeted way, however, psychological research is key. Not only do we need to examine the effectiveness of universally delivered interventions for AYAs, but we also need to understand the psychological mechanisms that these interventions target. We argue that prevention efforts will be most effective with the implementation of interventions that target key mechanisms that protect youth from developing mental health conditions (i.e., resilience factors; Fritz et al., 2019). The next section discusses two central and highly intertwined resilience factors.

1.2 Body Awareness and Emotion Regulation in Youth

Resilience factors (RFs) reduce the risk of developing mental health problems despite challenges to an individual's well-being (Diehl et al., 2012; J. Fritz et al., 2019). They can be biological (e.g., genes), intra-personal (e.g., healthy self-esteem), and inter-personal (e.g., family support; Fritz et al., 2019). Research has shown that RFs tend to operate in interrelated networks in which they enhance each other (J. Fritz et al., 2019). Here we focus on two intra-personal RFs that are interrelated and in process of development in young people: body awareness and emotion regulation. Intra-personal RFs were chosen, as opposed to biological or inter-personal RFs, because they can be targeted with psychological interventions.

Body Awareness

What is Body Awareness?

As human beings, we continuously experience sensations coming from the body informing us about our physical and emotional state. In the broad sense of the term body awareness (BA) refers to our ability to sense, interpret, and integrate these sensations (Craig, 2003; Khalsa et al., 2018). The term BA, as used in the present research, is part of the larger umbrella term known as interoception.

Interoception is a complex, multi-dimensional construct with a wide array of conceptualizations that have evolved over time (Ceunen et al., 2016; Mehling et al., 2009). In the early 20th century, interoception was defined as sensory representations coming from receptors in the viscera (Sherrington, 1906). This definition excluded input coming from the five senses (labeled as exteroceptive) or from skeletal tissue (labeled as proprioceptive). Over time, the definition of interoception expanded to include all bodily tissues that transmit information to the central nervous system about the present state of the body, prompting feelings as diverse as pain, hunger, thirst, visceral sensations, touch, itch, etc. (Craig, 2002, 2003). More recently, Desmedt et al. (2023) emphasized the

discrepancy between the earlier narrow conceptualization of interoception and the more recent inclusive conceptualization of interoception, which relies on different neural pathways. After a careful review of the interoception literature, Desmedt and colleagues (2023) found evidence for an inclusive conceptualization of interoception and proposed the following comprehensive definition: "Interoception includes the top-down and bottom-up processes by which an organism senses, interprets, and integrates signals from within itself and below the skin, across conscious and nonconscious levels" (Desmedt et al., 2023, p. 12).

Since the 1980s, research on interoception has steadily increased with a sharp rise in the early 2000s, as researchers discovered the relevance of the topic for a wide range of human experiences (e.g., mental health disorders, emotions, self-regulation, decision-making, etc.; Khalsa et al., 2018). The upsurge of research in recent decades has led to the development of various theoretical models of interoception (Desmedt, Luminent, et al., 2023; Forkmann et al., 2016; Khalsa et al., 2018; Suksasilp & Garfinkel, 2022). For a review of the different models see Desmedt et al. (2023). We will briefly introduce two of the models that guided our thinking in the present research and that are mentioned in the dissertation chapters: Khalsa and colleagues' (2018) Features of Interoceptive Awareness model and Suksasilp and Garfinkel's (2022) Comprehensive Multidimensional Interoception Framework.

Khalsa and colleagues (2018) conceptualize interoception as a complex process with several facets occurring at conscious and unconscious levels. Eight facets are outlined in their model: (1) interoceptive attention: merely observing body sensations; (2) interoceptive detection: conscious report of body sensations, (3) interoceptive magnitude: perceived intensity of body sensations, (4) interoceptive discrimination: differentiating sensations from different organ systems, (5) interoceptive accuracy: the ability to precisely monitor one's sensations, (6) interoceptive sensibility: one's perceived tendency to focus on body sensations, (7) interoceptive insight: confidence about one's interoceptive accuracy abilities, and (8) self-report scales: questionnaire assessments of interoception (Khalsa et al., 2018).

Suksasilp and Garfinkel (2022) build on Khalsa et al.'s (2018) model by proposing a more comprehensive model that includes and distinguishes between different levels of interoceptive processing. In their model, each dimension represents a different level of processing and dimensions are presented on a continuum from lower levels of processing (e.g., central nervous system activity) to higher levels of processing (e.g., interpretation of body sensations). Eight dimensions are included: (1) neural representation: central nervous system (CNS) activity of interoceptive processing, (2) strength of afferent signals: strength and variability of interoceptive signals traveling from the periphery to the CNS, (3) preconscious impact of afferent signals: how afferent signals preconsciously impact the processing of external stimuli, (4) interoceptive accuracy: one's ability to correctly monitor physiological events, (5) self-report and interoceptive beliefs: one's beliefs about body sensations, (6) interoceptive insight: one's evaluation of how accurately one can

monitor physiological events, (7) interoceptive attention: consciously attending to body sensations and one's habitual tendency to attend to body sensations, and (8) attribution of interoceptive sensations: one's interpretation of body sensations and why they arise (Suksasilp & Garfinkel, 2022).

The present research focuses on subjective aspects of interoception and hence on higher-order processing dimensions accessible to conscious awareness, measurable by self-report, and clinically relevant (i.e., they are associated with mental health outcomes and can be targeted with psychological interventions). The dimension of interoceptive accuracy is accessible to conscious awareness but was excluded because it was deemed clinically irrelevant as studies have found no association between interoceptive accuracy and mental health outcomes (Desmedt, van Den Houte, et al., 2022; Ferentzi et al., 2019). Therefore, the dimensions of interest in Khalsa et al.'s (2018) model are interoceptive sensibility and self-report scales. Similarly, the dimensions of interest in Suksasilp and Garfinkel's (2022) model are: self-report and interoceptive beliefs, interoceptive attention, and attribution of interoceptive sensations. These are summarized in Table 1. From this point forward, the term BA will be used to refer to these dimensions of interoception.

Within the realm of BA, the viewpoint most relevant to clinical psychology and most akin to the view of BA as a resilience factor, was that of Mehling et al. (2009, 2011, 2012, 2016). Therefore, the starting point for the present research was Mehling et al.'s (2011) definition of BA: the subjective, phenomenological and conscious experience of body sensations shaped by psychological processes such as attention, attitude, interpretation, and beliefs. Mehling et al. (2012) noted that BA can have different levels of adaptivity for

Table 1. Dimensions of interoception pertinent to the present research

Dimension	Reference	Definition
Interoceptive sensibility	Khalsa et al. (2018)	One's perceived tendency to focus on body sensations
Self-report scales	Khalsa et al. (2018)	Questionnaire assessments of interoception
Self-report and interoceptive beliefs	Suksasilp & Garfinkel (2022)	One's beliefs about body sensations
Interoceptive attention	Suksasilp & Garfinkel (2022)	Consciously attending to body sensations and one's habitual tendency to attend to body sensations
Attribution of interoceptive sensations	Suksasilp & Garfinkel (2022)	One's interpretation of body sensations and why they arise

mental and physical health depending on the way one pays attention to body sensations (i.e., attentional style) and how one uses body sensations to regulate oneself. Maladaptive forms of BA are characterized by paying attention to sensations in an anxiety-driven, evaluative, and avoidant manner and are associated with negative outcomes (reviewed in the next section), whereas adaptive forms of BA are characterized by paying attention to body sensations in a mindful, non-judgmental, and accepting manner and are associated with positive outcomes (reviewed in the next section; Cioffi, 1991; Mehling, 2016). Given the important clinical implications of distinguishing between adaptive and maladaptive forms of BA, and the lack of BA measures that were able to make the distinction at the

time, Mehling and colleagues (2012) developed the Multidimensional Assessment of Interoceptive Awareness (MAIA), which constituted a step forward for adaptive BA research.

The conceptual framework of the MAIA was the result of a conceptual and psychometric review (Mehling et al., 2009) and qualitative findings from focus groups with mind-body therapists and students (Mehling et al., 2011). The framework consisting of five general dimensions with a total of eight sub-dimensions is summarized in Table 2. Overall, the concept of adaptive BA described by this framework consists of the ability to: be aware of body sensations of different valences, to regulate attention to and from body sensations, to react to unpleasant body sensations without ignoring them or worrying about them, to be aware of the connection between body sensations and emotions, to regulate one's distress by attending to body sensations, to listen to body sensations for insight, and to experience the body as a trustworthy place (Mehling et al., 2012).

Though Mehling and colleagues' conceptual framework of adaptive BA was comprehensive and potentially relevant for the study of a wide range of mind-body therapies, it had important limitations. The main limitation was that it did not consider developmental aspects, as it was conceived by adults for adults. A second important limitation was that it lacked specificity, as the psychological interventions of interest in the present research were mindfulness-based interventions rather than all mind-body therapies. Other limitations of the MAIA conceptual framework and measure are discussed in Chapter 4.

In this dissertation, Mehling et al.'s (2011) definition served as a starting point in the process of specifying a new concept of adaptive BA relevant to youth and incorporating mindfulness theory. The aim was to have a construct that would be particularly relevant to the study of mindfulness-based interventions in youth. We coined the concept mindful body awareness to refer to paying attention to emotion and non-emotion related body sensations with an open and curious attitude and integrating this information into complex psychological processes, such as self-regulation. Further specification of this construct and the process of its measurement development are described in Chapters 3, 4, and Appendix A.

To conclude, BA, as defined in this dissertation, refers to the subjective experience of being aware of one's body sensations, an experience that is influenced by many mental processes such as attention, attitude, and interpretation. The present research focuses on the aspects of BA that are conscious, measurable by self-report, and relevant to clinical practice. BA can be adaptive or maladaptive depending on attentional style and regulatory aspects. This idea will be elaborated upon in the next section which discusses the link between BA and mental health.

Table 2. The Multidimensional Assessment of Interoceptive Awareness final conceptual framework of adaptive body awareness (copied from Mehling et al., 2012)

1)	*Awareness of Body Sensations*
	Noticing: Awareness of uncomfortable, comfortable, and neutral body sensations
2)	*Emotional Reaction and Attentional Response to Sensations*
	Not Distracting: Tendency to ignore or distract oneself from sensations of pain or discomfort
	Not Worrying: Emotional distress or worry with sensations of pain or discomfort
3)	*Capacity to Regulate Attention*
	Attention Regulation: Ability to sustain and control attention to body sensation
4)	*Awareness of Mind-Body Integration: access to more developed levels of body awareness*
	Emotional Awareness: Awareness of the connection between body sensations and emotional states
	Self-Regulation: Ability to regulate psychological distress by attention to body sensations
	Body Listening: Actively listens to the body for insight
5)	*Trusting Body Sensations*
	Trusting: Experiences one's body as safe and trustworthy

Why is Body Awareness Important to Youth Mental Health?

Research has shown that BA plays an important role in physical health and psychological well-being (Quadt et al., 2018). Adaptive forms of BA, characterized by paying attention to body sensations in a mindful, non-judgmental, and accepting manner, are associated with positive mental health outcomes; whereas maladaptive forms of BA or deficits in BA, characterized by paying attention to sensations in an anxiety-driven, evaluative, and avoidant manner, have been linked to negative mental health outcomes. Since research in youth is scarce, existing research in adults and youth will both be reviewed briefly.

In the adult literature, adaptive BA has been positively associated with positive mental health outcomes, whereas deficits in BA have been associated with negative mental health outcomes. Paying attention to body sensations with a mindful and accepting attitude has been associated with pain attenuation (Gard et al., 2012) and intuitive decision-making (Damasio, 1994). Furthermore, there is evidence for BA deficiencies in major depressive disorder (Avery et al., 2014), anxiety (M. P. Paulus & Stein, 2010), substance use disorder (May et al., 2014a), and various other disorders (see Khalsa & Lapidus, 2016). As an example, neuroimaging studies found abnormal patterns of activation in the insula (a key cortical structure underlying interoceptive awareness) in individuals with major depressive disorder (Avery et al., 2014). Moreover, maladaptive BA has been associated with the generation of negative emotions, hypochondriasis, somatization, anxiety disorders, and with increased trait anxiety when mediated by alexithymia (Aronson et al., 2006; Barsky et al., 1988; Barsky & Klerman, 1983; Cioffi, 1991; Olatunji et al., 2007; Palser, Palmer, et al., 2018). Taken together, these findings support the link between adaptive BA and mental health and deficits in BA and mental ill-being.

Though research in youth is less abundant, existing studies have replicated the above findings. For instance, BA (as measured by the Body Awareness Questionnaire; Shields et al., 1989) is positively associated with subjective well-being (i.e., positive mood, relaxation, activity, sleep quality) and negatively associated with symptom reports in young adults who were on average 22 years old (Ferentzi et al., 2019). Moreover, adaptive BA (as measured by the MAIA; Mehling et al., 2012), has been associated with positive body image in 13 to 16 year olds (Todd et al., 2019). The link between deficits in BA and negative mental health outcomes has also been replicated in youth. For instance, in a network analysis study, the central symptom linking BA to eating disorder symptoms was a lack of trust in one's body (as measured by the MAIA; Mehling et al., 2012; Brown et al., 2020). Furthermore, a longitudinal study in a population of community adolescents, found that BA deficits predicted eating disorder symptoms and suicidal ideation (Perkins et al., 2021). Lastly, theory suggests that during adolescence, poor BA skills may lead to risky decision-making and difficulties regulating emotions, which in turn may contribute to increased psychopathology and risky behaviors (Murphy et al., 2017) but more research is needed to test these hypotheses. Overall, these findings suggest that BA may play an important role in youth mental well-being and deficits in BA may put youth at risk for psychopathology, but more research is needed.

One key pathway via which BA may contribute to youth mental well-being is via its intimate connection with emotion regulation. Theorists posit that increased awareness of body sensations during affective experiences may lead to enhanced emotional awareness and regulation (Hölzel et al., 2011). Furthermore, there is functional imaging evidence that all human emotions involve the activation of the anterior insula and the anterior cingulate cortices (e.g., Murphy et al., 2003). According to Craig (2008), this is the neuroanatomical basis of a human emotion as it involves the aspect of subjective feeling or the body sensations (in the anterior insula) and the aspect of volitional agency (in the anterior cingulate cortex). This suggests that body sensations cannot be decoupled from emotions, and awareness of one necessarily enhances awareness of the other. Moreover, certain interoception researchers emphasize how accepting and examining bodily signals with curiosity can be an effective way to regulate emotions (Farb et al., 2015). This claim that BA and emotion regulation are connected is supported by research on interoceptive accuracy and emotions which shows that individuals with higher cardiac awareness are better at processing and recognizing emotional stimuli (Pollatos & Schandry, 2008). This claim is also supported by research on the impact of respiratory feedback on the generation of emotion (Philippot et al., 2002). Furthermore, research on mindfulness (i.e., attending to present-moment experiences in an open, accepting and curious way; Kabat-Zinn, 1990) shows consistent connections between mindful attention towards internal experiences (including body sensations) and increased emotion differentiation, less emotional difficulties, and effective emotion regulation (Hill & Updegraff, 2012; Van der Gucht et al., 2019). Taken together, the aforementioned research suggests that adaptive BA may be important to mental health via its enhancement of emotion

regulation, a psychological process intimately linked with psychological well-being as will be described later in the introduction.

Developmental Aspects of Body Awareness

Despite the growing evidence of the importance of adaptive BA in mental health, BA research has mostly focused on adult populations and important developmental periods such as adolescence and young adulthood remain largely unexplored. Adolescence and young adulthood are relevant periods to study BA because of the numerous bodily, brain, and identity changes occurring at this time. Adolescence begins with puberty, a biological process that transforms the body in ways including but not limited to: physical growth; sex-specific sexual maturation including changes in the face, voice, distribution of muscle and fat, genital development and development of the gonads; and sleep and circadian regulation changes (Dahl et al., 2018). This process is accompanied by a release of hormones that influence emotional, cognitive, motivational, and social processes leading to well-known youth behaviors such as heightened sensation seeking and increased importance of peers, sexual relationships, and status (Dahl et al., 2018). Regarding changes in the brain, brain development occurs until the age of 30 with a general tendency towards integration rather than segregation (Dennis et al., 2013). More specifically, there is a general increase in cortical white matter from childhood to adolescence, and an inverted U-shaped trend in cortical grey matter development (i.e., neuronal density and connections), peaking in childhood and then decreasing throughout adolescence and into early adulthood (Crone & Dahl, 2012). Synaptic pruning stabilizes the brain; however, new connections are also formed (e.g., increased innervation of the frontal cortex by amygdala neurons; Cunningham et al., 2002) leading to new forms of learning (Dahl et al., 2018). Last but not least, adolescence and early adulthood are important times for the development of self and identity (Arnett, 2000), autobiographical memory (Holmes & Conway, 1999), and narrative identity (Pasupathi & Hoyt, 2009). With all these age-specific changes taking place in adolescents and young adults, existing BA research in adults may not be translatable to this age group and there is a need to explore the role of BA in this highly dynamic stage of life.

Existing research on the development of BA in youth is scarce. One neuroimaging study found that mid to late adolescence is an important period of development for the sub-regions of the insula, which are involved in interoceptive processing but are also important for emotional processing and attentional and executive control (D. Li et al., 2017). However, these findings need to be replicated. There is very little research on the developmental trajectory of BA throughout adolescence and young adulthood and on the psychological processes that may be impacted by an adaptive or maladaptive BA. Many questions remain unanswered. For example, what is the typical development of BA throughout adolescence and emerging adulthood? Do BA skills naturally increase with age and is this negatively linked with psychopathology rates? Do poor BA skills impact decision-making during adolescence? Before these important questions can be

meaningfully explored, there is a need for a BA conceptualization and BA assessment tools adapted to youth. Chapters 3, 4, and Appendix A of this dissertation will provide data for a BA conceptualization relevant to youth and will provide BA measures adapted to youth.

In short, there is a need for more studies on the developmental trajectory of BA particularly during youth, a highly dynamic stage of life. BA theoretical frameworks in youth and BA measures grounded in these frameworks are needed for research in the field to progress.

Emotion Regulation

What is Emotion Regulation?

Emotions are a fundamental part of human life. They are multi-faceted experiences with physiological, cognitive, and behavioral components that intend to help us respond to important occurrences in our environments (Gross, 1999). Emotion regulation (ER) is a broad concept referring to how these emotional responses are regulated. It can be defined as "the ways individuals influence which emotions they have, when they have them, and how they experience and express these emotions" (Gross, 1999; p. 557). ER involves changing (intentionally or unintentionally) any element of one's initial emotional response to achieve a goal, fulfill one's needs, or pursue one's values (Beauchaine & Hinshaw, 2008; Gross, 1999).

How exactly are emotional responses changed? The consensual process model of emotion generation provides a helpful summary of emotion regulatory processes (Gross, 1999). This model posits that emotion begins with an internal or external situation that is attended to and evaluated in a certain way giving rise to a set of coordinated responses (see Figure 1). ER can occur at five points in this emotion generation process: (1) *Situation selection*: at the level of the triggering situation, an individual can choose to engage in or avoid certain emotion-eliciting situations, (2) *Situation modification*: likewise, at the situational level, if the individual is already in the situation, they can try to modify the situation in some way so as to change its emotional impact, (3) *Attentional deployment:* at the level of attention, individuals can choose how and where they direct their attention (e.g., by distracting themselves, by mindfully attending to internal or external aspects of the experience, etc.), (4) *Cognitive change:* at the level of evaluation, individuals can change the way they appraise the situation (e.g., cognitive reappraisal), and (5) *Response modulation:* at the level of response tendencies, individuals can choose to express or not express their emotions or to self-regulate by for instance changing their breathing pattern. In short, this model suggests there are many diverse ER strategies that can be used at different moments of the emotional experience.

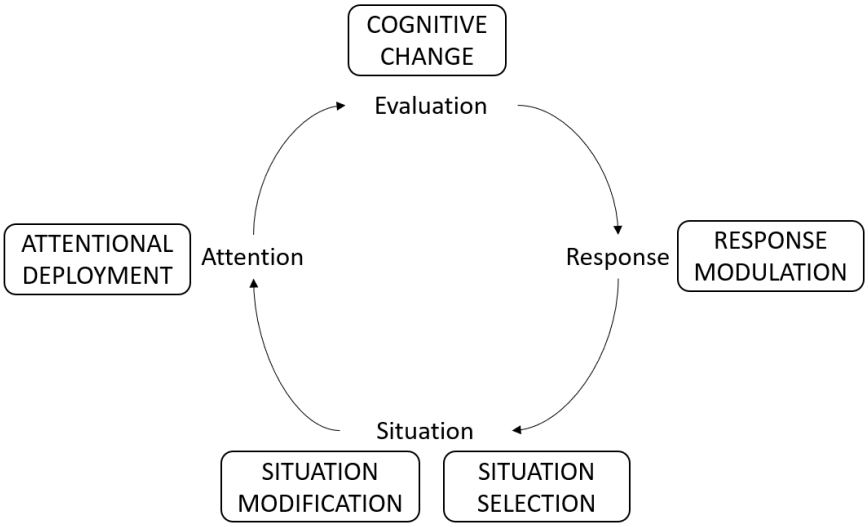

Figure 1. Consensual process model of emotion generation (Gross, 1999)

Though helpful in conceptualizing certain emotion regulatory processes, Gross's (1999) model has been criticized for being overly simplistic and failing to consider many aspects of the emotional experience. For one, it views emotions as being maladjusted phenomena that must be regulated and disregards the self-regulatory aspects of emotions and their adaptive components (Philippot, 2013). Second, it proposes a step-by-step process of emotion generation that fails to illustrate the complexity of a real emotional experience, in which many processes are happening simultaneously. For instance, attentional deployment, evaluation of the emotion, physiological responses related to the emotion all happen throughout the emotional experience, and not only at set points (Philippot, 2013). This narrow conceptualization of emotion has clinical implications as it puts too much focus on certain ER strategies (e.g., reappraisal) at the expense of other equally helpful strategies, many of which are bodily based (e.g., mindfulness, relaxation; Philippot, 2013).

Multi-level theories of emotion have been proposed to account for the complexity of emotional experiences (Philippot, 2013; Power & Dalgleish, 1999). These theories suggest that emotions are holistic processes occurring at different levels of representation (Power & Dalgleish, 1999). Stimuli are first processed by a perceptual system involving sensory organs, a process that happens automatically. This immediately interacts with the system of bodily responses (including physiological changes, urges, and associated behaviors) which is also automatic and highly biologically determined (e.g., a bodily response of panic in a baby when it perceives a lack of support from its environment). This "data" is then further processed at three levels that function in parallel: (1) the associative system which consists of a plethora of associations between perceptual indices and bodily responses that have been made throughout the years via classical conditioning

(e.g., an association between the smell of a loved one and a physiological experience of well-being); (2) the propositional level involves the formation of mental and conceptual images and representations of the experience (e.g., automatic thoughts, memories, etc.), and (3) the schematic level which represents a level of increased abstraction in which the experience is appraised and interpreted according to the individual's cognitive models of themselves and the world (Philippot, 2013; Power & Dalgleish, 1999). These systems interact with each other creating complex emotional sequences. From this perspective, regulation can occur at any of these levels (see Philippot, 2013 Chapter 5 for a review).

This wide range of ER processes described in different theories can have higher or lower levels of adaptiveness depending on their short-, mid-, and long-term consequences, the context, situation, and frequency of use (Beauchaine & Hinshaw, 2008; Troy et al., 2013). In terms of consequences, an example of maladaptive ER would be drinking large amounts of alcohol when facing a negative emotion. This could attenuate or even eliminate the negative emotion leading to a sense of relief in the short-term, but to fatigue, physical malaise, diminished productivity, and more negative emotions in the mid-term, and to conflicts in relationships, health problems, and a low sense of ER self-efficacy in the long-term, especially if the strategy is frequently used. These maladaptive patterns of ER in which the negative consequences outweigh the positive ones are referred to as emotion dysregulation (Beauchaine & Hinshaw, 2008). Adaptive ER, on the other hand, involves ER processes that move an individual closer to their well-being goals and their longer-term goals that are often linked with their values (Beauchaine & Hinshaw, 2008).

According to Gratz and Roemer (2004), adaptive ER requires a certain number of skills. The skillset includes being aware of one's emotions, understanding them, accepting them, behaving in accordance with one's goals when faced with emotions, and implementing ER strategies to modulate emotional experiences in a flexible and situationally appropriate way. From this perspective, emotion dysregulation (ED) can be defined as the absence of one or more of these skills (Gratz & Roemer, 2004). This skills perspective is interesting for concretely measuring the presence or absence of adaptive ER as well as for identifying which of these skills are targeted in psychological interventions. This topic will be further elaborated upon in Chapter 5 of the dissertation.

In short, ER refers to the many ways emotional responses can be changed to meet an individual's goals and can have higher or lower levels of adaptiveness depending on the consequences, context, and frequency of use. Adaptive ER requires a set of skills that can be trained with psychological interventions. From here on, ER will be used to refer to adaptive ER and ED will be used to refer to deficits in ER. The next section will explore the link between ER and mental health in youth.

Why is Emotion Regulation Important to Youth Mental Health?

ER is important to youth mental health for several empirically validated reasons: (1) it is negatively associated with negative mental health outcomes; (2) it is positively associated with mental well-being outcomes, (3) it protects against negative risk factors; and (4) its absence (or ED) is associated with negative outcomes.

There is evidence for a negative association between ER and negative mental health outcomes in youth. A meta-analytic review of 114 studies in children, adolescents, and adult populations found that adaptive ER strategies, namely problem solving and reappraisal, were negatively associated with psychopathology with medium to large effect sizes and small to medium effect sizes respectively (Aldao et al., 2010). These findings were supported by another meta-analytic study in adolescents in which adaptive ER strategies (e.g., acceptance, cognitive reappraisal, and problem solving) were negatively associated with anxiety and depressive symptoms, with the strongest effect found for acceptance (Özlem-Schäfer et al., 2017). The same trend is observed in diverse samples of adolescents, such as first-generation Latinx youth and individuals with Developmental Language Disability (Daniel et al., 2020). In their narrative review of 50 studies on the effect of ER on child and adolescent well-being, Daniel and colleagues (2020) summarize that on top of being associated with reduced symptomatology, adaptive ER strategies are also associated with decreased negative emotion, reduced alcohol use, reduced initiation of marijuana usage, and increased positive adjustment among a variety of adolescent samples. Lastly, another meta-analysis with 212 studies measuring the link between ER and coping and internalizing (e.g., anxiety, depression, and social withdrawal) and externalizing symptoms (e.g., aggression, impulsivity, and oppositional behaviors) in children and adolescents aged 5 to 19 years, found significant medium negative associations between ER and internalizing and externalizing symptoms (Compas et al., 2017). Taken together, these findings suggest that the higher youth's ER is, the less psychological symptoms and problematic behaviors they experience.

On top of being negatively associated with negative mental health outcomes, evidence supports the association between ER and positive mental health outcomes. One positive mental health outcome that has been empirically linked to ER is resilience. Resilience is "a dynamic process encompassing positive adaptation withing the context of significant adversity" (Luthar et al., 2000; p. 43). A study in 180 Norwegian high school students (mean age = 17, *SD* = 1.35) found that personal resiliency was significantly positively associated with self-reported ER and partly associated with a psychophysiological index of ER, resting vagally mediated heart rate variability (Sætren et al., 2019). More specifically, reappraisal was significantly positively associated with a sense of mastery (i.e., a component of personal resiliency referring to optimism about life and oneself, ability to learn from mistakes, and self-efficacy; Prince-Embury, 2014), and with a sense of relatedness (i.e., a component of personal resiliency involving trust in others, tolerance of differences, and social comfort and support; Prince-Embury, 2014). Both sense of relatedness and mastery were also significantly negatively associated with

emotional problems (Sætren et al., 2019). The link between resilience and ER was also found in a study by Mestre et al. (2017), who examined the topic in a sample of 13 to 16 year-old Spanish adolescents and found that ER ability and adaptive ER strategies such as positive reappraisal, predicted perceived resilience. Other than resilience, ER has been shown to promote other positive mental health outcomes in adolescents and emerging adults, such as increases in positive affect, positive relationships, a sense of meaning, positive accomplishments, among others (see Morrish et al., 2018 for a comprehensive review on this). Overall, these findings are strong indicators of ER's capacity to promote mental well-being in youth.

ER may also serve as a protective factor against risk factors in youth. The narrative review by Daniel et al. (2020) provides a helpful summary of findings published from 1995 to 2019 on ER's promotive and protective effect in youth. Zooming in on results for ER's protective effect, the general trend of results suggests that ER skills protect children and adolescents in at-risk, disadvantaged, under-privileged, and adverse family and community contexts from developing behavioral difficulties or psychological symptoms. To provide an example, Mohammad et al. (2015) found that emotionally-regulated coping moderated the association between youth's (aged 8-17) exposure to family abuse and youth anxiety, aggression, and post-traumatic stress symptoms in a sample of young people living in single-parent families that were homeless, living in emergency shelters, or living in poverty. This is one among many other studies that provide support for ER's protective effect on mental health particularly in at-risk situations.

Finally, ED is positively associated with negative mental health outcomes. A meta-analytic review found that maladaptive ER strategies, namely avoidance, suppression, and rumination, were positively associated with psychopathology with medium to large effect sizes for avoidance and suppression and a large effect size for rumination (Aldao et al., 2010). Moreover, suppression has been positively associated with conduct problems and hyperactivity in a sample of Norwegian high school adolescents (Sætren et al., 2019). The link between ED and negative mental health outcomes has also been examined in longitudinal studies. For example, a 1-year longitudinal study in 667 high school students found that low emotion identification skills predicted increases in negative affect, decreases in positive affect, and decreases in social support from Grades 8 to 9 (Ciarrochi et al., 2008). Last but not least, there is a widespread recognition of ED as a transdiagnostic factor of psychopathology as deficits regulating emotions are observed across psychological disorders (Beauchaine & Cicchetti, 2019). These findings suggest that deficits in ER skills make young people more likely to experience psychological symptoms and negative socioemotional consequences.

To conclude, the above evidence supports the claim that ER is important to youth mental health because it is associated with reduced negative psychological outcomes, increased positive psychological outcomes, it protects youth mental health in adverse situations, and its absence is associated with symptomatology.

Developmental Aspects of Emotion Regulation

ER is a developmental feat that undergoes many important transformations throughout childhood, adolescence, and early adulthood. From a developmental perspective, it is useful to think of ER as a dyadic process involving internal and external components (Morris et al., 2017). Internal components include ER strategies supported by neurobiological processes that individuals have access to within themselves, such as attention regulation or cognitive reappraisal. External components refer to external resources that can support ER, such as parents. During childhood, the ER neural machinery is not yet fully developed, so children have less access to internal components and a greater need for external components. For this reason, the parent-child relationship and family context are key elements in the early years of ER development (Morris et al., 2017).

Morris et al. (2007) provide a useful model that summarizes relevant external and internal components of ER development in childhood, which has downstream effects on ER development in adolescence. The Tripartite Model of the Impact of the Family on Children's ER and Adjustment (see Figure 2) posits that family context influences ER development through three pathways: (1) observation of parental ER behaviors based on the modeling hypothesis suggesting that children learn implicitly by imitating their parents' behaviors in emotional contexts, (2) emotion-related parenting practices such as parents' emotion coaching (or lack thereof) involving helping the child identify their emotions, validate them, and helping the child with problem solving, and (3) the family emotional climate which may be reflected in the quality of relationships (Morris et al., 2017; Morris et al., 2007). These pathways are also influenced by the parents' and the child's personal characteristics. Altogether, these factors affect the child's overall adjustment and create the foundation for ER and adjustment in adolescence (Perry et al., 2020).

Adolescence is a crucial period for ER development (Silvers, 2022). The ER neural machinery goes through important developmental changes during adolescence meaning internal ER components become increasingly important and external ER components diversify as adolescents seek less help from their parents and more from their peers (King et al., 2018; Klimes-Dougan et al., 2014; Silvers, 2022). Neurologically speaking, brain regions involved in higher-order ER, such as the prefrontal areas, go through a speedy development during adolescence (Ahmed et al., 2015). For instance, adolescents are increasingly able to use cognitive reappraisal strategies effectively (i.e., changing the way they see an emotion-eliciting event to reduce negative affect and amygdala activity), whereas children under the age of 10 are not (Dougherty et al., 2015; Silvers et al., 2017). Development in the subdivisions of the prefrontal cortex relevant to ER (i.e., the dorsolateral, ventrolateral, and ventromedial regions) continue well into early adulthood, suggesting ER is a protracted process (Ahmed et al., 2015). Moreover, connections between the amygdala and prefrontal brain regions mature during adolescence conferring the brain with a plasticity and flexibility that is conducive to learning (Ahmed et al., 2015).

For this reason, adolescence is a window of opportunity for delivering psychological interventions that target ER.

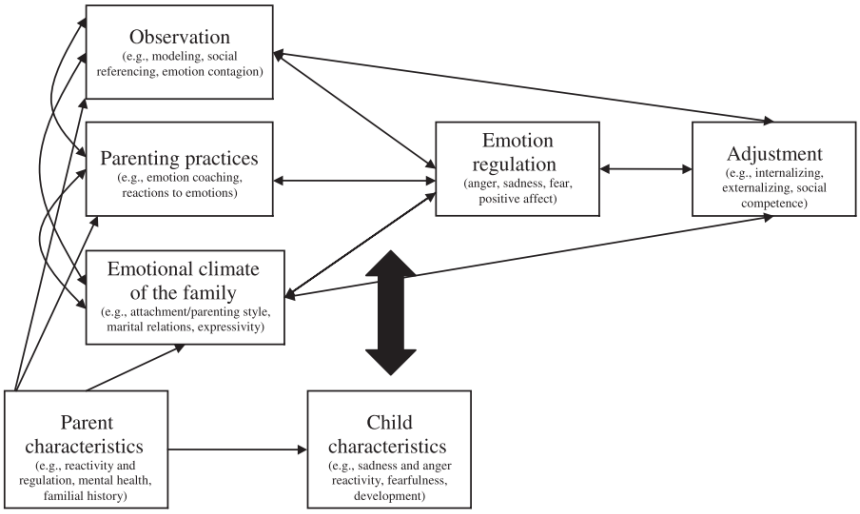

Figure 2. The Tripartite Model of the Impact of the Family on Children's Emotion Regulation and Adjustment (copied from Morris et al., 2007)

On top of being a time of speedy neurological changes, adolescence is also a period of great social, personal, and professional changes, increased autonomy, and increased demands, which must all be met with a brain that is still under development (Casey et al., 2010). In face of the numerous changes and demands characterizing this period of life, many adolescents experience difficulties coping with their emotional experiences (Silvers, 2022). These difficulties constitute a risk factor for psychological problems down the road (McLaughlin et al., 2011), as established in the above section. Certain models have attempted to explain this increased vulnerability to ED. For instance, Casey and Caudle (2013) explain it using the imbalance model of brain development, which posits that limbic brain structures develop more quickly than prefrontal brain regions leading to difficulties in ER, susceptibility to peer influence, and risky decision-making. In short, the mixture of neurobiological and contextual factors may contribute to adolescents' increased vulnerability to ED, which in turn increases their risk for developing a mental disorder.

To conclude, ER goes through important developmental changes from childhood to adolescence and emerging adulthood. Numerous factors influence ER development such as family context and neurobiological changes making childhood and adolescence an important time for ER learning and a vulnerable time for ED development.

1.3 Mindfulness-Based Interventions

Mindfulness-based interventions (MBIs) are psychological interventions that may enhance youth mental health by targeting both BA and ER. The next section will define what MBIs are, how they impact youth mental health, how they are theorized to exert their therapeutic effects, and how they could potentially impact BA and ER.

What Are Mindfulness-Based Interventions?

MBIs are programs (usually group-based) that teach people the skill of mindfulness through a systematic and sustained training in mindfulness meditation practice (Crane et al., 2017). They are part of the third wave of empirically tested psychotherapies (the first wave being behavioral therapy and the second wave being cognitive behavioral therapy). Third-wave approaches emphasize meta-cognition, acceptance, and relationship to experience as opposed to trying to change or control experience (Crane et al., 2017). To better understand what MBIs are, an understanding of what mindfulness is and what mindfulness meditation entails is required. The two will be described next.

Mindfulness has its roots in the 2500-year-old Buddhist tradition (Thera, 1973). Since the 1970s, certain aspects of the Buddhist mindfulness practices have been adopted, secularized, and recontextualized to the Western context particularly in the realm of psychology (Crane et al., 2017). The present work focuses on Western conceptualizations and applications of mindfulness.

Like many constructs in the psychological sciences, mindfulness is a challenging concept to define and measure (see Chiesa, 2013 for a review). A widely cited and endorsed definition of mindfulness is "the awareness that emerges through paying attention on purpose, in the present moment, and nonjudgmentally to the unfolding of experience moment by moment" (Kabat-Zinn, 2003, p. 145). Bishop et al. (2004) operationalized this definition and proposed the following two-component model of mindfulness: (1) self-regulation of attention (i.e., the capacity to maintain attention on present-moment experience) and (2) an orientation to present-moment experience characterized by openness, acceptance, and curiosity. This non-judgmental orientation does not translate to an absence of judgments, appraisals, or thoughts, but rather is defined by a welcoming attitude towards all internal experiences (Philippot et al., 2013). It can be likened to the position of a curious observer, who watches the mind's creations with interest. This moment of awareness is a pause allowing an individual to collect ample and unbiased data on their internal experience, giving them the freedom to act intentionally rather than automatically (Deplus et al., 2012). From this perspective, mindfulness involves a set of skills and attitudes that can be trained with practice (Bishop et al., 2004). Other mindfulness models exist (e.g., Shapiro et al., 2006), but Bishop et al.'s (2004) model was chosen to guide reflections in the present work because of its simplicity, pragmatism, and its overlap with Mehling's (2016) concept of attentional style which also involves attending to body sensations with a certain disposition. How these two

viewpoints inspired the mindful body awareness construct explored in this research is explained in Chapter 4.

Mindfulness meditation refers to a range of practices whose aim is to train the skill of mindfulness as defined above (Eberth & Sedlmeier, 2012). Formal mindfulness meditation practices taught in MBIs include sitting meditations, body scans, mindful movement, and short meditations called breathing spaces (Kabat-Zinn, 1990; Segal et al., 2018). The basic approach to these meditations is similar across practices and will be illustrated here with the example of a sitting meditation. During a sitting meditation, the mindfulness trainer asks the client to sit quietly in a comfortable position on a chair or on a meditation cushion with their eyes closed if that is comfortable. The trainer then guides the participant to pay attention to the somatic sensations related to their posture, and then the main guidance is given (feel free to try this at home):

> Bring your awareness to the changing patterns of physical sensations in the lower abdomen as the breath moves in and out of your body. Focus your awareness on the sensations of slight stretching as the abdominal wall rises with each inbreath, and of gentle deflation as it falls with each outbreath. As best you can, follow with your awareness the changing physical sensations in the lower abdomen all the way through as the breath enters your body on the inbreath, and all the way through as the breath leaves your body on the outbreath…There is no need to control the breathing in any way – simply let the breath breathe itself. As best you can, also bring this attitude of allowing to the rest of your experience. There is nothing to be fixed, no particular state to be achieved. As best you can, simply allow your experience to be your experience, without needing it to be other than it is. Sooner or later your mind will wander away from the focus on the breath in the lower abdomen to thoughts, planning, daydreams, drifting along – whatever. This is perfectly OK – it's simply what minds do. It is not a mistake or a failure. When you notice that your awareness is no longer on the breath, gently congratulate yourself – you have come back and are once more aware of your experience. You may want to acknowledge briefly where the mind has been (Ah, there's thinking). Then, gently escort the awareness back to a focus on the changing patterns of physical sensations in the lower abdomen, renewing the intention to pay attention to the ongoing inbreath and outbreath, whichever you find. (Segal et al., 2018, p. 171-172)

The above example illustrates how mindfulness meditation is a tool to train the two mindfulness components of self-regulation of attention and openness to the present moment. The object of awareness is changeable; it can be the physical sensations of the breath, the sensations of the body moving, thoughts, sounds, etc. The same kind of mindful attention can be practiced informally while doing activities throughout the day

such as walking, brushing one's teeth, etc. Both formal and informal mindfulness meditation practices are essential pedagogical tools in MBIs.

Regarding MBIs themselves, recent research has witnessed an explosion of MBI research, implementation, and program adaptations. The first manualized MBI was Mindfulness-Based Stressed Reduction (MBSR; Kabat-Zinn, 1982; Kabat-Zinn, 1990), initially developed to help manage stress, pain, and disease. Mindfulness-Based Cognitive Therapy (MBCT) was later adapted from MBSR with the aim of helping prevent depression relapse (Segal et al., 2018). These are the two most widely researched MBIs for which the evidence base is strongest (Crane et al., 2017). Both have been adapted for use with adolescents (e.g., Deplus & Lahaye, 2015 for MBCT and Tan & Martin, 2013 for MBSR), and several other MBIs have been developed for youth in the school context (e.g., Learning to Breathe by Broderick, 2013 and .b by Kuyken et al., 2013) or to target specific conditions (e.g., MBCT adapted for adolescents with ADHD and their parents; Bögels et al., 2008). The present work uses Deplus and Lahaye's (2015) MBI, an adaptation of the MBCT program for adolescents that will be described further in Chapter 6.

Given the many MBI curriculum adaptations in recent years, Crane et al. (2017) proposed an integrated framework of what is and what is not an MBI. A knitting metaphor was used to describe the essential elements a program must have to be considered an MBI, the warp, and the variable elements that can be adapted to meet the needs of a particular context and population, the weft. The 'warp' elements are that the program must: (1) be based on theory and practice drawing from contemplative traditions, science, medicine, psychology, and education; (2) be based on an empirically tested model addressing the causes of distress and ways to relieve it; (3) focus on developing a relationship with experience characterized by a decentered present-moment awareness based on an approach orientation; (4) support the development of greater self-regulation and positive qualities (e.g., compassion), (5) include an experiential learning process that engages participants in sustained training in mindfulness meditation practice and inquiry to develop insight. Moreover, the MBI teacher must have the skills to deliver the program, be able to embody mindfulness, have done a training to teach the MBI, commit to continued good practice, and participate in the learning process with their students. The 'weft' elements include adaptations in certain curriculum elements to meet the needs of a certain context and population; variations in length, structure, and delivery; and a teacher who has the relevant knowledge, experience, and training to teach that particular population (Crane et al., 2017).

To conclude, MBIs are evidence-based programs that use an experiential, inquiry-based learning style and a systematic training in mindfulness meditation practice to teach the skills and qualities of mindfulness. They can be adapted to specific contexts and populations, but certain elements must be maintained for it to be considered an MBI. The next section explores how MBIs impact youth mental health.

What Impact do Mindfulness-Based Interventions Have on Youth Mental Health?

MBIs have gained vast popularity in recent years and the evidence-base for their effects on youth mental health is growing. A meta-analysis of 18 RCTs in participants aged 12 to 25 years with depressive symptoms from clinical and non-clinical populations, found that MBSR reduced depression post-intervention relative to the control groups with moderate effects (Hedge's g = -0.45; Chi et al., 2018). A more recent meta-analysis of 66 RCTs in participants from clinical and nonclinical samples aged 18 or younger found significant positive effects of MBIs on executive functioning, attention, anxiety/stress, and negative and social behaviors in comparison with passive controls (Dunning et al., 2022). However, in comparison with active controls, MBIs only significantly improved anxiety/stress and mindfulness with small effect sizes. Furthermore, no significant effects were found at follow-up. These meta-analytic results suggest that MBIs may be promising for specific outcomes in youth, but since the evidence is of low quality and highly heterogeneous, more research is needed to make robust conclusions (Dunning et al., 2022).

Given their potential in targeting transdiagnostic risk factors and promoting resilience factors that can help youth face a variety of experiences, MBIs are being increasingly delivered as universal preventive programs in schools (Tudor et al., 2022). The evidence for the positive impact of universally delivered MBIs, however, is mixed. A systematic review containing 28 studies assessing the impact of MBIs in schools, demonstrated significant reductions in outcomes such as behavioral problems, depression, anxiety, and affective disturbances after the intervention (Felver et al., 2016). However, only a third of evaluated studies in the latter review were RCTs, which was identified as a key methodological limitation in the school-based mindfulness literature. A comprehensive meta-analysis assessing the effectiveness of MBIs for mental health in schools across 24 studies, found that MBIs were helpful in improving mental health outcomes post-intervention in comparison to control groups with small to moderate significant effects (Hedge's g = 0.24; Carsley et al., 2018). More recently, results from a methodologically strong, parallel group, cluster-RCT (84 schools, N = 8376) in the United Kingdom (known as the MYRIAD trial) revealed that a universal MBI was not superior to normal social-emotional education in terms of risk of depression, social-emotional-behavioral functioning, and well-being; however, it was more cost-effective (Kuyken et al., 2022). Given these mixed findings, there is an increased interest in the school-based mindfulness literature on "what works, for whom, and how" (Montero-Marin et al., 2022).

Certain studies and meta-analyses have examined moderators of MBI's effects on mental health in youth, particularly in school based MBIs. Results from a meta-analysis with 24 studies, found that MBIs consisting of a mixture of different mindfulness activities and taught during late adolescence (15-18 years old) had the largest impact on youth

mental health and well-being (Carsley et al., 2018). This result was replicated by a meta-analysis of 18 RCTs on 12 to 25 year-olds with depressive symptoms which found a significant moderating effect of age on MBI's effects on executive functions (Chi et al., 2018). Increased age was associated with greater benefits, which may be due to the increased brain plasticity in late adolescence (Ahmed et al., 2015; Chi et al., 2018). Another significant moderator was the type of trainer delivering the trainings. MBIs taught by outside facilitators had a significant effect on mindfulness skills but not on mental health outcomes at post-test, and MBIs taught by trained school teachers had a significant effect on mental health outcomes but not on mindfulness skills at post- and follow-up assessments (Carsley et al., 2018). Lastly, an assessment of moderators in the MYRIAD trials revealed that students with mental health difficulties had worse scores on risk for depression and well-being after the MBI and at 1-year follow-up in comparison to an active control condition, suggesting that school-delivered universal MBIs may not be recommended for young adolescents with mental health difficulties (Montero-Marin et al., 2022). However, another study contradicts these findings as it found that poor baseline mental health was associated with greater MBI-related mental health benefits in adolescents aged 13 to 18 (Van der Gucht et al., 2017). These findings suggest that there are important moderators to MBI's effects on youth mental health but research on the topic is scarce and more research is needed to provide a clearer picture (Tudor et al., 2022).

To conclude, MBIs have potentially positive effects on youth mental health, but the evidence is mixed for school based universally delivered MBIs. Current research has revealed important moderators such as age, type of MBI, and type of trainer, but more research is needed to understand for whom MBIs work best and how they work. The next section will discuss existing research on the "how" of MBIs.

How Do Mindfulness-Based Interventions Work? The potential role of body awareness and emotion regulation

Given the positive transdiagnostic impact of MBIs, there is increasing interest in how these programs exert their effects. The study of mechanisms is clinically important because it can: help optimize interventions via enhancement of their active ingredients; help differentiate between specific and non-specific treatment effects; inform research directions and interpretation of results; and contribute to understanding which intervention is best suited to which individual (Kazdin, 2007). The study of mechanisms in MBIs has received more attention in adult populations than in youth populations. Below we provide a non-exhaustive overview of mechanistic studies and theories pertinent to the present work.

Meta-analytic and review studies have provided evidence for certain MBI mechanisms in adults and youth. For example, Gu et al. (2015) conducted a review and meta-analysis of 20 mediation studies in adults (aged 18 or older), and found strong evidence for the mediating effect of cognitive and emotional reactivity, and moderate

evidence for mindfulness, rumination, and worry. Regarding adolescents, a recent scoping review assessing the moderators, mediators, and implementation factors of school delivered MBIs in 31 studies found evidence for the mediating effect of increased mindfulness skills, decreased cognitive reactivity, and decreased self-criticism (Tudor et al., 2022). The review also calls for more high-quality mechanistic studies in youth as they are very scarce. Though more research is needed, these findings suggest that increased mindfulness and reduced cognitive reactivity seem to be mechanisms of change across development stages, but how exactly do mindfulness skills, a multidimensional construct, lead to improved mental health outcomes?

Several theoretical models have been proposed to help answer this question (see Gu et al., 2015 for a summary). Here the focus will be on four theoretical models pertinent to the present dissertation: (1) Hölzel et al.'s (2011) model on the mechanisms of mindfulness meditation,(2) Lindsay & Creswell's (2017) Monitor and Acceptance Theory, (3) Deplus et al.'s (2014) Components of Mindfulness Model, and (4) Davidson et al.'s (2012) Model of the Psychological Constructs most Impacted by Contemplative Practices.

Hölzel et al.'s (2011) Model on the Mechanisms of Mindfulness Meditation

Hölzel et al. (2011) propose a theoretical framework outlining four mechanisms of MBIs: (1) attention regulation: the ability to maintain attention on an object and bring the attention back when it wanders away; (2) body awareness: being able to notice subtle body sensations, (3) emotion regulation: via the strategies of reappraisal (i.e., reconstruing stressful events as meaningful, beneficial, or benign), exposure to emotions, and the processes of extinction and reconsolidation in fear conditioning, and (4) change in perspective on the self: loosening the identification with a static sense of self. The authors provide neuroscientific, self-report, and experimental evidence for each of these mechanisms. From Hölzel et al.'s (2011) perspective, these mechanisms "interact closely to constitute a process of enhanced self-regulation" (p. 539) suggesting that these four mechanisms are highly intertwined. Zooming in on the two variables of interest in the present work, BA and ER, Hölzel et al. (2011) proposed that since body sensations are a crucial component of the emotional experience, increased awareness of emotion-related body sensations trained in an MBI, will increase awareness of the emotion itself, a necessary first step for emotion regulation to take place.

This theoretical framework has been supported by several empirical studies. First, a study testing Hölzel et al.'s (2011) model with path analysis in experienced meditators (aged 18 years or older) found that ER, BA, and nonattachment explained the effect of trait mindfulness (as defined using Bishop et al.'s (2004) two-component definition) on reduced anxiety and depression (Tran et al., 2014). ER was the most important mechanism with regards to symptoms, namely aspects of emotional acceptance, emotional clarity, and the ability to control and regulate emotional reactions. BA was

specifically negatively associated with anxiety, and nonattachment was specifically negatively associated with depression. These results were somewhat replicated in a large sample of non-meditators with differences in the strength and direction of certain associations (aged 18 years or older; Burzler et al., 2019). Once again, BA, ER, and nonattachment were mediators of the effect of trait mindfulness on symptoms of anxiety, somatization, and depression. ER was the strongest mechanism with negative associations with all symptoms. This was particularly true for emotional acceptance, which was negatively associated with all three sets of symptoms. Two new aspects of ER came to the foreground in a sample of non-meditators: impulse control, which was negatively associated with anxiety and somatization, and access to ER strategies, which was negatively associated with depression. Interestingly, BA now had a positive association with anxiety (albeit a small association). The negative association between nonattachment and depression remained. These results provide evidence for the role of BA and ER in explaining the effects of mindfulness on symptomatology. However, they have limitations as the data is cross-sectional so causality cannot be inferred, and they have not yet been tested in a population of youth under the age of 18. Although there are a few intervention studies that have assessed the role BA and ER in MBIs in adults (these will be reviewed in Chapters 2 and 6), there are almost no studies done in a population of youth, underlining the need for research on these topics.

Lindsay & Creswell's (2017) Monitor and Acceptance Theory

Lindsay & Creswell's (2017) Monitor and Acceptance Theory (MAT) provides a potential explanation for how MBIs exert their effects via mindfulness by dividing the mindfulness construct into its component parts and discussing how each of these components affects specific outcomes. The MAT posits that mindfulness has two main components: (1) ongoing attention to present-moment experience (i.e., attention monitoring) and (2) an attitude of non-judgment, openness, and equanimity toward present-moment experience (i.e., acceptance; Lindsay & Creswell, 2017). This model echoes Bishop et al.'s (2004) operational definition of mindfulness described in the "What are mindfulness-based interventions" section, but it goes further by framing these two components as active mechanisms and making specific predictions on how each component affects specific outcomes. The MAT posits that attention monitoring alone may be the mechanism by which MBIs improve cognitive functioning outcomes (e.g., sustaining attention, working memory, switching tasks, etc.). However, attention monitoring may also increase attention to affective information potentially leading to increased affective reactivity. By changing the relationship to inner experience, the acceptance component may be in charge of regulating this reactivity. Both mechanisms may be necessary to explain the following positive outcomes of MBIs: better performance in cognitive tasks involving ER, reduced negative reactivity (e.g., depression, anxiety, and stress), reduced positive reactivity (e.g., craving, substance use), and improved stress-related outcomes (Lindsay & Creswell, 2017). The MAT therefore identifies acceptance as

a key ER mechanism of MBIs (Lindsay & Creswell, 2019), which is in line with the findings described above in support of Hölzel et al.'s (2011) model.

There are several empirical findings supporting the MAT. For example, cross-sectional data found that self-reported tendency to monitor one's experience in the present moment is associated with negative outcomes (e.g., depressive, anxiety, and other symptoms) when not accompanied by self-reported acceptance (Curtiss et al., 2017; Lindsay & Creswell, 2019). Moreover, two dismantling RCTs in which mindfulness skills were dismantled into two trainings, one with attention monitoring training (MO) only and one with training in attention monitoring and acceptance (MA), found that daily positive affect increased significantly in the MA group in comparison to the MO group and a no treatment control group (Lindsay et al., 2018). Furthermore, another dismantling RCT with a similar design found that MA participants had increased nonjudgment and decreased stress after the intervention in comparison to a MO group and a no treatment group (Chin et al., 2019). These findings provide support for the claim that attention monitoring and an orientation of acceptance are necessary for MBIs to exert their positive effects.

The MAT echoes Mehling's (2016) notion of BA attentional styles. BA includes an aspect of noticing, but also an aspect of how one notices. Just like a disposition of acceptance may be necessary for mindfulness to exert its positive effects, a similar disposition may be necessary for BA to have positive effects. The MAT viewpoint is applied to awareness of body sensations in youth and merged with Mehling's adaptive BA framework to give rise to the concept of mindful body awareness. This is described further in Chapter 4.

Deplus et al.'s (2014) Components of Mindfulness Model: A developmental perspective

According to Deplus et al. (2014), from a developmental perspective, mindfulness has three main components: (1) cognitive training, (2), a particular orientation to one's internal experience, and (3) a commitment to actions that are in line with one's values. The cognitive training component includes attention and executive functions (i.e., inhibition and flexibility), which go through important developments during childhood and adolescence (Crone et al., 2017). The second aspect refers to paying attention to one's present-moment experiences with openness, curiosity, and acceptance. This allows individuals to become aware of their emotions in the present moment, regardless of their valence, which is the first step in ER. By adopting an attitude of mindful awareness of one's experiences, individuals then have the freedom to disengage from automatic and unhelpful patterns of behavior and engage instead in actions that are in line with their values, which is the third component of mindfulness according to this model (Deplus et al., 2014).

Davidson et al.'s (2012) Model of the Psychological Constructs most Impacted by Contemplative Practices

Davidson and colleagues (2012) propose that contemplative practices, such as mindfulness practices, impact key psychological constructs that would contribute to creating healthier educational contexts. Their model posits that contemplative practices impact psychological constructs at three levels: (1) neural substrates, (2) psychological functions, and (3) behavioral outcomes. In line with other models reviewed here, Davidson et al. (2012) proposes that the psychological constructs impacted by contemplative trainings include: ER, attention regulation, executive functions, self-representation, and empathy and perspective taking. Contemplative practices change these constructs at the neural and psychological levels, which in turn lead to changes at the behavioral level. Evidence for this framework is reviewed in Davidson et al. (2012).

To conclude, MBIs' mechanisms of change are numerous and interconnected. The four empirically supported theoretical models reviewed here propose attention regulation, acceptance, BA, ER, and change in perspective as important mechanisms. There is very little research on these mechanisms in youth. Therefore, the present work will focus on BA, composed of attention regulation with an orientation of acceptance towards body sensations, and ER as potential outcomes and mechanisms of MBIs in youth. The present PhD project's aims will be introduced in the next section.

1.4 Objectives and Outline of the PhD Project

Given the increasing prevalence of mental health conditions in youth, there is a need for accessible, evidence-based, and preventive psychological programs for this vulnerable population. Mindfulness-based interventions (MBIs) are programs with a growing evidence-base that have the potential to promote mental well-being in youth by targeting key resilience factors such as body awareness (BA) and emotion regulation (ER). However, at present, the evidence for MBIs' effects on youth mental-well being is mixed, particularly when it comes to universally delivered MBIs. Moreover, though many studies show positive effects of MBIs on various mental health outcomes in youth, a large number of studies suffer from methodological limitations potentially leading to an overestimation of the intervention's effects. Lastly, there is little understanding of the mechanisms of change of MBIs in youth, preventing an optimization of the trainings for particular contexts and individuals.

Therefore, to contribute to the literature on MBIs' effects and mediating mechanisms in youth, the general purpose of the present research is to evaluate the impact of an MBI on two developmentally important and interconnected resilience factors, BA and ER. If these two factors are significantly impacted by the MBI, their potential role as interconnected mediators of the MBI's effects on mental health, will also be assessed. The focus is on young people between the ages of 14 and 24 because of their high vulnerability

to mental health conditions and their increased receptivity to MBIs in comparison to other age groups (Ahmed et al., 2015; Carsley et al., 2018; Chi et al., 2018).

Inspired by the theoretical frameworks described in the General Introduction (i.e., Hölzel's, Lindsay and Creswell's, and Bishop's mindfulness models, as well as Mehling's adaptive BA framework), the general hypothesis is that MBIs lead to improvements in adaptive BA, characterized by attention to body sensations with a specific orientation of openness and acceptance. This increased awareness of body sensations leads to improvements in ER skills such as emotional awareness. The two mechanisms together explain the reduction in emotional distress observed after an MBI.

Given the scarcity of high-quality research on the role of BA in MBIs, the first part of the PhD is a proof-of-concept study assessing whether BA is an outcome and mechanism of MBIs in adults. Next, due to the scarcity of BA and ER measures validated for French-speaking youth, the second part of the PhD focuses on the development and validation of age-appropriate measures. Lastly, these measures are used for the implementation of an RCT in schools where the role of BA and ER in an MBI is examined.

Therefore, the objectives of the PhD are threefold:

(1) To replicate the impact of an MBI on BA and explore how BA mediates the MBI's effects on symptomatology in adults.

(2) To develop and/or validate multi-modal measures of BA and ER tailored to a population of French-speaking youth.

(3) To conduct an RCT to test whether BA and ER are outcomes and mechanisms of an MBI in youth.

Outline of the PhD Dissertation

Below is the outline of the chapters per objective.

Objective 1

Chapter 2 is a proof-of-concept study exploring the effect of an MBI on adaptive BA, related psychological processes (e.g., ER self-efficacy), and symptomatology in adults. The mediating role of BA in explaining the MBI's effects on symptomatology is assessed, and serial mediation models are explored with BA as first mediator and other relevant psychological processes as second mediators.

Objective 2

Chapter 3 is a qualitative focus group study exploring the understanding, experience, and description of the BA construct in adolescents and young adults. Results inform a

conceptual framework of the dimensionality of BA. Findings are used to inform item development for a novel BA self-report instrument tailored to youth.

Chapter 4 is a psychometric study introducing the mindful body awareness concept, describing the mixed-methods approach used to develop a novel BA self-report questionnaire for youth, and examining the factor structure, psychometric reliability, validity, and measurement invariance of the new questionnaire across age and gender groups.

Appendix A introduces the Body Awareness Indirect Assessment, a novel behavioral task adapted to youth and designed to indirectly measure attention to body sensations and integration of bodily information into complex psychological processes. The task is described in detail and results of a preliminary validation in youth are presented and discussed. This report was not included in the main text but in the appendices because its validation results are inconclusive, and more research is needed before the task can be recommended for future use.

Chapter 5 describes the adaptation and psychometric validation of the French version of the Difficulties in Emotion Regulation Scale-Short Form in a population of adolescents.

Objective 3

Chapter 6 describes the results of an RCT in schools examining the impact of an MBI on BA, ER, and emotional distress using the measures developed or adapted in the above chapters.

General Discussion

The general discussion (Chapter 7) summarizes the findings and discusses them within a broader context. Clinical implications, future research directions, and limitations are discussed.

Chapter 2.

Mindfulness-Based Interventions and Body Awareness: A proof of concept study in adults

Background. Body awareness (BA) has long been proposed as a working mechanism of mindfulness-based interventions (MBIs), yet research on the mediating role of BA is scarce. Hence, the present study assesses the impact of an 8-week MBI on self-reported and indirect measures of BA, investigates the potential mediating role of BA in the relationship between an MBI and symptomatology, evaluates the impact of an MBI on important psychological processes (i.e., experiential avoidance, rumination, self-efficacy, and self-discrepancy), and explores whether these variables act alongside BA in mediating the relationship between an MBI and symptomatology.

Method. A non-randomized controlled trial was conducted with 148 participants (n = 89 in the MBI group; n = 59 in the control group) who completed questionnaires assessing BA and the above-mentioned psychological processes before and after an MBI. A sub-sample of participants (n = 86) completed a task that evaluates BA indirectly.

Results and conclusions. Results showed a significant effect of MBI on self-reported BA but not on the indirect measure of BA. The MBI significantly reduced symptomatology, and this effect was mediated by regulatory and belief-related dimensions of BA. Multiple mediator models showed a significant mediation via various pathways involving improved BA and various transdiagnostic psychological processes.

Reference

Pérez-Peña, M., Notermans, J., Desmedt, O., Van der Gucht, K., & Philippot, P. (2022). Mindfulness-based interventions and body awareness. *Brain sciences*, *12*(2), 285. https://doi.org/10.3390/brainsci12020285

2.1 Introduction

Mindfulness-based interventions (MBIs) are programs that employ systematic and sustained training in mindfulness meditation practice as a core methodology (R. S. Crane et al., 2017). The main therapeutic component of MBIs is the skill of mindfulness, which can be defined as "the awareness that emerges through paying attention on purpose, in the present moment, and nonjudgmentally to the unfolding of experience moment by moment" (Kabat-zinn, 2003, p. 145). Ample evidence supports the effectiveness of MBIs in improving a range of physical and psychological conditions as well as quality of life in clinical and non-clinical populations (Bohlmeijer et al., 2010; Gotink et al., 2016; Kuyken et al., 2016). One of the theorized working mechanisms by which MBIs exert their positive effects is by improving body awareness (Farb et al., 2015; Hölzel et al., 2011; W. E. Mehling et al., 2009).

Although the term "body awareness" (BA) has been defined in different ways throughout the years, it can be broadly defined as paying attention to and being aware of internal bodily sensations (Mehling et al., 2009: see this reference for a review on the BA construct). More specifically, in the present paper, we use a multidimensional conceptualization of BA: "the subjective, phenomenological aspect of proprioception and interoception that enters conscious awareness, which is modifiable by mental processes including attention, interpretation, appraisal, beliefs, memories, conditioning, attitudes and affect" (Mehling et al., 2011; p. 1). The BA construct, as defined here, encompasses two important aspects of conscious bodily experience: interoceptive and proprioceptive awareness.

Interoception refers to the sensing, interpreting, and integrating of internal bodily signals by the nervous system at conscious and unconscious levels (Khalsa et al., 2018). Some examples of internal bodily sensations include heartbeat, respiration, satiety, and emotion-related sensations arising from the autonomic nervous system (Mehling et al., 2012). Khalsa and colleagues (2018) outline eight different features of interoception: interoceptive attention (i.e., merely observing body sensations), interoceptive detection (i.e., conscious report of body sensations), interoceptive magnitude (i.e., perceived intensity of body sensations), interoceptive discrimination (i.e., differentiating sensations from different organ systems), interoceptive accuracy (i.e., the ability to precisely monitor one's sensations), interoceptive sensibility (i.e., one's perceived tendency to focus on body sensations), interoceptive insight (i.e., confidence about one's interoceptive accuracy abilities), and self-report scales (i.e., questionnaire assessments of interoception). In light of the definition of BA stated in the previous paragraph, our main interests with regards to interoception are the aspects that are available to conscious awareness and self-reporting, mainly "interoceptive sensibility" and "self-report scales" (Khalsa et al., 2018). In the present paper, we employ the term interoceptive awareness (IAw) to refer to these two components of interoception.

Proprioception is the perception of body position and movements and relies on both physiological (e.g., mechanosensory neurons throughout the body referred to as proprioceptors) and psychological processes (e.g., memory and learning) (Han et al., 2016; Tuthill & Azim, 2018). Like interoception, proprioception is largely unconscious, but some proprioceptive information is accessible to conscious awareness (Tuthill & Azim, 2018). The conscious perception of body position and movement is known as proprioceptive awareness (PAw) (W. E. Mehling et al., 2012) and is the present study's main interest with regards to proprioception.

An important note must be made regarding the attention styles and regulatory aspects of BA. The literature has identified two attention styles (i.e., the attitude with which one pays attention to bodily sensations): one that is anxiety-driven, evaluative, and avoidant (i.e., maladaptive BA) and another that is mindful, non-judgmental, and accepting (i.e., adaptive BA; Cioffi, 1991; Mehling, 2016; Mehling et al., 2009). The first is associated with negative outcomes, such as the generation of aversive emotions (Aronson et al., 2006), hypochondriasis (Barsky & Klerman, 1983), and anxiety disorders (Olatunji et al., 2007), whereas the second is associated with positive outcomes, such as increased subjective wellbeing (Ferentzi et al., 2019), pain attenuation (Gard et al., 2012), and reduced severity of post-traumatic stress disorder symptoms (Goldstein et al., 2017). Moreover, several authors have considered how awareness of body sensations can be used to regulate psychological distress (Farb et al., 2015). Farb and colleagues (2015) propose that sensations (and the affective states associated with them) can be regulated using different strategies: changing the sensation itself, in line with psychological accounts of regulation (e.g., distraction, reappraisal, and suppression) or changing the attitude towards the sensations following contemplative accounts of regulation (e.g., equanimity and acceptance).

The present study focuses on BA as characterized by a mindful and accepting attention style and a contemplative regulatory strategy. By teaching individuals to pay attention to their bodily experiences in an open, accepting, and curious way, MBIs may train adaptive BA (Kabat-Zinn, 2013; Segal et al., 2018). BA is an essential element of the exercises taught in MBIs, which involve paying attention to the body at rest (e.g., body scan and breathing meditation) and in movement (e.g., yoga and mindful walking). Existing research on the topic, however, has yielded mixed results. Below, we briefly review the literature on MBIs (and related practices), IAw, and PAw.

The interoception literature has found evidence for the claim that mindfulness practices improve IAw. Several randomized-controlled trials (RCTs) have found a positive impact of mindfulness training on IAw as measured by the Multidimensional Assessment of Interoceptive Awareness (MAIA; Mehling et al., 2012) in individuals with chronic pain and comorbid depression (De Jong et al., 2016), women in their third trimester of pregnancy (Duncan et al., 2017), and participants with depression (Fissler et al., 2016). Despite these promising results, two of these studies were underpowered pilot studies (De Jong et al., 2016; Duncan et al., 2017) in need of replication. Furthermore, a non-

randomized clinical trial found significant improvements in the IAw (as measured by the MAIA; Mehling et al., 2012) of healthy individuals after an adapted bodily focused mindfulness training; effects were particularly strong for the regulatory aspects of IAw (i.e., regulating one's distress by attending to body sensations, regulating attention to and from body sensations, and listening to the body for important information; Bornemann et al., 2014). Qualitative studies are in line with the aforementioned findings (Hölzel et al., 2011; Marc, 2008; Morone et al., 2009). These self-report findings are also supported by neuroscientific studies that have found evidence for increased insular activation, the brain region associated with interoception (Craig, 2003; Khalsa et al., 2018; Young et al., 2018), after an MBI in a general population (Farb et al., 2007) and in mindfulness meditators (Grant et al., 2010). A recent meta-review on the topic confirms these findings by showing that, across various systematic reviews, the insular cortex is the brain area most consistently activated by both interoception and mindfulness (Casals-Gutiérrez & Abbey, 2020). Conversely, studies assessing other facets of interoception have found weak or no associations between mindfulness and interoceptive accuracy and detection (Khalsa et al., 2020; Treves et al., 2019).

The literature assessing proprioception and mindfulness is much less extensive than the literature on mindfulness and interoception; however, existing studies support the claim that mindfulness practices improve proprioception. For example, mindfulness meditation was associated with improved motor performance (i.e., efficient control of motor processes), slower and more accurate body movements, and increased awareness of perceptual-motor conflict in a visuo-motor reaching task with false feedback (Naranjo & Schmidt, 2012). This was true for novice meditators who had just completed an MBI and for long-term meditators (Naranjo & Schmidt, 2012). Furthermore, an RCT found that elderly women who engaged in an 8-week walking meditation intervention showed improved balance and ankle proprioception (as measured by an ankle reposition test) in comparison to a control group (Chatutain et al., 2019). Lastly, two non-randomized controlled trials found that yoga practices led to improved proprioceptive skills (i.e., higher accuracy of joint position) in healthy individuals (Telles et al., 2007) and in congenitally blind young people (Mohanty et al., 2014).

Taken together, the aforementioned findings suggest that an MBI may improve BA. However, since there are only a few existing studies assessing this relationship, and since many of them are underpowered pilot studies, there is a need to replicate these findings. Furthermore, it is important to explore the mechanisms involved in the relationship between MBIs, BA, and psychological symptomatology in order to understand how MBIs can be effective as well as improved. Very few studies have investigated the mediating mechanisms involved. De Jong and colleagues (2016) found that the positive impact of an MBI on depressive symptomatology was mediated by BA (as measured by the MAIA; Mehling et al., 2012), particularly by the tendency to not distract oneself from unpleasant sensations. However, this study was limited by a small sample size ($N = 31$). Additionally, Fissler and colleagues (2016) found that an MBI significantly reduced depressive

symptoms, and this was mediated by a serial pathway in which increased BA (as measured by the MAIA; Mehling et al., 2012) was positively associated with one's ability to decenter (i.e., stepping out of one's thoughts and feelings and observing them as temporary and not necessarily related to the self; Fresco et al., 2007), which was associated with reduced depressive symptoms. However, changes in BA alone did not explain the reduction in symptoms. Considering the limited number of studies that have investigated the mediating role of BA in MBIs' effect on symptomatology, the field could benefit from a replication of this finding. Moreover, existing research on the topic could be extended by exploring multiple-mediator mechanisms capturing the potential interplay between BA and other psychological variables (i.e., experiential avoidance, rumination, self-efficacy, and self-discrepancy) in explaining the relationship between an MBI and reduced symptomatology. These specific psychological variables were selected because prior reviews and studies have documented their mediating role in explaining the effects of mindfulness-based practices (Gu et al., 2015; Hölzel et al., 2011; Luberto et al., 2014). Last but not least, considering how challenging it is to measure a multi-faceted construct like BA and taking into account the lack of association between self-report and objective measures of BA found in the literature (Garfinkel et al., 2015), studies would strongly benefit from using mixed measures of BA (e.g., both self-report and indirect measures of BA) and explore the link between the two.

Taking the above into account, the present study aims to answer the following research questions: (1) What is the impact of an 8-week MBI on self-reported and indirect measures of BA? (2) What is the relationship between scores on self-reported measures of BA and performance on an indirect measure of BA? (3) What is the impact of an MBI on experiential avoidance, rumination, self-efficacy, and self-discrepancy? Finally, (4) what is the impact of an MBI on symptomatology, and is this effect mediated by BA and related psychological processes (i.e., experiential avoidance, rumination, self-discrepancy, and self-efficacy)? Regarding the first research question, we hypothesized that participants in the MBI group would show significant improvements in BA, as measured by both self-report and indirect measures, in comparison to the control group. More specifically, we hypothesized an increase in the tendency to report body sensations during the recall of positive and negative autobiographical memories, as measured by the indirect BA measure, in all facets of the Functional Body Sensation Questionnaire (FBSQ; Pauels, 2022), and in the MAIA (Mehling et al., 2012) facets of Not-Distracting (De Jong et al., 2016), Attention Regulation (Bornemann et al., 2014; Fissler et al., 2016), Emotional Awareness (Bornemann et al., 2014), Self-Regulation (Bornemann et al., 2014; De Jong et al., 2016; Fissler et al., 2016), Body Listening and Trusting (Bornemann et al., 2014; Fissler et al., 2016) in the MBI group in comparison to baseline and to the control group. We did not hypothesize significant changes in the facets of Noticing or Not-Worrying as no prior studies, to our knowledge, have found this effect.

Regarding the second research question, we hypothesized a significant correlation between scores in the indirect measure of BA and the MAIA subscale Emotional

Awareness, given that participants talked about emotional memories during the task. Correlations between scores in the indirect measure and other facets of the MAIA and all facets of the FBSQ were computed in an exploratory fashion.

Concerning the third research question, we hypothesized a significant reduction in experiential avoidance (i.e., the tendency to avoid unpleasant internal experiences; Duarte & Pinto-Gouveia, 2016; Labelle et al., 2015), a significant reduction in unconstructive rumination (i.e., abstract, analytical thinking focused on past and future events; Campbell et al., 2012; Heeren & Philippot, 2011; Kingston et al., 2007; Labelle et al., 2010; Ramel et al., 2004), a significant increase in constructive rumination (i.e., concrete thinking on one's present moment experience; Heeren & Philippot, 2011), a significant increase in general self-efficacy (i.e., confidence in one's ability to carry out specific behaviors in different domains of life; Chang et al., 2004; Perez-blasco et al., 2013), a significant increase in the self-efficacy dimension of emotion regulation (i.e., confidence in one's ability to regulate one's emotions; Hill & Updegraff, 2012; Roemer et al., 2015), a significant reduction in the actual-ideal self-discrepancy gap (i.e., the discrepancy between who people believe they are and who they would like to be; Philippot et al., 2018) and the distress elicited by this discrepancy (Crane et al., 2008), no change in the actual-ought self-discrepancy gap (i.e., the discrepancy between who people believe they are and who they believe others would want them to be; (Crane et al., 2008; Philippot et al., 2018), and a significant reduction in the distress elicited by the actual-ought self-discrepancy in the MBI group in comparison to the control group.

With regards to the fourth research question, we hypothesized that participants in the MBI group would show significant improvements in symptomatology in comparison to the control group and that this effect would be significantly mediated by training-related increases in BA, as measured by the MAIA and FBSQ. Since there is evidence suggesting that BA does not act on its own, but in conjunction with other psychological processes, such as decentering (Fissler et al., 2016), exploratory multiple mediator models were computed with BA as the first mediator and other psychological variables measured in the present study as second mediators (i.e., rumination, experiential avoidance, self-discrepancy, self-efficacy).

The present study's hypotheses, data analysis plan, and information about the dataset have been pre-registered at the Open Science Framework (Pérez-Peña, 2021)[1].

[1] This is the link to the pre-registration on OSF: https://osf.io/uwngd

2.2 Materials and Methods

Participant Recruitment and Procedure

The study consisted of two groups of French-speaking participants: an intervention group consisting of adults following an 8-week Mindfulness-Based Cognitive Therapy program (MBCT; Segal et al., 2018) and a control group consisting of age-, gender-, and educationmatched controls. The majority of intervention group participants were recruited on a voluntary basis, following a free information session about MBCT offered by the University of Louvain's (UCLouvain) Specialized Psychological Consultation Center (CPS). During this information session, participants were informed about the general structure and aims of MBCT as well as the indications and contra-indications for participation. Contraindications included: suffering from acute depression, severe attention deficit, dissociations, psychotic disorders, substance abuse, or lack of motivation. Participants were also asked to participate in all sessions as well as to practice daily exercises. Motivation and engagement were highlighted as important criteria for participation. A minority of participants was recruited via collaborators who are self-employed practitioners and whose client base is similar to that of the CPS. These participants received the same information as participants recruited via the CPS.

After the information session, interested participants were contacted by their instructors via email. The email included a link giving participants access to a battery of seven questionnaires (through the online Qualtrics platform), which took approximately 40 min to complete. The email mentioned that the study was investigating the effects of MBCT on specific psychological symptoms and mechanisms and specified that questionnaires were to be completed before, or one or two days after, the first MBCT session. In parallel to this email, another email was sent to determine an appropriate time for interested participants to complete a modified version of the Autobiographical Memory Test (mAMT; Williams & Broadbent, 1986). Data collected after the questionnaire and task completion comprised the pre-treatment measures (i.e., Time 1). At the end of the 8-week program, participants were asked to fill in the same questionnaires and complete the mAMT a second time, comprising the post-treatment measures (i.e., Time 2). MBCT training was given to various intervention groups over a 2-year time span (between 2016 and 2018).

Control group participants were healthy volunteers recruited via word of mouth, social media, and advertisements at the UCLouvain Psychology faculty. The information distributed to control group participants was similar to the information given to intervention group participants. Control group participants were selected and matched with intervention group participants in terms of age, gender, and level of education. Participants in the control group were also asked to fill in the battery of questionnaires and to complete the mAMT task before and after an 8-week time frame.

This study was conducted in accordance with the Code of Ethics for research involving human participants in the Faculty of Psychology and Educational Sciences of UCLouvain. All participants signed an informed consent form. A debriefing was done at the end of the study (after Time 2 of data collection)—8 to 10 weeks after the start of the training—in order to disclose the full objectives of the study. There was no randomization of the groups and no blinding in the experiment. Inclusion criteria for both groups were: (1) being at least 18 years old, (2) being comfortable speaking and understanding French, (3) having no prior meditation and/or mindfulness experience, and (4) not having any brain injuries and/or cerebral anomalies.

Intervention

The intervention consisted of 2 h weekly group sessions and lasted eight weeks. It was based on the MBCT program described by Segal and colleagues (2018), which combines mindfulness practices with elements of cognitive-behavioral therapy. MBCT teaches a non-judgmental, curious, and accepting attitude towards one's experiences. The present study's programs were taught by seven MBCT accredited and experienced mindfulness professionals who are also licensed clinical psychologists.

Measures

In order to achieve its aims, the present study employed two self-report questionnaires and one indirect measure of BA. The questionnaires were: the French version of the MAIA (Mehling et al., 2012; Michael et al., 2016) and the Functional Body Sensation Questionnaire (FBSQ; in the process of being validated; Pauels, 2017). Both of these self-report measures operationalize BA as defined in the Introduction section, considering mindful and open attention to body sensations as well as how these sensations can be used for self-regulation. They differ in the following ways: (1) the FBSQ focuses on sensations associated with emotions whereas the MAIA evaluates emotion and non-emotion-related sensations; (2) the FBSQ includes a sub-scale, which measures differentiation of emotion-related sensations, which the MAIA does not include; and (3) the MAIA includes sub-scales measuring one's tendency to not distract oneself from sensations (Not-Distracting), one's tendency to not react with worry or distress to sensations (Not-Worrying), and one's experience of the body as safe (Trusting), which the FBSQ does not include. Finally, to address the criticism that using self-reporting to assess BA is limited because participants are asked to report on something they may not be aware of (Mehling et al., 2012), the present study employed an indirect measure of BA (see mAMT below).

Socio-Demographic Variables

Participants were asked to provide information on gender, age, socio-professional status, and level of education. Those in the MBCT group were also asked whether they practiced mindfulness (or other forms of meditation) in the past/present as well as the

duration of this practice, whether they took medications, and to provide the name of their MBCT instructor.

The Multidimensional Assessment of Interoceptive Awareness

The MAIA was translated from English to French and validated in a French-speaking sample by Michael and colleagues (2016) from the MAIA questionnaire developed by Mehling and colleagues (2012). The MAIA includes 32 items investigating eight dimensions, namely Noticing (i.e., awareness of pleasant, unpleasant, and neutral body sensations), Not-Distracting (i.e., tendency not to ignore or distract oneself from sensations of pain or discomfort), Not-Worrying (i.e., tendency not to worry or feel distress with sensations of pain or discomfort), Attention Regulation (i.e., ability to sustain and control attention to body sensations), Emotional Awareness (i.e., awareness of the connection between body sensations and emotional states), Self-Regulation (i.e., ability to regulate psychological distress by attention to body sensations), Body Listening (i.e., actively listening to the body for insight), and Trusting (i.e., experiencing one's body as safe and trustworthy). Answers were rated on a six-point Likert scale from 0 (Never) to 5 (Always). The psychometric properties of the MAIA are well-documented (Mehling, 2018; Mehling et al., 2012). Regarding the validity of the MAIA, results suggested that the factorial structure of the MAIA was similar to the English version [62]. Internal consistency in the current sample at baseline was a = 0.83 (Noticing), a = 0.55 (Not-Distracting), a = 0.61 (Not-Worrying), a = 0.90 (Attention Regulation), a = 0.82 (Emotional Awareness), a = 0.80 (Self-Regulation), a = 0.87 (Body Listening), and a = 0.86 (Trusting).

The Functional Body Sensation Questionnaire

The FBSQ includes 12 items investigating 3 dimensions (each made up of 4 items), namely Perception, Differentiation, and Emotion Regulation. The latter dimension can be understood as using body sensations to regulate emotions. Answers are rated on a five-point Likert scale ranging from 0 (Not at all) to 4 (Completely). A preliminary estimation of the psychometric properties of the questionnaire was done by Pauels and colleagues (2017) and suggested good convergent validity. A formal evaluation of its psychometric properties is pre-registered and underway (Perez-Peña et al., 2021). Internal consistency in the current sample at baseline was a = 0.92 (total score), a = 0.78 (Perception sub-scale), a = 0.86 (Differentiation sub-scale), and a = 0.83 (Emotion Regulation sub-scale).

Multidimensional Experiential Avoidance Questionnaire

The Multidimensional Experiential Avoidance Questionnaire (MEAQ) is composed of 62 items rated on a six-point Likert scale ranging from 1 (strongly disagree) to 6 (strongly agree) (Gámez et al., 2011). It measures avoidance through 6 dimensions, namely Behavioral Avoidance, Procrastination, Distraction/Suppression, Repression/Denial, Distress Aversion (i.e., nonacceptance of or negative attitudes towards

distress), and Distress Endurance (i.e., motivation to engage in behaviors consistent with one's values regardless of distress). The questionnaire was validated in a French-speaking sample (Baeyens et al., 2015). The present study used 38 out of the 62 items because only four dimensions were of interest for this study: Behavioural Avoidance, Procrastination, Distraction/Suppression, and Repression/Denial. Internal consistency in the current sample at baseline was a = 0.90 (total score), a = 0.88 (Behavioral avoidance), a = 0.86 (Procrastination), a = 0.86 (Distraction/Suppression), and a = 0.85 (Repression/Denial).

Mini Cambridge Exeter Repetitive Thought Scale

The Mini Cambridge Exeter Repetitive Thought Scale (Mini-CERTS) was adapted from the Cambridge Repetitive Thought Scale (CERTS) (Barnard et al., 2007) and translated into French by Douilliez and colleagues (Douilliez et al., 2014) and consists of 15 items. Items are rated on a four-point Likert scale ranging from 1 (almost never) to 4 (almost always). The questionnaire evaluates the processing mode of repetitive negative thought based on two dimensions: abstract analytical thinking (i.e., unconstructive rumination) and concrete experiential thinking (i.e., constructive rumination). Assessment of the Mini-CERTS' psychometric properties in a French-speaking population was performed by Douilliez and colleagues (Douilliez et al., 2014). Internal consistency in the current sample at baseline was a = 0.74 (Unconstructive rumination) and a = 0.68 (Constructive rumination).

The Self-Efficacy Questionnaire

The Self-Efficacy Questionnaire (S-EQ) was created by Philippot and colleagues (2019), following recommendations by Bandura and colleagues (1997) in developing self-efficacy scales. The questionnaire comprises 10 items about different life domains such as family, work, relationships, hobbies, etc. Individuals evaluate their level of confidence in their ability to manage each domain on a scale from 0 (not certain at all of my capacity to do this) to 100 (highly certain of my capacity to do this), with 10-point increments. This questionnaire allows clinicians and researchers to identify in which domain self-efficacy is considered the lowest and/or the highest for an individual. The psychometric properties of this newly developed questionnaire have not yet been assessed. Internal consistency in the current sample at baseline was a = 0.85.

The Self-Discrepancy Scale

The Self-Discrepancy Scale (S-DS) was developed by Philippot and colleagues (2018) and inspired by the Integrated Self-Discrepancy Index (Hardin et al., 2009). It measures discrepancies between mental representations of the self, namely between the actual self and the ideal or socially-prescribed selves. Participants are asked to estimate the perceived gap between their actual and ideal self and between their actual and socially-prescribed self on a seven-point Likert scale (1 = very close to the ideal to 7 = very far from the ideal), and whether these perceived gaps create distress (1 = no distress to 7 = high distress). The

psychometric validation of the scale is described in Philippot and colleagues [58]. Internal consistency in the current sample at baseline was $a = 0.81$.

The Symptom Checklist-90 Revised

The Symptom Checklist-90 Revised (SCL-90-R) was developed by Derogatis and Cleary (Derogatis & Cleary, 1977) and later validated and translated in French by Pariente and colleagues (1989). It is composed of 90 items measuring psychopathological symptoms in terms of nine dimensions. Items are rated on a five-point Likert scale ranging from 0 (Not at all) to 4 (Extremely). The present study only calculated the Global Severity Index (GSI) to measure general symptom severity. Internal consistency in the current sample at baseline was $a = 0.96$.

Modified Autobiographical Memory Test

A sub-sample of participants ($n = 86$; $n = 43$ in the control group; $n = 43$ in the MBCT group) completed the mAMT, which measures the spontaneous tendency to report body sensations when reporting emotional personal events. The mAMT can be most precisely described as a memory task that can be used to assess the attention allocated to body sensations by counting the number of spontaneous references to body sensations in the memory report. The task is best categorized as an indirect self-reporting measure because, during the task, participants are not explicitly asked to report body sensations, but report of body sensations is an outcome of interest. In the original version of the mAMT (Williams & Broadbent, 1986) and its validated French version (Neumann & Philippot, 2006), participants are given 10 cue words (five negative and five positive) and are asked to retrieve and describe a specific personal memory (i.e., the memory of an event personally experienced that lasted less than 24 h; Williams et al., 2007) in response to each word. Next, supplementary information is asked about the emotional intensity attributed to the event (measured on a scale of 0 to 10) and when the event happened. The researcher then codes the memories as specific (i.e., concerning an event that is precisely situated and lasting less than 24 h), extended (i.e., concerning an event lasting longer than 24 h such as "my university years"), generic (i.e., concerning repetitive events such as weekly dance lessons), or omissions (i.e., memories not lived personally and not about the past; Griffith et al., 2012). To calculate scores, specific memories receive three points, extended memories receive two points, generic memories receive one point, and omissions receive zero points. Total points are then summed per participant per valence (negative or positive memories).

The mAMT introduced in the present study includes an extra step called the Autobiographical Memory Description Task, which is administered after the AMT. In this part of the task, participants are reminded of six out of the ten keywords for which they retrieved a memory, and are subsequently invited to give as many details as possible about their state during the event constituting the memory. The researcher then codes the participant's description for mention of body sensations (i.e., details about physical states

and non-verbal expression), internal states (i.e., cognitive or emotional details), sensory details (i.e., details linked to the 5 senses), and contextual details (i.e., external, physical or spatiotemporal conditions, people/things that were there, or historical context of the event). Scores are then obtained by summing the mention of details per category. The score for the mention of body sensations can be interpreted as the number of spontaneous references to body sensations and can be used as a proxy for the attention allocated to the body while describing an emotional experience.

Data Analysis

Differences in participants' characteristics at baseline were assessed with independent sample t-tests for continuous variables and Chi-square tests for categorical variables.

Multilevel linear models were used to assess intervention effects because the data is nested (Field & Wright, 2011). Participants are nested within mindfulness instructors (n = 7). Hence, the independence of errors assumption is violated, which rules out the use of statistical tests in which this assumption must be true (i.e., ANOVA, regression, t-tests) (Field & Wright, 2011). Multilevel analyses can model the variation resulting from contextual variables (i.e., different mindfulness instructors), allowing us to overcome the lack of independence (Field & Wright, 2011). Since our primary interest was an association between Level-1 variables in data with 2-level hierarchy (i.e., patients nested within mindfulness instructors), centering within clusters was used, as suggested by Enders and Tofighi (Enders & Tofighi, 2007).

The R package nlme (Pinheiro et al., 2022) was used to compute multilevel models. The steps outlined in Field and Wright (2011) were followed to build the models. Different models were computed (i.e., first with random effects on the intercept, and then with random effects on both intercept and slope), and model fit was assessed with the Akaike's Information Criterion (AIC). The model with the lowest AIC was selected for reporting.

Model 1 (random intercept) : $Y_{ij} = b_{0j} + b_1 \text{Intervention}_{ij} + b_2 \text{Base\_Y}_{ij} + r_{ij}$ (1)

Model 2 (random intercept and slope) : $Y_{ij} = b_{0j} + b_{1j} \text{Intervention}_{ij} + b_2 \text{Base\_Y}_{ij} + r_{ij}$ (2)

The above equations represent a 2-level model in which Level-1 was represented by the participants and Level-2 by the mindfulness instructors. The only difference between model 1 and model 2 was that model 2 had random effects on the slope, whereas model 1 did not. Y_{ij} denotes the outcome of the *j*-th mindfulness instructor for the *i*-th participant. Separate models were generated with the following outcome measures: post-intervention BA as measured by the FBSQ (total score and facets), MAIA (facets), and the mAMT; post-intervention experiential avoidance (total score and facets); post-intervention actual-ideal self-discrepancy gap; post-intervention actual-ideal self-discrepancy distress; post-intervention actual-ought self-discrepancy gap; post-

intervention actual-ought self-discrepancy distress; post-intervention unconstructive rumination; post-intervention constructive rumination; post-intervention self-efficacy, and post-intervention symptomatology. Base_Y*ij* are the baseline levels of each of the aforementioned outcome variables. The residual is represented by r*ij*. The treatment group is denoted by the categorical predictor Intervention*ij* with 0 being the control condition and 1 being the MBCT condition.

Correlations among scores in the FBSQ (total score and facets), MAIA (facets), and the mAMT were computed separately for both time points in order to answer research question 2.

Finally, pre- and post-change scores were calculated for relevant variables and included in a simple mediator model. To assess the mediating role of changes in BA in the effect of MBCT on symptomatology, we used the steps outlined in Yzerbytz and colleagues (Yzerbyt et al., 2018). According to them, the method that achieves the best balance between power and Type I error is the component method by which one assesses the significance of the component paths of the indirect effects individually first, and then together. The significance of the individual component paths was assessed using joint significance testing as the data was normally distributed. The significance of the indirect effect was then assessed by Monte Carlo confidence intervals. The R package, JSmediation developed by Batailler and colleagues (Batailler et al., 2022), was used to compute these simple mediation models.

Lastly, exploratory multiple-mediator models were calculated using the R package Lavaan. The dimensions of BA that were significantly affected by the MBI were included in separate serial mediator models with BA as a first mediator and experiential avoidance, unconstructive rumination, emotion regulation self-efficacy, actual-ideal self-discrepancy gap, actual-ideal self-discrepancy gap distress, and actual-ought self-discrepancy gap distress as second mediators.

2.3 Results

Participant Characteristics

A total of n = 148 (n = 59 in the control group; n = 89 in the MBCT group) participants were included in the analyses. A sub-sample of participants n = 86 (n = 43 in the control group; n = 43 in the MBCT group) also completed the mAMT. This sub-sample was a convenience sample of participants who were willing and able to complete the task within the specific time frame following recruitment. For details on the flow of participants throughout the study, please see Figure 3. For more details on how the data was preprocessed, please see the pre-registration section: "Prior work based on this dataset" (Perez-Peña et al., 2021).

Participant characteristics are shown in Table 3. Most participants in the experimental group suffered from anxiety and mood disorders. There were no significant differences between the MBCT and control groups in most demographic variables, with the exception of employment status. There were several significant differences in average baseline scores between the two groups (see Table 4).

For the sub-sample who completed the mAMT (n = 86), across groups, participants were on average 44 years old (M = 44.09, SD = 12.99), and college graduates (93% completed higher education studies). Most participants were female (61.6%) and employed (65.13%). In the subsample, 20.94% of participants were taking psychotropic medications. This subsample did not differ from the sample who did not complete the mAMT in terms of age, gender, or medication use. However, there were significant baseline differences in employment status, X^2 (2) = 13.76, p = 0.001, with the mAMT group containing fewer students and more people in the employed and other categories. There was also a significant difference in the level of education, X^2 (2) = 12.49, p = 0.002, with the mAMT group containing more participants who completed university studies. Concerning baseline levels of the outcome and process variables measured in the present study, there were no significant differences between the two groups except in the case of the FBSQ total and dimension scores (the mAMT group scored significantly higher) and the Distraction/Suppression facet of the MEAQ (the mAMT group scored significantly lower).

There was 3% missing data, with 14 out of the 148 participants who did not complete all questionnaires at a given time point. According to Bennett (2001), less than 10% of missing data is not problematic and is not likely to bias the statistical analyses. All available data were used for the analyses.

Table 3. Baseline Demographic and Clinical Characteristics per Group

	MBCT	CONTROL	t/χ^2-test		
	(n = 89)	(n = 59)	t/χ^2	df	p
Age (*M, SD*)	43.12 (12.59)	41.03 (16.18)	0.84	103	0.40
Female gender (%)	65.20	71.20	0.34	1	0.56
Education (%)			2.63	2	0.27
Secondary	6.74	13.59			
Higher education (non-university)	24.7	28.80			
Higher education (university)	68.5	57.6			
Employment status (%)			9.02	2	0.01
Employed	66.31	50.83			
Student	6.74	23.7			
Other	26.92	25.4			
Current use of medication (%)	26.98	11.85	3.01	1	0.08

Outliers

A robust Mahalanobis distance with shrinkage estimators was used to detect multivariate outliers (Cabana et al., 2021). Eleven outliers were detected for the

questionnaire data, and three outliers were detected for the mAMT data. Analyses were run with and without outliers. All results were the same except for: the intervention effect on the mAMT's specific positive memories, which was significant with outliers but not significant without outliers; the simple mediation model with the MAIA facet Trusting as mediator, which was significant with outliers and not significant without outliers; the multiple mediator model with MAIA Attention Regulation and Emotion Regulation Self-Efficacy as mediators, which was significant with outliers and not significant without outliers; and the multiple mediator model with MAIA Self-Regulation and Actual-Ought Self Discrepancy Gap Distress as mediators, which was not significant with outliers and significant without outliers. Results with outliers are reported below. In the case of results that changed in the sensitivity analysis, the results of analyses with and without outliers are reported.

Multilevel Analyses: Intervention Effect Models

The multilevel models reported here are the random-intercept models because they had the lowest AIC. Multilevel model results can be found in Table 5[2].

What Is the Impact of an MBI on Self-Report and Indirect Measures of BA?

The fixed effects of the random-intercept models (see Table 5) indicated that the intervention had a significant effect on post-treatment average FBSQ scores and all facets of the FBSQ (i.e., Perception, Differentiation, and Regulation). There was also a significant effect of intervention on the MAIA facets of Noticing, Not-Worrying, Attention Regulation, Emotional Awareness, Self-Regulation, Body Listening, and Trusting. No significant effect of intervention was found on post-treatment MAIA Not-Distracting.

Concerning the adapted mAMT, multilevel models revealed that the intervention had a significant effect on post-treatment-specific positive memories but no significant effect on post-treatment-specific negative memories. There was also no significant effect of intervention on the post-treatment mention of body sensations, internal states, sensory details, or contextual details during recall of positive or negative memories.

Significant effects of the intervention were above and beyond the effect of pre-intervention levels.

[2] Effect sizes were not included in the published article but can be found in Appendix B S1.

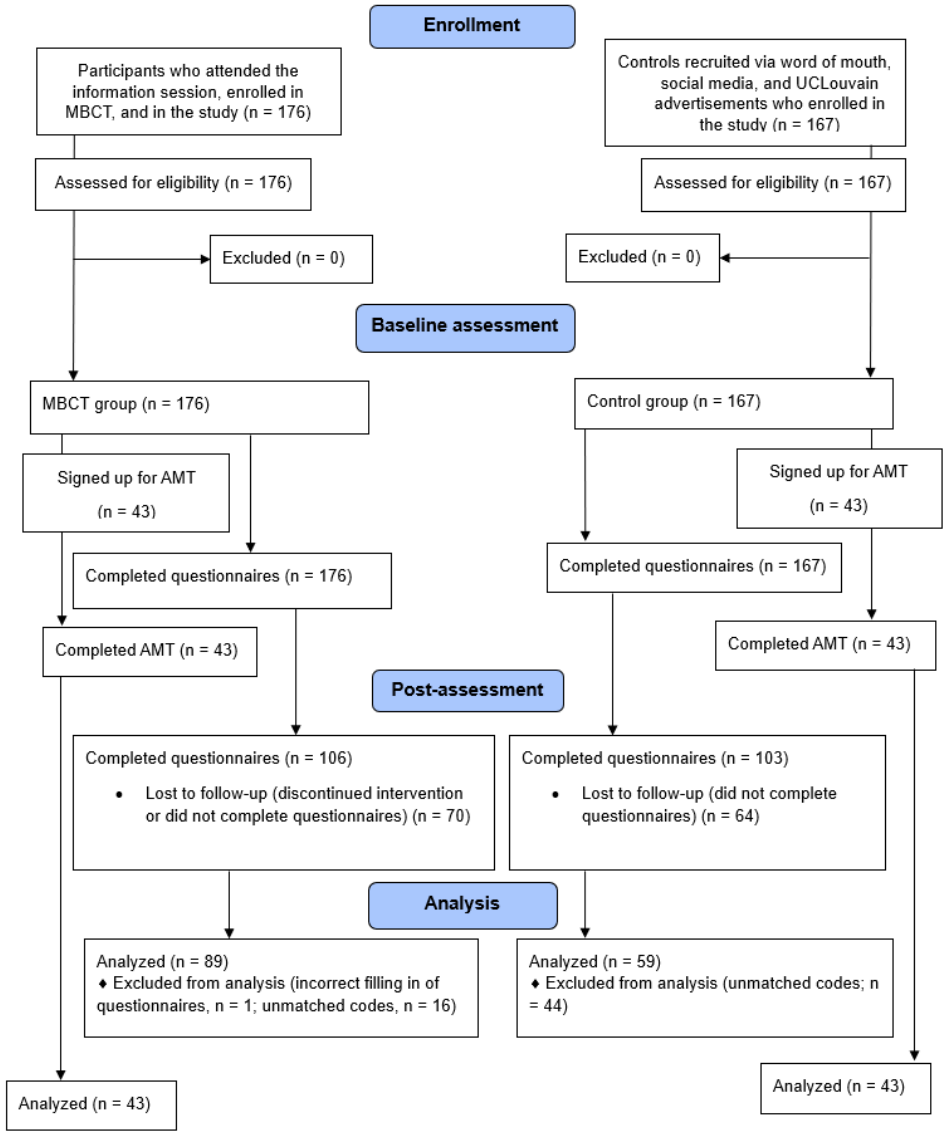

Figure 3. Flow of participants through study.

Table 4. Means and Standard Deviations of Variables, Stratified by Group and Measurement Occasion

		MBCT (*n* = 89)		CONTROL (*n* = 59)	
Variable		Baseline *M (SD)*	Post *M (SD)*	Baseline *M (SD)*	Post *M (SD)*
FBSQ total		1.41 (0.71)$_a$	2.18 (0.82)$_a$	1.88 (0.87)$_b$	1.92 (0.93)$_a$
	Perception	1.41 (0.78)$_a$	2.16 (0.81)$_a$	1.92 (0.91)$_b$	1.91 (0.93)$_a$
	Differentiation	1.70 (0.92)$_a$	2.31 (0.94)$_a$	2.14 (0.96)$_b$	2.19 (1.04)$_a$
	Regulation	1.11 (0.81)$_a$	2.09 (0.99)$_a$	1.58 (0.95)$_b$	1.64 (0.98)$_b$
MAIA					
	Noticing	2.44 (1.07)$_a$	3.39 (0.72)$_a$	2.99 (1.26)$_b$	2.91 (1.12)$_b$
	Not-Distracting	2.20 (0.98)$_a$	2.64 (0.95)$_a$	2.26 (0.98)$_a$	2.36 (0.97)$_a$
	Not-Worrying	2.30 (0.99)$_a$	2.78 (0.83)$_a$	2.34 (1.08)$_a$	2.35 (1.08)$_b$
	Attention Regulation	1.76 (0.99)$_a$	3.20 (0.60)$_a$	2.09 (1.06)$_a$	2.11 (1.08)$_b$
	Emotional Awareness	2.73 (1.01)$_a$	3.59 (0.80)$_a$	2.94 (1.10)$_a$	2.85 (1.20)$_b$
	Self-Regulation	1.63 (0.95)$_a$	3.32 (0.69)$_a$	2.17 (1.08)$_b$	1.93 (1.06)$_b$
	Body Listening	1.26 (0.97)$_a$	2.73 (0.81)$_a$	1.84 (1.18)$_b$	1.88 (1.16)$_b$
	Trusting	2.15 (1.22)$_a$	3.28 (0.98)$_a$	2.81 (1.21)$_b$	2.89 (1.10)$_b$
MEAQ total		125.76 (27.17)$_a$	103.56 (21.86)$_a$	115.71 (25.67)$_b$	115.75 (25.80)$_b$
	Behavioral avoidance	40.89 (10.57)$_a$	32.08 (8.32)$_a$	38.20 (11.11)$_a$	38.49 (12.17)$_b$
	Procrastination	24.78 (8.32)$_a$	20.72 (7.32)$_a$	20.59 (7.50)$_b$	19.81 (7.21)$_a$
	Dist. /Suppression	24.54 (7.36)$_a$	22.13 (6.26)$_a$	24.84 (8.10)$_a$	26.58 (7.63)$_b$
	Repression & denial	35.56 (12.70)$_a$	28.64 (9.31)$_a$	32.09 (10.62)$_a$	30.88 (10.74)$_a$
Mini-CERTS					
	Unconstructive R	21.00 (4.18)$_a$	17.48 (3.70)$_a$	18.98(3.99)$_b$	18.81 (3.95)$_b$
	Constructive R	16.15 (3.16)$_a$	17.48 (2.39)$_a$	16.96 (3.46)$_a$	16.98 (4.10)$_a$
SE-Q total		58.11 (12.96)$_a$	72.03 (9.75)$_a$	69.20 (13.43)$_b$	71.70 (12.12)$_a$
	Emotion regulation SE	36.14 (18.31)$_a$	65.37 (14.69)$_a$	54.19 (23.95)$_b$	56.59 (19.22)$_b$
SD-S					
	Actual-ideal gap	4.75 (1.39)$_a$	3.74 (1.23)$_a$	3.77 (1.53)$_b$	3.96 (1.35)$_a$
	Actual-ideal distress	4.42 (1.57)$_a$	3.55 (1.53)$_a$	2.86 (1.69)$_b$	2.91 (1.81)$_b$
	Actual-ought gap	4.26 (1.53)$_a$	3.73 (1.25)$_a$	3.23 (1.32)$_b$	3.30 (1.31)$_a$
	Actual-ought distress	4.15 (1.74)$_a$	3.23 (1.38)$_a$	2.55 (1.56)$_b$	2.58 (1.60)$_b$
SCL-90-R		2.00 (0.40)$_a$	1.57 (0.34)$_a$	1.78 (0.57)$_b$	1.73 (0.52)$_b$
AMT					
	Specific positive mem	3.44 (1.35)$_a$	4.29 (0.89)$_a$	3.58 (1.05)$_a$	3.56 (1.01)$_b$
	Specific negative mem	3.00 (1.40)$_a$	3.69 (1.26)$_a$	2.93 (1.24)$_a$	3.60 (1.24)$_a$
	Mention of BS positive	1.21 (1.81)$_a$	2.10 (2.73)$_a$	0.93 (1.30)$_a$	0.86 (1.06)$_b$
	Mention of BS negative	1.88 (2.37)$_a$	3.33 (3.27)$_a$	1.42 (1.83)$_a$	1.53 (1.92)$_b$

Note. This table reflects between-group t-test comparisons of baseline and post-assessment scores. Per row, variables sharing the same subscript (i.e., a and a) do not differ at $p < .05$. Variables with different superscripts (i.e., a and b) significantly differ at $p < 0.05$. Mem = memories; mention of BS positive = mention of body sensations during positive memory recall; mention of BS negative = mention of body sensations during negative memory recall.

Table 5. Intervention effect on psychological parameters assessed by random-intercept multilevel models

Post-treatment outcome measures	Intercept	β(*SE*) - Intervention	β(*SE*) – Baseline levels
FBSQ total	0.03 (0.09)	0.61 (0.12)**	0.63 (0.07)***
		p = .002	*p* < .001
FBSQ Perception	-0.003 (0.10)	0.57 (0.13)**	0.50 (0.07)***
		p =.004	*p* < .001
FBSQ Differentiation	0.04 (0.10)	0.45 (0.13)*	0.64 (0.07)***
		p = .01	*p* < .001
FBSQ Regulation	0.05 (0.11)	0.71 (0.14)**	0.55 (0.08)***
		p = .002	*p* < .001
MAIA Noticing	-0.002 (0.10)	0.67 (0.13)**	0.39 (0.06)***
		p = .003	*p* < .001
MAIA Not-Distracting	0.07 (0.12)	0.22 (0.15)	0.32 (0.08)***
		p = .204	*p* < .001
MAIA Not-Worrying	-0.02 (0.10)	0.38 (0.13)*	0.51 (0.06)***
		p = .025	*p* < .001
MAIA Attention Regulation	0.06 (0.09)	0.96 (0.13)***	0.41 (0.06)***
		p < .001	*p* < .001
MAIA Emotional Awareness	-0.02 (0.10)	0.68 (0.14)**	0.54 (0.06)***
		p = .003	*p* < .001
MAIA Self-Regulation	-0.12 (0.10)	1.29 (0.14)***	0.39 (0.06)***
		p < .001	*p* < .001
MAIA Body Listening	0.06 (0.11)	0.99 (0.15)***	0.43 (0.07)***
		p < .001	*p* < .001
MAIA Trusting	0.12 (0.11)	0.71 (0.14)**	0.47 (0.06)***
		p = .003	*p* < .001
Mini-CERTS Unconstructive R	-0.12 (0.41)	-2.65 (0.53)**	0.56 (0.06)***
		p = .003	*p* < .001
Mini-CERTS Constructive R	0.04 (0.34)	1.05 (0.44)	*b* = 0.60 (0.07)***
		p = .053	*p* < .001
MEAQ total	-0.07 (2.59)	-16.94 (3.39)**	0.53 (0.06)***
		p = .002	*p* < .001
MEAQ Behavioral avoidance	0.20 (1.08)	-7.13 (1.41)**	0.55 (0.06)***
		p = .002	*p* < .001
MEAQ Procrastination	-0.80 (0.72)	-2.50 (0.93)*	0.62 (0.06)***
		p = .04	*p* < .001
MEAQ Dist. /Suppression	1.38 (0.80)	-3.02 (1.04)*	0.42 (0.07)***
		p = .027	*p* < .001
MEAQ Repression & denial	-1.02 (2.04)	-4.54 (2.35)	0.59 (0.05)***
		p = .101	*p* < .001
SCL-90-R total	-0.03 (0.04)	-0.32 (0.06)**	0.58 (0.06)***
		p = .001	*p* < .001
SE-Q total	1.87 (1.14)	8.40 (1.50)**	0.49 (0.06)***
		p = .001	*p* < .001
SE-Q Emotion regulation SE	0.99 (2.00)	17.99 (2.71)***	0.31 (0.06)***
		p < .001	*p* < .001
SD-S Actual-ideal gap	0.18 (0.16)	-0.87 (0.21)**	0.35 (0.07)***
		p = .006	*p* < .001
SD-S Actual-ideal gap distress	0.06 (0.20)	-0.71 (0.26)*	0.43 (0.08)***
		p = .037	*p* < .001
SD-S Actual-ought gap	0.06 (0.15)	-0.47 (0.20)	*b* = 0.42 (0.07)***
		p = .057	*p* < .001

SD-S Actual-ought gap distress	-0.01 (0.18)	-0.60 (0.24)* p = .047	0.27 (0.07)*** p < .001
AMT's specific positive memories (with outliers)	-0.02 (0.14)	0.56 (0.20)* p =.046	0.26 (0.08)** p =.002
AMT's specific positive memories (without outliers)	-0.02 (0.14)	0.54 (0.20) p = .06	0.26 (0.08)** p =.003
AMT specific negative memories	0.49 (0.16)	0.06 (0.23) p = .808	0.47 (0.09)*** p < .001
AMT mention of BS positive	-0.04 (0.30)	0.60 (0.43) p = .232	0.32 (0.14)* p = .02
AMT mention of BS negative	0.07 (0.38)	0.99 (0.54) p = .14	0.43 (0.13)** p = .001

Note. *p < .05, **p < .01, ***p < .001; R = Rumination; SE = Self-efficacy; mention of BS positive = mention of body sensations during positive memory recall; mention of BS negative = mention of body sensations during negative memory recall

What Is the Impact of an MBI on Symptomatology?

Multilevel models indicated that the intervention had a significant effect on posttreatment symptomatology after controlling for pre-intervention levels (see Table 5).

What Is the Impact of an MBI on Experiential Avoidance, Self-Discrepancy, Rumination, and Self-Efficacy?

Random-intercept models (see Table 5) indicated that intervention significantly reduced post-treatment total Experiential Avoidance, Behavioral Avoidance, Procrastination, and Distraction/Suppression as measured by the MEAQ. However, no significant effect of intervention was found on the MEAQ facet of Repression/Denial. The intervention also significantly reduced post-treatment actual-ideal self-discrepancy gap, actual-ideal self-discrepancy gap distress, and actual-ought self-discrepancy gap distress. No significant effect of intervention was found on the post-treatment actual-ought self-discrepancy gap. Furthermore, intervention significantly reduced post-treatment unconstructive rumination, and there was a marginally significant trend towards an increase in post-treatment constructive rumination. Lastly, the models showed that intervention significantly increased post-treatment general self-efficacy, and emotion regulation self-efficacy. All significant effects were above and beyond the effects of pre-intervention levels.

Correlations Between Self-Report and Indirect Measures

There were weak correlations between the FBSQ and MAIA scores and the scores in the mAMT at the pre-treatment phase across groups ($r \leq 0.22$). At post-treatment, most correlations between the FBSQ and the mAMT task were weak as well ($r \leq 0.26$) except in the case of the mention of body sensations during recall of positive memories and FBSQ differentiation ($r = 0.31$, $p = 0.007$). In the case of correlations between the MAIA and the mAMT, most correlations were small ($r \leq 0.27$) except for: Attention Regulation and mention of body sensations during recall of positive memories ($r = 0.37$, $p = 0.001$),

Attention Regulation and mention of body sensations during recall of negative memories ($r = 0.30$, $p = 0.009$), Emotional Awareness and mention of body sensations during recall of positive memories ($r = 0.33$, $p = 0.003$), and Self-Regulation and mention of body sensations during recall of positive memories ($r = 0.34$, $p = 0.002$).

Mediation Analyses

Is the Impact of an MBI on Symptomatology Mediated by BA?

Separate simple mediation models were tested with all BA dimensions that were significantly impacted by the MBI (i.e., all dimensions of the FBSQ and all MAIA facets except for Not-Distracting). Only the significant models are reported here. All models had intervention as the independent variable, change in a particular facet of BA as a mediator, and change in symptomatology as the dependent variable. Post-minus pretreatment change scores were used in the mediation models. All models reported below showed a significant effect of intervention (MBCT or control) on symptomatology, $c = -0.394$, $t(134) = -6.00$, $p < 0.001$.

The first significant model included MAIA Attention Regulation as mediator. Joint significance testing (Yzerbyt et al., 2018) revealed a significant effect of intervention on Attention Regulation, $a = 1.354$, $t(143) = 8.67$, $p < 0.001$, and a significant effect of Attention Regulation on symptomatology controlling for intervention, $b = -0.105$, $t(133) = 2.98$, $p = 0.003$. The effect of intervention on symptomatology after controlling for Attention Regulation was still significant but to a lesser degree, $c' = -0.252$, $t(133) = 3.15$, $p = 0.002$. Consistent with this result, the Monte Carlo confidence interval for the indirect effect did not contain 0, CI95% (-0.246; -0.0443) indicating that Attention Regulation partially mediated the effect of the intervention on symptomatology.

The second significant model included MAIA Self-Regulation as mediator. Joint significance testing (Yzerbyt et al., 2018) revealed a significant effect of intervention on Self-Regulation, $a = 1.842$, $t(143) = 11.24$, $p < 0.001$, and a significant effect of Self-Regulation on symptomatology controlling for intervention, $b = -0.086$, $t(133) = 2.47$, $p = 0.015$. The effect of intervention on symptomatology after controlling for Self-Regulation was still significant but to a lesser degree, $c' = -0.227$, $t(133) = 2.42$, $p = 0.017$. Consistent with this result, the Monte Carlo confidence interval for the indirect effect did not contain 0, CI95% (-0.285; -0.0325) indicating that Self-Regulation partially mediated the effect of the intervention on symptomatology.

The third significant model included MAIA Body Listening as mediator. Joint significance testing (Yzerbyt et al., 2018) revealed a significant effect of intervention on Body Listening, $a = 1.392$, $t(143) = 7.94$, $p < 0.001$, and a significant effect of Body Listening on symptomatology controlling for intervention, $b = -0.079$, $t(133) = 2.33$, $p = 0.021$. The effect of intervention on symptomatology after controlling for Listening was still significant, $c' = -0.283$, $t(133) = 3.51$, $p < 0.001$. The Monte Carlo confidence interval

for the indirect effect did not contain 0, CI95% (-0.214; -0.0198) indicating that Body Listening partially mediated the effect of the intervention on symptomatology.

The final significant model included MAIA Trusting as mediator. Joint significance testing (Yzerbyt et al., 2018) revealed a significant effect of intervention on Trusting, a = 0.955, $t(143) = 5.37$, $p < 0.001$, and a significant effect of Trusting on symptomatology controlling for intervention, b = -0.061, $t(133) = 2.00$, $p = 0.047$. The effect of intervention on symptomatology after controlling for Trusting was still significant, c' = -0.332, $t(133) = 4.61$, $p < 0.001$. The Monte Carlo confidence interval for the indirect effect did not contain 0, CI95% (-0.128; -0.00174) indicating that Trusting partially mediated the effect of the intervention on symptomatology. However, this result was not robust in the sensitivity analysis. Analyses without outliers revealed a significant effect of intervention on Trusting, $a = 0.931$, $t(133) = 5.19$, $p < 0.001$, and a non-significant effect of Trusting on symptomatology controlling for intervention, b = -0.052, $t(123) = 1.72$, $p = 0.087$. The effect of intervention on symptomatology after controlling for Trusting was still significant, c' = -0.405, $t(123) = 5.85$, $p < 0.001$. The Monte Carlo confidence interval for the indirect effect contained 0, CI95% (-0.11; 0.008) indicating that Trusting did not mediate the effect of the intervention on symptomatology.

Is the Impact of an MBI on Symptomatology Mediated by BA Alongside Other Psychological Variables?

In an exploratory fashion, separate multiple mediator models were calculated with intervention (MBCT vs. control) as the independent variable, change in symptomatology as the dependent variable, and change in aspects of BA that were significant in the simple mediator models (i.e., Attention Regulation, Self-Regulation, Body Listening, and Trusting) as the first mediator, and a transdiagnostic psychological process as a second mediator. A total of six sets of models were calculated in this way. For an overview and summary of the models, please refer to Figure 4. As with the above models, there was a significant effect of intervention (MBCT or control) on symptomatology, c = -0.394, $t(134) = -6.00$, $p < 0.001$. Only significant models are reported below.

The first set of models was tested with intervention (MBCT vs. control) as the independent variable, change in symptomatology as the dependent variable, change in aspects of BA that were significant in the simple mediator models (i.e., Attention Regulation, Self-Regulation, Body Listening, and Trusting) as the first mediator, and experiential avoidance total score as the second mediator.

Results revealed a significant indirect effect of intervention on symptomatology through Attention Regulation, $a1 \times b1$ = -0.132, z = -2.75, p = 0.006, CI95% (-0.225; -0.038), and Experiential Avoidance $a2 \times b2$ = -0.103, z = -3.00, p = 0.003, CI95%(-0.17; -0.036),with a total indirect effect of $(a1 \times b1) + (a2 \times b2)$ = -0.235, z = -4.07, $p < 0.001$, CI95% (-0.348; -0.122).

There was also a significant indirect effect of intervention on symptomatology through Self-Regulation, $a1 \times b1 = -0.156$, $z = -2.39$, $p = 0.017$, CI95% (-0.284; -0.028), and Experiential Avoidance, $a2 \times b2 = -0.105$, $z = -3.04$, $p = 0.002$, CI95% (-0.173; -0.037), with a total indirect effect of $(a1 \times b1) + (a2 \times b2) = -0.261$, $z = -3.58$, $p < 0.001$, CI95% (-0.405; -0.118).

A second set of models included intervention (MBCT vs. control) as the independent variable, change in symptomatology as the dependent variable, and change in aspects of BA that were significant in the simple mediator models (i.e., Attention Regulation, Self-Regulation, Body Listening, and Trusting) as the first mediator, and unconstructive rumination as a second mediator.

Results revealed a significant indirect effect of intervention on symptomatology through Attention Regulation, $a1 \times b1 = -0.115$, $z = -2.49$, $p = 0.013$, CI95% (-0.206; -0.024), and Unconstructive Rumination, $a2 \times b2 = -0.145$, $z = -3.70$, $p < 0.001$, CI95%(-0.222; -0.068),with a total indirect effect of $(a1 \times b1) + (a2 \times b2) = -0.261$, $z = -4.47$, $p < 0.001$, CI95% (-0.375; -0.146).

There was also a significant indirect effect of intervention on symptomatology through Self-Regulation, $a1 \times b1 = -0.142$, $z = -2.23$, $p = 0.026$, CI95% (-0.266; -0.017), and Unconstructive Rumination, $a2 \times b2 = -0.15$, $z = -3.77$, $p < 0.001$, CI95% (-0.228; -0.072), with a total indirect effect of $(a1 \times b1) + (a2 \times b2) = -0.291$, $z = -3.99$, $p < 0.001$, CI95% (-0.434; -0.149).

A third set of models was tested with intervention (MBCT vs. control) as the independent variable, change in symptomatology as the dependent variable, change in aspects of BA that were significant in the simple mediator models (i.e., Attention Regulation, Self-Regulation, Body Listening, and Trusting) as the first mediator, and Emotion Regulation Self-Efficacy as the second mediator.

Results revealed a significant indirect effect of intervention on symptomatology through Attention Regulation, $a1 \times b1 = -0.105$, $z = -2.27$, $p = 0.023$, CI95% (-0.196; -0.014), and Emotion Regulation Self-Efficacy $a2 \times b2 = -0.187$, $z = -3.96$, $p < 0.001$, CI95% (-0.279; -0.094), with a total indirect effect of $(a1 \times b1) + (a2 \times b2) = -0.291$, $z = -4.74$, $p < 0.001$, CI95% (-0.412; -0.171). However, this result was not robust as the sensitivity analysis without outliers revealed a non-significant indirect effect of intervention on symptomatology through Attention Regulation, $a1 \times b1 = -.075$, $z = -1.67$, $p = 0.094$, CI95% (-0.162; -0.013), and a significant effect through Emotion Regulation Self-Efficacy $a2 \times b2 = -0.175$, $z = -3.86$, $p < 0.001$, CI95% (-0.264; -0.086), with a total indirect effect of $(a1 \times b1) + (a2 \times b2) = -0.250$, $z = -4.27$, $p < 0.001$, CI95% (-0.364; -0.135).

A fourth set of models was tested with intervention (MBCT vs. control) as the independent variable, change in symptomatology as the dependent variable, change in aspects of BA that were significant in the simple mediator models (i.e., Attention

Regulation, Self-Regulation, Body Listening, and Trusting) as the first mediator, and the actual-ideal self-discrepancy gap as the second mediator.

There was a significant indirect effect of intervention on symptomatology through Attention Regulation, $a1 \times b1$= -0.124, z = -2.52, p = 0.012, CI95% (-0.220; -0.027), and Actual-Ideal Self-Discrepancy Gap $a2 \times b2$ = -0.066, z = -2.18, p = 0.029, CI95% (-0.125; -0.007), with a total indirect effect of $(a1 \times b1) + (a2 \times b2)$ = -.394, z = -6.04, $p < 0.001$, CI95% (-0.296; -0.083). There was a significant indirect effect of intervention on symptomatology through Body Listening, $a1 \times b1$= -0.103, z = -2.15, p = 0.031, CI95% (-0.196; -0.009), and Actual-Ideal Self-Discrepancy Gap $a2 \times b2$ = -0.073, z = -2.39, p = 0.017, CI95% (-0.133; -0.013), with a total indirect effect of $(a1 \times b1) + (a2 \times b2)$ = -0.176, z = -3.18, $p < 0.001$, CI95% (-0.285; -0.068).

A fifth set of models was tested with intervention (MBCT vs. control) as the independent variable, change in symptomatology as the dependent variable, change in aspects of BA that were significant in the simple mediator models (i.e., Attention Regulation, Self-Regulation, Body Listening, and Trusting) as the first mediator, and actual-ideal self-discrepancy gap distress as the second mediator.

There was a significant indirect effect of intervention on symptomatology through Attention Regulation, $a1 \times b1$= -0.122, z = -2.80, p = 0.005, CI95% (-0.208; -0.036), and Actual-Ideal Self-Discrepancy Gap Distress $a2 \times b2$ = -0.109, z = -3.08, p = 0.002, CI95% (-0.178; -0.040), with a total indirect effect of $(a1 \times b1) + (a2 \times b2)$ = -0.231, z = -4.14, $p <$ 0.001, CI95% (-0.340; -0.121).

There was also a significant indirect effect of intervention on symptomatology through Self-Regulation, $a1 \times b1$ = -0.135, z = -2.26, p = 0.024, CI95% (-0.252; -0.018), and Actual-Ideal Self-Discrepancy Gap Distress, $a2 \times b2$ = -0.109, z = -3.08, p = 0.002, CI95% (-0.179; -0.040), with a total indirect effect of $(a1 \times b1) + (a2 \times b2)$ = -0.244, z = -3.55, $p <$ 0.001, CI95% (-0.379; -0.109).

There was a significant indirect effect of intervention on symptomatology through Body Listening, $a1 \times b1$ = -0.098, z = -2.28, p = 0.023, CI95% [-0.181; -0.014], and Actual-Ideal Self-Discrepancy Gap Distress $a2 \times b2$ = -0.110, z = -3.09, p = 0.002, CI95% [-0.180; -0.040], with a total indirect effect of $(a1 \times b1) + (a2 \times b2)$ = -0.208, z = -3.75, $p < 0.001$, CI95% [-0.317; -0.099].

A sixth set of models was tested with intervention (MBCT vs. control) as the independent variable, change in symptomatology as the dependent variable, change in aspects of BA that were significant in the simple mediator models (i.e., Attention Regulation, Self-Regulation, Body Listening, and Trusting) as the first mediator, and actual-ought self-discrepancy gap distress as the second mediator.

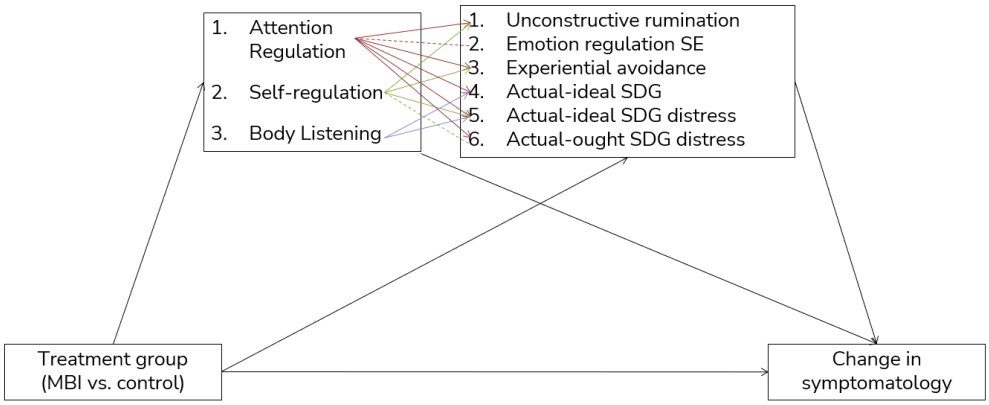

Figure 4. A summary of the multiple mediator models of the effects of treatment on symptomatology through body awareness and transdiagnostic psychological processes as described in Section 3.5.2.

Note. All variables indicate changes in the variable (pre- and post-change scores). Dashed lines indicate associations that were not robust in the sensitivity analysis. SDG = self-discrepancy gap; SE = self-efficacy.

There was a significant indirect effect of intervention on symptomatology through Attention Regulation, $a1 \times b1$ = -0.137, z = -2.97, p = 0.003, CI95% (-0.227; -0.046), and Actual-Ought Self-Discrepancy Gap Distress $a2 \times b2$ = -0.083, z = -2.74, p = 0.006, CI95% (-0.142; -0.024), with a total indirect effect of $(a1 \times b1) + (a2 \times b2)$ = -0.219, z = -3.99, $p <$ 0.001, CI95% (-0.327; -0.112).

There was a non-significant indirect effect of intervention on symptomatology through Self-Regulation, $a1 \times b1$ = -0.121, z =-1.905, p = 0.057, CI95%(-0.246; 0.003), and a significant effect through the Actual-Ought Self-Discrepancy Gap Distress $a2 \times b2$ = -0.079, z = -2.68, p = 0.007, CI95%(-0.138; -0.021), with a total indirect effect of $(a1 \times b1) + (a2 \times b2)$ = -0.201, z = -2.93, p = 0.003, CI95% (-0.335; -0.066). However, the sensitivity analysis without outliers showed a significant indirect effect of intervention on symptomatology through Self-Regulation, $a1 \times b1$ = -0.132, z = -2.20, p = 0.03, CI95% (-0.250; -0.014), and Actual-Ought Self-Discrepancy Gap Distress $a2 \times b2$ = -0.08, z = -2.77, p = 0.006, CI95% (-0.136; -0.023), with a total indirect effect of $(a1 \times b1) + (a2 \times b2)$ = -0.212, z = -3.29, p = 0.001, CI95%(-0.338;-0.086).

2.4 Discussion

The present study investigated the impact of MBCT on BA as measured by self-report questionnaires and an indirect BA task in a heterogeneous clinical adult sample. The association between self-report and indirect measures of BA was evaluated. Furthermore, the potential role of various facets of BA in explaining the reduction in symptomatology

observed after MBCT was assessed. Last but not least, the present study evaluated the impact of MBCT on transdiagnostic psychological processes (i.e., experiential avoidance, rumination, self-efficacy, and self-discrepancy) and explored the mediating role of BA alongside these psychological processes in explaining the reduction in symptomatology after MBCT.

In accordance with the initial hypotheses, there was a significant increase in most dimensions of self-reported BA and a significant reduction in psychological symptomatology after the intervention in the MBCT group in comparison to the control group. Moreover, as predicted, the reduction in symptomatology was partially mediated by changes in four dimensions of self-reported BA, mainly Attention Regulation, Self-Regulation, Body Listening, and Trusting. Lastly, as hypothesized, there was a significant improvement in most of the transdiagnostic processes in the MBCT group in comparison to the control group (i.e., experiential avoidance and three of its dimensions, unconstructive rumination, general self-efficacy, emotion regulation self-efficacy, the actual-ideal self-discrepancy gap and the distress caused by this gap, and actual-ought self-discrepancy gap distress). Exploratory analyses further revealed that BA acts alongside several of these transdiagnostic variables in explaining the positive effect of MBCT on psychological symptoms. Contrary to our hypotheses, there was no effect of the intervention on the mAMT, an indirect measure of BA, and most correlations between mAMT scores and BA questionnaire scores were weak. The results are discussed for each research question separately below.

What Is the Impact of an MBI on Self-Report and Indirect Measures of BA?

The present study revealed a significant increase in all dimensions of the FBSQ and on all dimensions of the MAIA (with the exception of Not-Distracting) in the MBCT group in comparison to the control group. Compared to control group participants, those who completed the MBCT reported an increased ability to: notice and perceive comfortable, uncomfortable, and neutral body sensations (FBSQ Perception and MAIA Noticing); regulate attention to body sensations (MAIA Attention Regulation); link body sensations and emotions in a differentiated way (MAIA Emotional Awareness and FBSQ Differentiation); use awareness of body sensations to regulate psychological distress (MAIA Self-Regulation and FBSQ Regulation); not worry when faced with sensations of pain or discomfort (MAIA Not-Worrying); listen to the body for insights (MAIA Body Listening); and experience the body as trustworthy (MAIA Trusting). These findings are in line with prior studies showing significant improvements in various MAIA facets after an MBI in clinical (De Jong et al., 2016; Fissler et al., 2016; Van Der Velden et al., 2021) and non-clinical populations (Bornemann et al., 2014; D'Antoni et al., 2021).

Improvements in the facet of Noticing were surprising because prior studies failed to find this effect (Bornemann et al., 2014; D'Antoni et al., 2021; De Jong et al., 2016; Fissler et al., 2016). The absence of an effect on Noticing has been previously explained by the absence of a significant effect of MBIs on interoceptive accuracy (Parkin et al., 2014). However, the fact that subjective and objective measures of BA often do not correlate (Garfinkel et al., 2015) sheds doubt on this explanation of an absence of an effect on Noticing. The present study shows that participants in a heterogeneous clinical sample report being able to notice body sensations of different valences after mindfulness training, which is in line with the skills cultivated in MBIs. Mindfulness meditation exercises (particularly the body scan) continuously invite participants to notice the presence or absence of body sensations (Segal et al., 2018), which may train the skill of Noticing. There are several potential reasons for why some studies did not find an effect on Noticing. First, some studies lacked adequate power (De Jong et al., 2016; $N = 29$), which may have prevented them from finding an effect. Second, some studies were conducted on a population of healthy adults (D'Antoni et al., 2021), meaning there may have been little room for improvement. Baseline levels of Noticing in the mindfulness group in the study by D'Antoni and colleagues (2021) were higher (3.19) than baseline levels in the present study (2.44). Finally, other studies used shorter or adapted versions of an MBI (Bornemann et al., 2014; Fissler et al., 2016), which may have lacked the assiduous training employed in standard 8-week courses, thereby diminishing the effect of the intervention on Noticing.

Improvements in Not-Worrying contradict prior studies that found no effect on this facet of BA (Bornemann et al., 2014; Fissler et al., 2016; Van Der Velden et al., 2021). However, our results are in line with a more recent study that found a significant effect of a 7-week Mindfulness-Oriented Meditation intervention on Not-Worrying in a sample of healthy individuals (D'Antoni et al., 2021). There are several potential explanations for the inconsistency of results. As mentioned above, some studies use shorter or adapted versions of an MBI (Bornemann et al., 2014; Fissler et al., 2016), which may not target the ability to skillfully relate to difficult and painful experiences. The present study used the complete, standardized MBCT program, which includes sessions and meditations on dealing with difficult experiences, and may help explain the improvements in Not-Worrying observed in the present study. Another reason why there may be inconsistent results is that the MAIA sub-scale of Not-Worrying has been shown to have poor internal consistency in various studies (Bornemann et al., 2014; Fissler et al., 2016; Mehling et al., 2012), including the present study ($a = 0.61$).

Contrary to our hypotheses, there was no significant effect of MBCT on the tendency to ignore or distract oneself from sensations of discomfort or pain (MAIA Not-Distracting) as compared to the control group. This contradicts De Jong and colleagues' (2016) findings that Not-Distracting not only improves after MBCT but also mediates the

effect of MBCT on depressive symptomatology. One would expect that MBCT would significantly impact Not-Distracting as one of the aims of the training is to teach people to approach their internal experience in a curious and gentle way (Segal et al., 2018), which is at odds with the strategy of distraction. Furthermore, the present study shows that MBCT significantly reduced participants' experiential avoidance and, more specifically, their tendency to avoid experience via distraction and suppression, which is not congruent with the absence of an effect on Not-Distracting. One of the potential reasons for this null finding is that the Not-Distracting sub-scale exhibited poor internal consistency in prior studies (Mehling et al., 2012) and in the present study as well (a = 0.55). Therefore, this result must be interpreted with caution.

Contrary to our hypotheses, there was no significant impact of MBCT on BA as measured by the mAMT. More specifically, there was no effect on the mention of body sensations during autobiographical memory recall. This is in line with prior research using other measurement types, such as behavioral measures, which found no improvements in interoceptive accuracy (Khalsa et al., 2018) in meditators (Khalsa et al., 2008, 2020; Nielsen & Kaszniak, 2006), completers of an MBI (Parkin et al., 2014), nor individuals with high trait mindfulness (Parkin et al., 2014). With regards to the mAMT used in the present study, the lack of an effect may be due to numerous reasons. First, since the adapted version of the task has not yet been validated, the exact construct it is measuring is still unclear. There are many different processes potentially involved in the tendency to spontaneously report one's bodily state while reporting an emotional autobiographical memory. Some of these underlying processes can be interoceptive, such as an improved ability to attend to and detect body sensations. However, other non-interoceptive processes should be considered, such as participants' autobiographical memory encoding and recall capacities, as well as their ability (e.g., vocabulary) and willingness to communicate about their body sensations with a stranger. Hence, there is a multiplicity of concurrent variables that may be blurring the effect. Second, the task may lack sensitivity because participants were only asked to discuss three positive and three negative memories. More instances may be needed per category of memories in order to increase the task's sensitivity. Last but not least, the task's sensitivity may be reduced because participants are asked to be as specific as possible, which may have interfered with how they would naturally behave. Perhaps if there was less of an emphasis on specificity, the task would be more sensitive to participants' spontaneous behavior and hence more likely to pick up differences between the MBCT group and control group.

How Do Results in the Indirect Measure of BA Correlate with Results in Self-Report Measures of BA?

Results only partially supported the hypothesis that performance on the mAMT would be correlated with scores on BA questionnaires. We had specifically hypothesized

a significant correlation between performance on the task and the MAIA subscale Emotional Awareness, given that participants talked about body sensations during emotional memories. There was some evidence for this hypothesis as there was a medium correlation between mention of body sensations during recall of positive memories and Emotional Awareness, suggesting that the more aware participants were of the connection between body sensations and emotions, the more they reported body sensations linked to a positive memory. Furthermore, the more participants were able to regulate their attention to body sensations, differentiate the states suggested by these sensations, and use these sensations to regulate themselves, the more they reported body sensations when talking about positive memories. This suggests that increased adaptive BA could lead to more awareness and, therefore, reporting of positive body sensations. This can be explained by the fact that an increased ability to regulate one's attention towards body sensations may lead to more awareness of positive body sensations as people can consciously and deliberately place their attention on positive sensations. Lastly, these correlations point to a congruence between the mAMT and specific facets of self-reported BA.

Globally, however, all other correlations between self-reported BA and performance on the task were small and not significant, which may be due to the task's lack of sensitivity or to the fact that the task and questionnaires are measuring different constructs. These findings are in line with prior research in which self-report measures of BA do not correlate with other measurement types such as behavioral measures (Forkmann et al., 2016; Garfinkel et al., 2015). To date, it has been very difficult to find a sensitive and valid behavioral measure of BA. While it assesses different interoceptive dimensions than the mAMT, the most widely used behavioral measure of interoceptive accuracy is the heartbeat counting task, which has been greatly criticized for relying on non-interoceptive processes (Desmedt et al., 2018). There is a need for valid indirect and behavioral measures of BA and a clear explanation of what aspect of BA they are measuring. Overall, these findings suggest that BA questionnaires and the mAMT may be measuring both common and different aspects of BA. A refinement of the mAMT is needed, and more research assessing the exact processes at play in the task.

What Is the Impact of an MBI on Transdiagnostic Psychological Processes?

In line with our hypotheses and prior research (see Introduction), MBCT had a significant positive effect on most of the psychological processes measured in the present study; mainly, experiential avoidance (including behavioral avoidance, procrastination, and distraction), unconstructive rumination, emotion regulation self-efficacy and general selfefficacy, actual-ideal self-discrepancy gap and distress, and actual-ought self-discrepancy gap distress in comparison to the control group. Furthermore, as

hypothesized, there was no effect of MBCT on the actual-ought self-discrepancy gap. Lastly, contrary to our hypotheses, there was no effect on repression and only a tendential effect on constructive rumination.

Overall, these results support the notion that MBCT is a transdiagnostic intervention that impacts processes common to many psychological disorders (Baer, 2007; Teasdale et al., 2003). For example, experiential avoidance is an important maintenance factor in disorders such as obsessive compulsive disorder, panic disorder with agoraphobia, borderline personality disorder, depression, and substance use (Hayes et al., 1996). Likewise, unconstructive rumination has been positively associated with depression, anxiety, co-morbid obsessive-compulsive disorder and generalized anxiety disorder, and borderline personality disorder (Watkins, 2009). With regards to self-efficacy, it has been shown to play an important role in specific phobias and traumatic experiences (Bandura, 1983, 1997). Last but not least, perceived discrepancies are involved in depression, anxiety, and eating disorders (Mason et al., 2019). The influence of MBCT on the aforementioned psychological and transdiagnostic processes may explain its positive effects on a wide array of conditions and populations (Chiesa & Serretti, 2011; Goldberg et al., 2017). Whether these processes explain the impact of MBCT on symptomatology is the question we address next.

What Is the Impact of an MBI on Symptomatology, and Is This Effect Mediated by BA and Related Psychological Processes?

As hypothesized, MBCT significantly reduced symptomatology, and this effect was mediated by the regulatory and belief-related aspects of BA (i.e., Attention Regulation, Self- Regulation, Body Listening, and Trusting). This is in line with De Jong and colleagues' (2016) findings showing that BA, as measured by the MAIA, explained the effects of MBCT on depressive symptoms. Unlike the present study, however, De Jong and colleagues (2016) found a mediating effect of the facet Not-Distracting only, which may be attributed to their small sample and their specific population (i.e., patients with chronic pain and comorbid active depression). The present study's findings provide evidence for the long-standing hypothesis that BA is an essential component by which MBCT, and MBIs in general, exert their effects (Hölzel et al., 2011). Here, the aspects of BA that are highlighted as most important are: regulating attention to the body, using body sensations to regulate oneself, and listening to and trusting the body. Therefore, it is not just paying attention to the body that is important but paying attention with an attitude of trusting and using this trusting awareness of the body to regulate one's distress.

Contrary to our hypotheses, none of the FBSQ facets (i.e., Perception, Differentiation, and Regulation) were significant mediators of the MBCT's effects on

symptomatology. This may be attributed to several reasons. First, the FBSQ is a scale that has not been formally validated and may have some psychometric limitations, meaning that results need to be interpreted with caution. Second, as discussed in the Methods section, the FBSQ and the MAIA evaluate slightly different aspects of BA: the FBSQ focuses on perception, differentiation, and regulation of body sensations during emotional experiences, whereas the MAIA adopts a wider approach and measures attention, attitudes, and reactions towards emotion and non-emotion-related body sensations. Using both measures allowed us to hone in on the nuanced aspects of BA that play a key role in MBIs. The results visibly reveal that it is the attitudinal, regulatory, and attentional aspects across emotional and non-emotional bodily states that explain the effects of an MBI on symptomatology.

Furthermore, multiple mediator models showed that BA (more specifically, the dimensions of Attention Regulation, Self-Regulation, and Body Listening) does not exert its effects alone, but via six other mediators: reduction in experiential avoidance, reduction in unconstructive rumination, enhancement of emotion regulation self-efficacy, reduction of the actual-ideal self-discrepancy gap, and reduction of the distress caused by the actual-ideal and actual-ought self-discrepancy gaps. This suggests that MBCT trains participants to allocate attention to their body with a spirit of listening and regulating, providing the necessary defusion (i.e., a distanced, open, and objective stance towards inner experience) (Naragon-Gainey & DeMarree, 2017) from experience to allow for more functional processes to take place (e.g., adaptive emotion regulation), and to reduce the use of dysfunctional strategies (e.g., experiential avoidance, unconstructive rumination, discrepancy thinking). Altogether, the synergy of these processes explains the effects of MBCT on reduced symptomatology in a heterogeneous clinical sample. These findings are in line with Fissler and colleagues (2016), who found that the effect of MBCT on depressive symptoms was explained by an increase in the regulatory and belief-related aspects of BA (as measured by the MAIA) and an increase in the ability to decenter. Results were also in line with the theoretical model of MBCT, in which the central skill is to recognize and disengage from unhelpful states of mind (mainly abstract, repetitive, negative discrepancy-based thinking), which can quickly spiral into a depressive episode (Segal et al., 2018). Awareness of the body is an important skill used throughout the program that helps participants disengage from automatic ruminative thinking and enter the so-called "being-mode" in which there is a direct engagement with the present-moment experience of the body. The present study's findings suggest an important role of BA in this process. Finally, our results are in line with recent neurobiological frameworks that suggest that by practicing mindfulness, a transition is observed from the narrative self (activity in the default mode network) to the experiential or embodied self (activity in the salience network; Schuman-Olivier et al., 2020; Tabibnia, 2020).

Strengths and Limitations

Three important strengths of the present study are its heterogeneous and representative clinical sample, its multi-modal measurements of the BA construct, and the assessment of a variety of process variables that had not been previously investigated alongside BA. The heterogeneous clinical sample was recruited following routine clinical practice and ensured the study's ecological validity, thereby contributing to the scarce literature on the effectiveness of MBCT (i.e., its application in routine clinical practice) (Geurts et al., 2021). Furthermore, the sample supports the study's external validity in comparison to other RCTs investigating MBCT, as it closely reflects a clinical population who would likely participate in MBCT in the real world (Rosenkranz et al., 2019). Using different measures of BA allowed for a multi-faceted and nuanced exploration of MBCT's effect on BA. Last but not least, assessment of a diversity of process variables alongside BA helps advance the literature on the transdiagnostic nature of MBCT and the synergy of mechanisms involved in explaining its effects.

The present study has several limitations that need to be considered. First of all, participants were not randomized to their respective groups, which may have increased bias (Hariton & Locascio, 2018). Since there was no randomization, it is not possible to rule out extra-therapeutic and nonspecific factors (e.g., motivation and expectation of improvement) that may have led to improvements in the participants (Lilienfeld et al., 2014). Second, the control group consisted of age-, gender-, and education-matched controls, meaning we cannot know for sure to which degree the effects observed are due to the treatment itself or to other variables that were not controlled for, such as nonspecific treatment factors (e.g., placebo effects, novelty effects, or effort justification) (Lilienfeld et al., 2014). Furthermore, there were significant baseline differences between the MBCT group and the control group, which may have led to an overestimation of the intervention's effects. For more adequate comparisons, future studies should employ an active control condition with comparable baseline characteristics to the experimental group. Third, there was some attrition bias as various participants did not complete assessments at Time 2 and were excluded from the analyses. These participants were, on average, younger than participants who completed both assessment points. Fourth, the present study did not include follow-up measurements preventing us from drawing conclusions about whether the effects are preserved in the long term. Fifth, the present study used two unvalidated measures, the mAMT and the FBSQ, which may have influenced the validity of the results obtained with these two measures. Finally, the conclusions that can be drawn from the mediation analyses are limited because they indicate whether covariations are consistent or not with a hypothesized causal model, but they do not ascertain causality (Fiedler et al., 2011).

Chapter 3.

Body Aware: Adolescents' and young adults' lived experiences of body awareness

Background. Paying attention to body sensations has been associated with many positive outcomes such as increased subjective well-being, enhanced emotion regulation, and reduced symptom reports. Furthermore, body awareness has an important therapeutic utility in the treatment of various psychological ailments. Despite its importance in mental health, there is very little research on body awareness during adolescence and young adulthood – important developmental periods characterized by bodily changes and the development of one's relationship to one's body. Therefore, the present qualitative study sought to explore how body awareness is understood, experienced, and described by adolescents and young adults.

Method. Four online focus groups were conducted with young people between the ages of 14 and 24 ($N = 20$).

Results. Thematic analyses revealed a multidimensional and highly contextualized understanding and experience of body awareness in this age group. In general, young people reported mainly attending to intense and unpleasant body sensations with a particular attitude (e.g., accepting or avoidant) depending on the type of sensation, leading to a variety of cognitive, emotional, and behavioral reactions to these sensations. These processes were embedded in an underlying schema of beliefs about body awareness and an overarching physical and socio-cultural context. Results further revealed a more nuanced experience and understanding of body awareness in women and in young adults.

Conclusions. The present findings can be used as a foundation for the development of body awareness theoretical frameworks and self-report instruments for youth and can aid the generating of hypotheses for future research on body awareness in this age group.

Reference

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3.1 Introduction

Adolescence and emerging adulthood are crucial periods of development. Numerous bodily changes occur during this period of life such as physical growth, sexual maturation, as well as sleep and circadian regulation changes (Dahl et al., 2018). Furthermore, important habits such as one's awareness of, relationship with, and image of one's body begin to form (Laufer, 1996; Lunde & Frisén, 2011). Despite the salient role that the body and awareness of the body play throughout this developmental period, few studies have explored how adolescents and young adults view, experience, and describe these processes from a subjective point of view.

Interoception can be broadly defined as the sensing, interpretation, and integration of internal bodily signals at conscious and unconscious levels (Khalsa et al., 2018). It is a complex, multi-dimensional construct with a wide array of conceptualizations in the literature (see Mehling et al., 2009). A recent, comprehensive theoretical framework of interoception consists of eight dimensions (see Suksasilp & Garfinkel, 2022 for a thourough presentation of these dimensions). The present article focuses on three of these dimensions that are accessible to awareness and that we consider are of greatest clinical interest: interoceptive attention, self-report and interoceptive beliefs, and attributions of interoceptive sensations. Interoceptive attention refers to people's tendency to attend to body sensations (Suksasilp & Garfinkel, 2022). The dimension of self-report and interoceptive beliefs refers to people's subjective experiences of their body sensations (Suksasilp & Garfinkel, 2022). Finally, the dimension of attributions of interoceptive sensations refers to people's appraisal of perceived bodily signals (Suksasilp & Garfinkel, 2022). For example, individuals with panic disorder tend to view body sensations as dangerous and life-threatening (Ehlers, 1993). These three dimensions will be qualitatively explored in the present study and are integrated into the definition of self-reported interoception used in this study: the subjective, phenomenological, and conscious experience of body sensations shaped by complex psychological processes such as attention, attitude, interpretation, and beliefs (Mehling et al., 2011). This definition highlights two key aspects of self-reported interoception: (1) the perceptual and attentional aspects (i.e., consciously perceiving and attending to body sensations), and (2) conscious mental processes that go beyond perception, such as attitude, attributions of body sensations, and reactions to body sensations. The word "BA" will be used for the remainder of the article to refer to self-reported interoception as defined in this paragraph.

Researching BA is important because BA plays an important role in psychological well-being and in the treatment of psychological disorders. It is positively associated with emotion regulation (Aronson et al., 2006; Barrett et al., 2004; Hölzel et al., 2011; James, 1884; Pollatos & Schandry, 2008) and intuitive decision-making (Damasio, 1994) – two processes that foster mental well-being. Furthermore, adult research has shown that deficits in BA are associated with many mental health conditions such as anxiety, depression, eating disorders, post-traumatic stress disorder, substance use disorders, and

somatic symptom disorders (Khalsa et al., 2018). Research in youth is scarce but existing research has replicated the link between BA (particularly distrust in body sensations) and eating disorder symptoms (T. A. Brown et al., 2020), and a positive association has been found between BA and positive body image (Todd et al., 2019). Finally, BA has therapeutic utility in evidence-based psychological interventions such as somatic experiencing (i.e. a form of therapy in which the body's natural protective reactions and attention to body sensations are used as key therapeutic tools; Brom et al., 2017; Payne et al., 2015), and mindfulness-based interventions, which involve a systematic training in mindfulness meditation practice (De Jong et al., 2016; Fissler et al., 2016; Pérez-Peña et al., 2022). These findings suggest that, in youth, BA may be a protective factor for mental health, whereas atypical BA may be a risk factor for psychopathology.

Studying BA in a population of youth is particularly important because BA may be a key factor in understanding the high rates of psychopathology during this period of life (De Girolamo et al., 2012). Murphy and colleagues (2017) theorize that during adolescence, poor BA skills may lead to risky decision-making and difficulties regulating emotions, which in turn may contribute to increased psychopathology and risky behaviors. However, there is very little research on the developmental trajectory of BA throughout adolescence and young adulthood and on the psychological processes that may be impacted by an atypical BA; hence, more studies are needed to test this theory. Numerous questions remain unanswered. For example, what is the typical development of BA throughout adolescence and emerging adulthood? Do BA skills naturally increase with age and is this negatively linked with psychopathology rates? Do poor BA skills impact decision-making during adolescence?

Before these important questions can be meaningfully explored, there is a need for a BA conceptualization and BA assessment tools adapted to youth. Influential BA theoretical frameworks (Garfinkel et al., 2015; Khalsa et al., 2018; Mehling et al., 2012; Suksasilp & Garfinkel, 2022) have mostly been based on adult research and do not integrate developmental aspects. There has been a call for adopting a developmental neuroscience perspective on BA, as BA may differ with age and have different implications across stages of life (J. Murphy et al., 2017). This call has been echoed by other authors who highlight the need for a better understanding of the developmental aspects of BA (Khalsa et al., 2018). However, to move the field forward, adequate and valid measures are needed. To our knowledge, there are only two self-report measures evaluating BA that have been validated in a population of youth. The first is the Multidimensional Assessment of Interoceptive Awareness (MAIA) for youth, which measures BA in a multidimensional way, and was adapted and validated in children and adolescents between the ages of 7-17 (Jones et al., 2020). The second one is the Bodily Awareness subscale of the Emotion Awareness Questionnaire revised, which conceptualizes BA as maladaptive and focuses on "the physiological aspects of the emotion experience" (Rieffe et al., 2008, p. 757). Both measures have important limitations. The MAIA for youth was initially developed for an adult population based on findings from adult focus groups.

Hence, it may not be valid for youth's experience of BA. The questionnaire was then adapted for youth by changing specific words and phrasing (Jones et al., 2020), but the language may remain overly complex. Regarding the Emotion Awareness Questionnaire revised, it focuses on a very narrow conceptualization of BA, which does not consider the nuances, dimensions, and adaptive qualities of BA. In short, there is a need for BA theoretical frameworks in youth and BA measures grounded in these frameworks for research in the field to progress.

The purpose of the present study is to gain insights into how BA is subjectively understood, experienced, and described by adolescents and young adults in order to inform BA theoretical frameworks and self-report measures tailored to youth. The nature of this research is exploratory and hypothesis-generating rather than confirmatory or hypothesis-driven. To reach the study's aim, a series of focus groups (FGs) with young people between the ages of 14 and 24 were conducted. The age range of 14-24 was chosen because we wanted to include participants with sufficiently established self-reflection capacities. The capacities of self-reflection, meta-cognition, and self-evaluation become increasingly established from mid-adolescence onward with the maturation of the frontal lobes (Steinberg, 2005). A qualitative approach was chosen because of its potential for identifying important domains of interest in the topic of BA in youth (Carey & Asbury, 2016), which is under-explored and poorly understood (Jones et al., 2020; Murphy et al., 2017). Furthermore, BA research in youth has focused on quantitative methods using measures and definitions of BA borrowed from research with adults (Emanuelsen et al., 2015; Todd et al., 2019), which may not be directly transferable to this age group. To our knowledge, existing qualitative studies that explicitly focus on the subjective experience of BA have been performed on adult populations (e.g., Mehling et al., 2011). Existing qualitative studies with youth include BA as a secondary measure, but not as the main focus of their research question (e.g., Bugge et al., 2012). Therefore, the present study will explicitly focus on the subjective experience of BA in a sample of young people. The aim is not to generalize the findings, but to provide rich, in-depth, and detailed data on the experience of BA in a sample of youth.

3.2 Methods

Participant Recruitment

Recruitment began on February 7th, 2020 and ended on March 23rd, 2020. Adolescents and young adults were recruited via various means. The research team sent a recruitment email to five youth movements and two secondary schools in Brussels and vicinity, to acquaintances of the research team, as well as to students in the Faculty of Psychology and Educational Sciences of the University of Louvain. A recruitment post was also shared on social media platforms (i.e., Facebook). The invitation included a brief description of the objectives of the study, its modalities, and the compensation.

Participants were invited to contact the researcher if they were interested in participating. The inclusion criteria were: (1) being between the ages of 14 and 24, (2) speaking French fluently, and (3) having access to a device with internet connection, as the FGs were conducted online due to the Covid-19 pandemic. Interested participants were then e-mailed information sheets explaining the details of the study (minors were emailed two information sheets, one for the teenager and one for the parents, and a parental consent form to be signed and sent before the FG), as well as a Doodle link to schedule the date and time of the group. Once the date and time were confirmed, a final e-mail was sent containing practical details and the following documents: a list of the five questions that would be asked during the virtual FG, the informed consent form to be read prior to the FG, and an instruction sheet explaining how to use the virtual platform Adobe Connect (Adobe Connect, 2021). All participants below the age of 18 sent us signed, written parental consent forms, and all participants electronically signed written informed consent forms prior to the start of the virtual FG, including the permission to audio-record and transcribe the discussions, as well as to publish the results. The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Ethical Committee of the Psychological Sciences Research Institute at the University of Louvain (Projet2020-07; approved on January 29th, 2020).

Data Collection

A total of 20 young people between the ages of 14 and 24 agreed to participate in the online FGs. FGs were chosen for data collection in order to explore youth's experiences, attitudes, and opinions on BA in a rich way (Ravitch & Carl, 2016). Due to their interactive nature (e.g., sharing a diversity of viewpoints and building on each other's ideas), FGs may provide richer data than individual interviews (Guest, Namey, Taylor, et al., 2017). We originally planned to conduct the FGs in person but the Covid-19 lockdown obliged us to conduct online FGs, which have both limitations and advantages (see Tuttas, 2015). The groups were divided by age in order to create a more comfortable and less intimidating environment in which participants could express themselves freely. Moreover, we divided participants by self-reported gender (i.e., including the options male, female, and other) to foster an open and authentic expression which may be hindered in mixed-gender groups (Millward, 1995). Participants were divided into one of these two groups based on their self-reported gender, with one exception. One participant identified as transgender and was assigned to the group of their sex assigned at birth with the participant's consent. We conducted a total of 4 FGs (2 groups per developmental stage and 2 groups per gender) with 4 to 7 participants per group. Group number was based on research showing that 2 to 3 FGs is enough to reveal 80% of discoverable themes (Guest, Namey, & McKenna, 2017), and group size was based on literature showing that 4 to 10 participants is enough, as smaller groups provide richer data (Carey & Asbury, 2016; Millward, 1995; Sweet, 2001).

Participants in FG1 were female young adults ($N = 7$; mean age = 22.29, $SD = 1.98$), and were university students at the bachelor ($n = 2$) or master level ($n = 5$), studying human sciences ($n = 6$) and audiovisual studies ($n = 1$). Participants in FG2 were male young adults ($N = 4$; mean age = 20.25, $SD = 1.71$), and were all university students at the bachelor level studying human sciences ($n = 3$) or biomedical sciences ($n = 1$). Participants in FG3 were male adolescents ($N = 5$; mean age = 15.6, $SD = 0.55$), who were mostly secondary school students in 9th ($n = 2$) and 11th grade ($n = 2$). Finally, participants in FG4 were female adolescents ($N = 4$; mean age = 15.75; $SD = 0.5$) and were secondary school students in 9th ($n = 1$), 10th ($n = 1$), and 11th grades ($n = 2$). All participants' mother tongue was French, and most participants were of Belgian nationality (except for one participant in FG1 who was of French nationality). See Appendix C S1 for more details on participants' demographic characteristics.

The online FGs were conducted between March and May 2020 on the web conference platform Adobe Connect (Adobe Connect, 2021), which was selected according to the eight criteria outlined by Tuttas (2015): the platform should (1) allow for meetings with up to 10 participants, (2) allow for real-time audio and video, (3) permit audiovisual recordings of the discussion that only the host would be able to record, (4) make audiovisual recordings accessible to the host only, (5) be easy to use for participants, (6) make it easy for participants to join the meeting, (7) require no purchasing or installation from the part of participants, and (8) only allow invitees to access the meeting.

The duration of the online FGs was one hour and a half. The groups were co-facilitated by three members of the research team (MP, JN, JP). Two of the co-facilitators took turns leading the discussion and taking notes on verbal and non-verbal communication. The third co-facilitator oversaw technical aspects (e.g., helping participants if they encountered technical issues, recording the session, copy pasting the questions in the virtual discussion board, timekeeping). Regarding positionality, all three co-facilitators were cisgender women of Latin American or Western European origins, conducting psychological research at the master or doctoral level with a focus on the topics of body awareness, mindfulness, and youth. At the beginning of the session, participants were asked to sign the informed consent form electronically and to fill in a short demographic survey regarding gender, age, nationality, mother tongue, the year and orientation of their educational studies, and whether they would like to receive the results of the study. At the end of the FG, participants were asked to fill in a short survey asking them to evaluate their experience of the virtual FG. Young adult participants received 8 euros for their participation and adolescent participants received a store voucher of 10 euros for their participation.

The multidimensional conceptualization stated in the introduction was used to draft the questions. Hence, questions included the perceptual aspects of BA, as well as the conscious mental processes beyond perception, such as attitudes, reactions, beliefs, and interpretations of body sensations. The following questions were asked:

1) Do you remember a time when you felt a sensation in your body (e.g., stomach rumbling, eyes stinging) due to a specific state (e.g., when you felt a particular emotion or were hungry, thirsty, or tired)? What did you feel? Did you notice what you were feeling while you were feeling it or afterwards?

2) During the day, what kind of sensations do you pay attention to in your body?

3) When you notice a sensation in your body during a particular state (e.g., because you felt an emotion, or perhaps you felt tired or hungry), what do you do? Please give a concrete example from your daily life.

4) Do you think that paying attention to body sensations is helpful, not helpful, or not important to you? Could you give concrete examples of times when it was helpful and/or times when it was not helpful/ or times when it was bad to pay attention to your body sensations?

5) In your experience, is there a connection between noticing sensations in your body and noticing the state you are in at that moment? Why or why not? Can you give examples from your daily life?

Data Analysis and Interpretation

All FG sessions were audiovisually recorded. Immediately after the FG, the co-facilitators (MP, JN, JP) did a debriefing to go over the main observations. Soon after this, the core qualitative team (MP, JN, JP) conducted a preliminary analysis that involved thoroughly reviewing the notes taken during the FG session, listening to the recordings, and noting down important observations. Next, the team conducted verbatim transcriptions of all FG sessions and checked all transcripts for accuracy. The data was then analyzed using a team-based thematic analytical approach derived from the approaches described in Braun and Clarke (2006) and Ravitch and Carl (2016). A thematic analytical approach was chosen because the goal was to identify and analyze patterns in the data. Thematic analyses were conducted separately for young adult and adolescent FGs, leading to two sets of themes. The approach involved: (1) familiarizing ourselves with the data by reading through it multiple times, highlighting text that stood out, and jotting down initial impressions, (2) generating codes (i.e., the most basic piece of information that can be assessed meaningfully; Boyatzis, 1998) (3) searching for themes based on the different codes, (4) reviewing the themes, (5) defining and naming the themes, and (6) writing up the results. These steps were followed by the members of the core qualitative team. NVivo was used to for steps one through five (QSR International Pty Ltd, 2020). Regular meetings were held to come to a consensus on the codes and themes, and to further discuss the themes with the other team members.

3.3 Results

The resulting themes of our thematic analyses can be found in Table 6. Results are discussed for adolescent and young adult groups separately and include quotes reflecting the essence of each theme. In order to be concise, not all relevant quotes were included under each theme, but interested readers can refer to the Appendix C S2 to find additional quotes.

Table 6. Overview of themes and sub-themes of adolescent and young adult FGs

Adolescents	Young adults
1. Attention a. Attention grabbers (intensity, novelty[W], problematic[W], and unpleasantness) b. Temporality of attention 2. Awareness of body sensations a. Types of sensations (emotions, muscular, and physiological needs) b. Contextual influence c. Lack of awareness 3. Reactions to body sensations a. Hedonic (feel pleasure and avoid pain) b. Accepting c. Listening d. Instrumental 4. Beliefs about BA a. Adaptivity b. Consequences of not listening c. Good balance d. Link between states and sensations	1. Attention a. Attention grabbers b. Temporality of attention c. Types of attention (voluntary and non-voluntary) 2. Body sensations a. Types (emotion-related, physical, and undefined) b. Impermanent[M] 3. Processes a. Labeling body sensations b. Interpretation c. Attitudes (hypervigilance-driven, mindful, and trusting[W]) 4. Factors influencing BA a. Activities b. Sociocultural context c. Past experiences[W] d. Physio-temporal context (e.g., time of day) e. Mood or state 5. Reactions to body sensations a. Reactions to physical sensations b. Reactions to emotion-related sensations (accepting, being submerged, analyzing, avoiding, approaching, and using body sensations to regulate) c. Reactions to undefined sensations 6. Mind-body connection a. Mind-body distinction[W] b. Sensations, states, and mind 7. (Mal) adaptivity of BA a. Adaptive b. Maladaptive

Note: [W] = sub-themes present only in the women's discourse. [M] = sub-themes present only in the men's discourse.

Adolescent results

Attention

With regards to attention, adolescents spoke of the characteristics of body sensations that immediately capture their attention, and the exact moment in which they notice these sensations, during or after they are experienced.

Attention Grabbers. Adolescents, in both the male and female FGs, reported a general lack of attention to body sensations in their daily lives unless sensations were intense, novel, unpleasant, or problematic. When asked what kind of body sensations they paid attention to throughout the day, most adolescents spoke of intense body sensations such as sensations associated with strong emotions or sensations linked with accumulated fatigue.

> If I'm running and um in that moment I pay attention because during a sprint we feel tired suddenly and then really good and since the sensation is intense I pay attention but if not it's really rare. (FG3)

Female adolescents also spoke of paying attention to body sensations that were out of the ordinary or not part of their everyday life.

> Participant: But if not, I notice unusual things more often.
>
> Facilitator: And what are unusual things for you?
>
> Participant: Well becoming really angry, I don't usually get angry so…I don't really know… or when I experience a big stress but that also doesn't happen every day… (FG4)

However, some female adolescents pointed out paying attention to everyday body sensations that were considered problematic such as sensations of tiredness, because even though these sensations were not novel or unusual, they prevented them from accomplishing tasks in their daily life (e.g., falling asleep at night, performing well during a piano audition, starting their day).

Finally, the negative valence or unpleasantness of body sensations was also an important characteristic that captured adolescents' attention in an instant and automatic way. Attention to these sensations was motivated by a desire to fix the unpleasant sensations or make them go away.

> I personally pay attention more quickly to unpleasant sensations, except when I really want to enjoy a moment…then I pay attention to pleasant sensations but it's not automatic, but for unpleasant sensations it's really automatic because it's something that bothers me or something and so I try to pay attention to fix it, in any case it's more automatic. (FG4)

Temporality of Attention. This refers to the moments in which adolescents pay attention to body sensations, when perceiving them and/or afterwards. When body

sensations were intense, novel, problematic or unpleasant, adolescents reported paying automatic and immediate attention to their direct bodily experience. However, when body sensations were milder or when adolescents were engaged in other activities, body sensations were usually not attended to in the moment but afterwards (when their intensity increased or otherwise changed).

> So I feel sensations during when they are strong emotions but when they're small for example a mild tiredness well I feel them as they accumulate and so I don't feel them necessarily in the moment itself but when I'm for example extremely tired or angry, well I feel it more. (FG4)

Awareness of Body Sensations

Awareness of body sensations refers to the aspects of awareness that adolescents alluded to in the FGs, mainly the content of awareness (i.e., types of body sensations), context, and lack of awareness of the body.

Types of Sensations. When adolescents spoke of the different body sensations they attended to in their everyday lives, they spoke of three categories of sensations. First, most adolescents reported being aware of body sensations related to emotions, mainly body sensations related to stress, anxiety, and anger. A few adolescents spoke of body sensations related to sadness and joy. Concerning anxiety, one participant in FG4 expressed: "When I start to find it difficult to breathe or I have a weight on my lungs I know I'm anxious."

Second, various adolescents also identified muscular body sensations linked to posture and muscles particularly in the context of doing sports: "When you do sports, well, the body sends signals that you are suffering… For example, your muscles are aching, you are tired, you are out of breath, your heart is beating faster, uh, sweating and all that." (FG3)

Lastly, adolescents spoke of a category of body sensations related to the body's physiological needs such as the need for food or rest expressed as sensations of hunger and fatigue respectively. For example, a participant in FG3 expressed: "It's fatigue, a sensation in which your eyes often sting, I don't want to do anything anymore."

Contextual Influence. Adolescents spoke of the contexts, times of day, and activities in which they paid attention to body sensations. Most mentioned paying attention to body sensations when they were doing some form of physical activity (e.g., at the gym, hiking, sprinting, dancing), during stressful moments (e.g., exams), at specific moments in the day (i.e., when waking up and going to sleep), in social contexts (e.g., when with family), and when alone.

> Otherwise it's true that in the evening, for example, when I lie down in bed, I pay attention, especially when I can't sleep, I say to myself: What do I feel here? What do I feel here? And except for the moments when it's really a moment alone or I don't have to do

> anything but otherwise as soon as I'm doing something else, I don't think about the sensations in my body. (FG4)

Lack of Awareness. Adolescents reported a lack of awareness of body sensations in certain contexts. Most adolescent boys reported a general lack of attention to their body sensations except when there was a physiological need or pain in the body.

Adolescent girls, on the other hand, reported specific moments when they were not aware of their body sensations; mainly when completing tasks or when at school.

Okay, um, but it's true that the time when I'm least aware of the sensations in my body is as soon as I'm busy because as soon as I have to think about something else, about work, about doing sports or whatever, well, unless it's a really big pain, I'm not going to feel it. (FG4)

Reactions to Body Sensations

Adolescents spoke of four main kinds of behavioral and emotional reactions to their body sensations: (1) hedonic, (2) accepting, (3) listening, and (4) instrumental.

Hedonic. Most adolescents expressed a hedonic way of relating to their body sensations. They actively sought pleasant sensations and tried to make them last, enjoy them, repeat them, and remember them.

With regards to unpleasant sensations, they reported avoiding and rejecting these sensations and seeking ways to make them go away: "When I have a sad sensation, I don't know, something like that, I try to think of something else… Mmhmh, something nice, find an activity that makes me forget a bit." (FG3)

Accepting. Some adolescents reported reacting to body sensations with an attitude of acceptance; particularly when it came to body sensations associated with intense unpleasant and pleasant emotions. Acceptance is defined as a way of relating to experiences with present moment awareness, openness (i.e., giving space to the experience without changing it) and self-compassion (i.e., acceptance of one's limits and imperfections; Philippot, 2011). One participant describes this attitude very clearly.

> I think you have to take care of yourself and ask for help if you need it, but sometimes you have to tell yourself that it's normal…There are certain periods when you are a little bit, well I'm a little bit fragile and I know that I can cry for a yes or a no and two minutes later I say to myself, well shit, I shouldn't have cried, but it's not a big deal…I think we have to be careful but we also have to tell ourselves that our body is not perfect and that sometimes there are things that don't work and we can't explain everything. (FG4)

Listening. Various adolescents reported reacting to body sensations by simply listening to them. This refers to paying attention to sensations and acting in accordance with what they communicate. Such a reaction is mainly evoked in relation to

physiological needs (e.g., eating when hungry, drinking when thirsty, sleeping when tired) and to sensations of pain (e.g., changing positions or stopping an activity when the body gives signals of pain). For example, a participant in FG3 expressed: “When I'm tired, I don't feel like doing anything and my eyes sting, so I go take a nap.”

Instrumental. Several adolescents stated having an instrumental response to bodily sensations, handling them in ways that promote the accomplishment of specific tasks or goals. Performance and evolution are goals that are particularly present in the discourse of some boys. They explain that in sporting or emotional contexts, it is sometimes necessary to divert attention from bodily sensations in order to evolve.

Some adolescents also discuss the usefulness of bodily sensations, the aim being to listen only to the sensations they consider useful and to repress or transform those they consider unnecessary, or which are not advantageous for the accomplishment of an objective, for example the good progress of an oral presentation:

> It's true that there are times when uh me too I repress the sensations I feel, so when it's also not really useful (...) I have to present something in front of the class well then I start to have a lump in my stomach and it's really not the time because I have to present my thing and it's graded and all that and so at that time I I repress a little bit what I feel inside to try to manage my stress and still present something good" (FG4)

Beliefs About BA

Finally, adolescents spoke about their beliefs regarding the utility and dangers of BA as well as the link between body sensations and emotional and physical states. Four main types of beliefs were present in the adolescent discourse, each of which is described below.

Adaptivity. Various adolescents expressed the belief that BA is adaptive because it allows them to become aware of their physical and emotional state, their needs, and their limits. It also helps them gain a better understanding of themselves.

> Participant: I don't know if it [BA] can make us feel better, but it can help us understand ourselves, which I think is always helpful.
>
> Facilitator: What do you mean by understanding ourselves?
>
> Participant: Well, for example, for the emotions, by noticing when there was an emotion and when there wasn't, we can establish causes and consequences and then know what puts us in this emotion and what puts us in another emotion and then know how we can choose the emotions we feel or things like that... (FG3)

Consequences of not Listening. Various adolescents expressed their belief that not listening to body sensations is harmful because when one does not listen to body sensations or when one suppresses them, these sensations become more intense and problematic, and may even lead to physical symptoms or an explosive reaction.

> I think it's very important to pay attention to them [emotion-related sensations] quickly enough, not always at the same time, but to pay attention to them and not to repress them, because things can really get out of hand if we wait too long... (FG4)

Good Balance. Although adolescents reported believing that BA is generally adaptive, they added that it is only adaptive under certain conditions. According to most adolescents, paying a balanced attention to body sensations is important but paying too much attention (i.e., abstract rumination, obsession, being overwhelmed by them) should be avoided.

> I think that in most cases it's [BA] useful but not in all cases like in anger for example, if you think about it too much it can make the situation worse, so it's a bit case by case that, sometimes it's useful to think about it and sometimes not...it's good to know that I'm angry, but then to be able to move on. (FG3)

Link Between States and Sensations. Most adolescents reported believing there is a link between body sensations and physical or emotional states. They spoke of body sensations as signals of particular states (e.g., hunger, emotions). They reported that most of the time, body sensations and states are coherently connected (i.e., neutral body sensations indicate a neutral emotional state) whereas other times there is a perceived incoherence (i.e., body sensations signal a state that is incoherent with what one expects to feel or experience).

> Well, I would say that the body is finally the mirror of our sensations because all the emotions that we feel in us will always be translated in our body by... a discomfort or even a pain or a stupid sensation, a tingling or something like that, it's really a mirror and even if sometimes we don't realize that both are there I think that very often both are there. (FG4)

Young Adult Results

Attention

Like adolescents, young adults also spoke about different aspects of attention to body sensations, mainly the characteristics of body sensations that most capture their attention, the moment in which body sensations are noticed, and whether sensations are attended to automatically or voluntarily.

Attention Grabbers. Like the adolescent discourse, young adults reported noticing intense and/or problematic body sensations very quickly. Several young adults reported not paying voluntary attention to their body sensations throughout the day. However, when intense (e.g., sensations of being in love, enthusiasm of going to a party) or troublesome sensations (e.g., sensations that distract them from the task they are doing) arose, they paid attention in order to understand them or take some action: “When it's

really strong sensations in the body and it's really a problem for me, I know that I'm going to really listen and then I'm going to stop doing whatever it is that's causing me that sensation." (FG1)

Temporality of Attention. Similar to adolescents, young adults described paying attention to body sensations at different moments in time. Some young adults reported noticing body sensations as they occurred in the present moment and were also capable of immediately linking the sensation to a physical or emotional state. Others reported not noticing body sensations in the moment in which they occurred, but afterwards when they were trying to make sense of their prior experience. Yet others noted not paying voluntary attention to body sensations in the moment unless the sensations were very strong, which is in line with the Attention Grabbers sub-theme described above.

> ...well if it's a negative sensation in any case, maybe the positive ones, I don't get them directly but it's afterwards when I come back maybe in a more normal atmosphere, we'll say like if I come back to my family after a night out with my friends, well I'm going to feel... well I'm going to start to understand the kinds of sensations that I had with my friends. (FG2)

Types of Attention. Two distinct types of attention were present in the young adult discourse: automatic attention (i.e., paying attention to body sensations automatically) and voluntary attention (i.e., voluntarily paying attention to body sensations). There were many examples of automatic attention, particularly in the male group, where we observed a continuum between ignoring body sensations throughout the day and being unable to disengage attention from body sensations.

> Yes, I find it difficult to get my mind off the sensations, especially the stressful ones, that my body imposes on me, for example, I recently suffered from tinnitus, during which time I thought about it all day... Generally, I have difficulty detaching my attention from my body sensations if I am not engaged in a particular task. (FG2)

Young adults also reported paying deliberate attention to body sensations throughout the day. This was most prevalent in the female group. Participants reported voluntarily paying attention to sensations during physical activity, when experiencing certain emotions, or at random moments in the day to simply come back to the present moment.

> ...several times a day, even I would say yeah several times a day anyway because almost every hour in my opinion there is at least one time when I say to myself uh where am I? Uh what is it? I mean I tell myself come back to your body or I immerse myself in the present moment through my senses or I'm trying to cut off the mind. (FG1)

Body Sensations

During the FGs, young adults spoke of the content of their BA. They spoke of the different types of body sensations they observed in their direct experience as well as the impermanent quality of body sensations.

Types. Young adults spoke about the different types of body sensations they were aware of. They identified three main categories of body sensations: (1) physical sensations (i.e., body sensations related to physiological needs like hunger; physical sensations such as pain, muscular tension or release; and body sensations coming from the 5 senses), (2) emotion-related sensations (i.e., body sensations experienced during emotional states), and (3) undefined sensations (i.e., body sensations that do not fit under the previous two categories and whose meaning or source is difficult to understand, such as an undiagnosed medical condition).

> Yes, for me there are different uh there are many different emotions or sensations that we can feel, for example there is the sensation of hunger, tiredness uh anger yes, it's as if it was linked to emotions in fact, for me the sensations can be intimately linked to emotions. (FG2)

Impermanent. Young adults (particularly men) expressed a clear awareness of the changing nature of body sensations. Some examples participants mentioned include: pressure in the body being eased by breathing, contraction turning into relaxation, and complex emotions disappearing with time.

> Participant: I have the impression that the sensations are evolving.
>
> Facilitator: What do you mean by the sensations evolve?
>
> Participant: That this pressure is evacuated by my breath… That while I am in the same room as the person who mobilizes anger in me I feel a certain pressure… and when I leave this room, I feel my body relax… The parts that I felt contracted… are relaxed and I feel that it is by breathing out that the pressure decreases. (FG2)

Processes

The young adult discourse revealed three distinct psychological processes involved in BA, mainly the labeling of, cognitive interpretation of, and attitude towards body sensations.

Labeling Body Sensations. Several young adults reported that when they experience a body sensation, they often label it as physical, emotion-related, or undefined and based on the label, they choose how to best deal with it.

> Personally, what I do is that when I feel a sensation in the body, I categorize it in itself, I make the difference between a sensation which is precisely provoked by an emotion and therefore there is the mental work to be done and thus to see a little bit what there is to do,

> the sensation which is caused by a more normal state like hunger, fatigue, thirst which can be satisfied, well-regulated in a rather direct way, and then there are sensations which are precisely a little less normal but which are not going to be linked to something emotional, which require a little more analysis... And so it is on the basis of this categorization finally that there is action or inaction which is chosen... (FG1)

Interpretation. On top of categorizing body sensations, young adults also spoke about their cognitive interpretation of body sensations (i.e., the meaning they ascribed to them). Some interpretations included: sensations as symptoms, sensations as a reminder of one's sex assigned at birth (in the case of a transgender participant), and sensations as indicators of things one does not like in life. For example, a participant in FG2 expressed: "If I realize that this sensation is a symptom, I'll tend to tell myself 'It's just a message from my body' and I'll be able to ignore it more easily." Furthermore, a couple of participants highlighted that it's not the body sensations themselves that can be problematic but one's interpretation of them.

Attitudes. Young adults spoke of different attitudinal stances toward body sensations. Three main attitudes emerged from the discourse: (1) hypervigilance-driven, (2) mindful, and (3) trusting.

A hypervigilance-driven attitude was characterized by an abstract ruminative focus on unpleasant body sensations. Young adults used words such as "a negative spiral", "an obsession", and "an over-consciousness" when describing this attitude.

> Sometimes if something happens in our body, we will want to analyze it at all costs and so on and we will want to know exactly what it is and this can turn into an obsession or we can misinterpret it or something like that and I think that it can be harmful because it makes us ruminate...(FG1)

A few young adults also spoke of instances when they mindfully approached body sensations. This kind of attitude was characterized by focusing attention on present-moment sensations without trying to change them. Of the three attitudes cited in this theme, this was the least commonly mentioned amongst young adults.

> ...almost every hour in my opinion there is at least one time when I say to myself uh where am I? Uh what is it? You come back to your body or I come back to the present moment through my senses or I try to cut off the mind... (FG1)

Finally, several young adult women spoke of a third attitude towards body sensations: trusting. This attitude was characterized by the belief that body sensations were often truer indicators of one's needs, wants, and dislikes than thoughts. From the viewpoint of this trusting attitude, body sensations were seen as a trustworthy internal compass that must be listened to.

> I find that in fact both in the example to know where we are in our cycle and to know well what corresponds to us or not uh staying in the thoughts, in the mind it doesn't give a real indicator in my opinion, so it is only the, well through the body that we have true information. (FG1)

Factors Influencing BA

This theme refers to the contextual, individual, and social aspects influencing young adults' awareness of body sensations (i.e., making them more or less aware). The young adult discourse revealed five main factors influencing their BA, each of which is described below.

Activities. Various young adults reported an increased and deliberate awareness of body sensations during particular activities such as: drinking or smoking a joint, doing sports, experiencing emotions, and before and after eating. For example, a participant in FG2 expressed: "On the other hand, when I drink or smoke a joint, I will pay attention on purpose to the sensations that appear, it will not be automatic anymore."

Sociocultural Context. Some young adults also spoke of the effect of social and cultural aspects on their BA. For instance, regarding social context, one young adult reported paying less attention to body sensations when with friends and more attention when with family. With regards to cultural context, the young adult women discourse showed that the cultural ideals of beauty made some of them hyper-aware of their body (e.g., size of breasts and hips, weight, body size). From this perspective, the young adult understanding of BA expands from awareness of internal body sensations to awareness of external body image as well.

> At the beginning of adolescence if we take for example the fact that we begin to put on... if we have very strong awareness of our body and thus we are aware of the breasts which develop or of certain shapes which appear or of certain parts which put on a little weight and we have a strong awareness of it when around us finally there are other girls who can't put on weight or that there is a model of beauty which is not validated, all of a sudden this bodily awareness, we are so aware of our body that it becomes a hyper-awareness. (FG1)

Past Experiences. Young adults (in the women's group) spoke about past experiences that augmented their BA. This sub-theme was only present in the young adult women discourse. Participants said that after experiencing medical problems (i.e., lung and back problems) they became more attentive of their bodily signals. Other participants reported that their level of BA increased greatly after receiving specific trainings or therapies (i.e., hypnotherapy and a particular training with horses).

> I had a pneumothorax...it's a small problem in the lung and it's probably the physical sensation that I felt the most... This event really increased the attention I gave to my own body, not only what I

> was feeling inside, because before that it's true that I was like everyone else only paying attention at the external physical level or to sensations of touch but that really… I started to pay attention to the slightest little pain, to the slightest little pull, the slightest, the slightest sensation really that there was. (FG1)

Physio-Temporal Context. This sub-theme refers to the influence of physical context and time of day on young adults' BA. Young adults reported being more attentive of their body sensations when in front of a mirror, in the shower, or in bed. For example, one participant in FG2 expressed: "When I shower in the morning, I feel like I pay close attention to the messages my body sends me." With regards to time of day, most young adults reported an increased BA in the morning when waking up or in the evening before sleeping. One participant mentioned deliberately paying attention to body sensations before sleeping in order to fight insomnia.

Mood or State. A few young adults reported that their mood or state influenced their level of BA. For instance, sensations became more intense when in a state of fatigue leading to increased BA. Furthermore, another participant mentioned that one's mental state can define whether BA is helpful or not.

> If, well if I'm tired basically uh it's, the sensations are going to be stronger in fact and uh well the negative situations I'm going to be even more sensitive to them and if they are positive it won't change. (FG2)

Reactions to Body Sensations

In line with categories of body sensations outlined above, young adults reported reacting to body sensations in a specific way depending on the type of sensation they experienced.

Reactions to Physical Sensations. This sub-theme refers to how young adults react to body sensations related to physiological needs or physical pain. Similar to adolescents, young adults generally approached physical sensations by using a method of problem-solving. More specifically, if a particular body sensation indicated a physical need (e.g., hunger), then they met the need (e.g., eat); if a sensation indicated that something was wrong (e.g., pain), then they found a solution (e.g., stretching, massaging). For physical sensations that could not be resolved so easily (e.g., menstruation-related sensations), the approach was to simply do nothing and go on with one's day despite the discomfort.

> …when I have my period for example, because it's true that it's a state where I'm totally conscious of what's going on but I don't do anything about it, I don't know how to say it, I try to go on with my life with the inconveniences (laughs). I think it's really a particular moment where I try to get over it and to uh, because there's not much you can do about it (unintelligible). (FG1)

Reactions to Emotion-Related Sensations. Regarding reactions to body sensations linked to emotions, the young adult discourse was very rich. In contrast to physical sensations that could be easily "fixed" or "solved", young adults reported that handling emotion-related sensations was less straightforward. They hence reported a diversity of reactions to emotion-related sensations. The problem-solving approach was still present as various young adults talked about analyzing their emotion-related sensations (i.e., thinking about their source) in order to act and attenuate the sensations. For example, a participant in FG2 expressed: "…when it's an angry feeling and so on, trying to think about it, to see why it's there, how, what can we do to solve it. And if it can help us to calm down this feeling…"

When the problem-solving approach did not work (e.g., when feelings were intense), young adults used other methods such as simply accepting the emotion-related sensations (i.e., letting them follow their course and not doing anything to change them): "…a grief that you can't really uh do anything about, it's more interesting to get over it." (FG2) Another method used was approaching the sensations (i.e., feeling what you feel). Several young adults reported having difficulties dealing with unpleasant sensations linked to negative emotions. In these cases, some participants reported feeling submerged or taken over by the sensations:

> In general, what blocks me more physically speaking is especially when it's emotions, often sadness or things like that, and there, well, that blocks me and, uh, I don't know how to do anything when I'm sad, or let's say I'm dumped, or something like that, well, I wouldn't be able to eat, or things like that, and, uh, and that's where I feel it much more in relation to emotions. (FG1)

Other participants reported trying to avoid feeling these sensations altogether: "I find that there are more sentimental sensations or even bodily sensations…which are better to put blinders on because sometimes they can do more harm than anything else…" (FG2)

Finally, some participants talked about reacting to emotion-related sensations by using the body to regulate the intensity of their emotional experience.

> I think that for example if I am angry well I will go to well be alone somewhere, to calm this anger all alone, I don't know I will try to run or to make a physical movement to try to release a little this anger which is in me by putting energy into what I am doing with my body, to expend this anger… (FG2)

Reactions to Undefined Sensations. A few young adults spoke about their reactions to undefined sensations (see above for definition). Once again, different young adults reported different reactions. Some engaged in negative thinking and their mood was affected; others took action in order to improve their situation and alleviate the sensations associated with it; and yet others tried to analyze the sensations to find a solution.

> There are sensations that are a little less normal but that are not linked to anything emotional, that require a little more analysis and to see in the long term what, what I can do, is it maybe linked to the contraceptive pill, is it linked to a state that I am not aware of, is it linked to something else. (FG1)

Mind-Body Connection

One of the themes that emerged from the young adult discourse was the notion of the mind and body as separate yet connected entities, with a tendency to listen more to the body rather than the mind. Two sub-themes emerged from this theme: an understanding of the mind and body as separate and an understanding of the interconnectedness between body sensations, states, and thoughts.

Mind-Body Distinction. The young adult discourse, particularly that of young adult women, showed an understanding of separation between the body and mind. Since the two were perceived as separate, one could choose which one to trust and listen to. There was a general tendency to listen to and trust the body (i.e., bodily signals) rather than the mind (i.e., thoughts).

> It's only through the body that we have real information, so it's useful for me to know where I am in my menstrual cycle, in particular so I don't pay as much attention to the thoughts that I have at certain moments of my menstrual cycle, so typically when I'm approaching my period, when everything is going wrong and it's the end of the world and I'll never get to the end of my master thesis, etc. (laughs) I can say to myself: "Oh, okay, I'm having sensations that indicate to me that there's something talking up there, but we're not going to believe it," and this allows me to know what is useful in my life and what isn't, in terms of what my mind is telling me. (FG1)

Sensations, States, and Mind. This sub-theme revealed young adults' conceptual and experiential understanding of the interconnectedness between body sensations, states (e.g., emotions or physical states like tiredness), and thoughts. Most young adults agreed that body sensations and states (both mental and emotional) were like two sides of the same coin, one could not exist without the other. However, one could choose to pay attention to the different elements of experience (i.e., sensations, emotions, and thoughts) separately. Some young adults discussed that becoming aware of their body sensations often helped them understand the emotional state they were in, whereas others explained that becoming aware of their emotional state instigated them to attend to their body sensations. Yet others found it difficult to experientially make the connection between body sensations and emotions. Finally, one participant also mentioned that emotion-related body sensations could be induced by thinking certain thoughts (e.g., like in gratitude practices).

> I think that the three [body sensations, emotions, and thoughts] are articulated but that one can pay attention to these elements

> separately... That the three influence each other all the time but that it is possible to focus on one of the three, even if all three are mobilized all the time, in my opinion. (FG2)

(Mal)adaptivity of BA

This theme addresses the question of whether young adults perceive BA as adaptive or maladaptive. Young adults described specific situations in which it was adaptive to be aware of one's body sensations and situations in which BA was maladaptive or even dysfunctional.

Adaptive. Young adults mentioned numerous reasons why BA was adaptive for them. They reported that BA was adaptive for the following: emotion regulation, savoring pleasant sensations, respecting the body's limits, preventing severe physical problems (e.g., severe back pain) or injuries, understanding one's emotions, choosing what action to take, anticipating one's menstrual cycle, choosing what one wants and does not want in life, working with horses, finding a healthy balance, getting to know oneself, and indicating when one is stressed. One participant shared how BA helped her recover from eating-related issues.

> Personally, being aware of my body has helped me a lot to get out of destructive spirals, you know, especially in adolescence, 14-15 years old, in terms of eating habits, it is sometimes problematic, so personally I had a phase that was more problematic in that respect and uh we'll say that I lost a lot of weight intentionally but it was in fact negative in the end and it is after being aware again of my body that told me ah finally stop here or don't force this thing or at that level you are fine, that I was able to reconcile myself with my body but also mentally that allowed me to have a better balance.... (FG1)

Maladaptive. Young adults engaged in a rich discussion regarding whether BA is maladaptive. Some participants could not think of any situation in which BA was maladaptive. Others, however, gave examples of moments in their lives when paying attention to body sensations led to negative outcomes. Some examples include: when attending to unpleasant body sensations leads to dark ideas and dysphoria (e.g., in the case of a transgender person whose body sensations were a constant reminder of their sex assigned at birth); when BA becomes obsessive and hypervigilant (e.g., in the case of eating-related issues); and when it leads to unconstructive rumination (e.g., constantly asking oneself why one has a certain body sensation). In the young adult women group, the conclusion was that BA itself was not maladaptive but the way one "reads" body sensations and how these sensations relate to the external context determine whether it is adaptive or not.

> I don't put the word harmful on the bodily sensation as such...and on the fact of paying attention to one's body, it's rather uh the reading that we make of it because if we are always blocked there and always trying to analyze it, to understand and all that, and that we go round

> and round trying to analyze the sensation of which we are conscious, well for me it's a little bit that which is harmful in fact but not the sensation or the awareness itself. (FG1)

3.4 Discussion

The purpose of the present study was to explore adolescents' and young adults' understanding, experience, and description of BA using a qualitative approach. The analyses of four FGs with adolescents and young adults revealed a multidimensional and highly contextualized understanding and experience of BA across age and gender. Several layers of BA were discussed starting with the content of BA: body sensations that were categorized similarly across groups (i.e., sensations related to emotions or physiology). Then, there was the dimension of attention paid to the content of BA which was contingent upon various factors such as the intensity and valence of body sensations (i.e., intense and unpleasant sensations were noted quicker and more often). Next, were the cognitive, emotional, and behavioral reactions to these sensations that were colored by a particular attitude (e.g., mindful and accepting or avoidant and obsessive). The previous layers were embedded in a larger layer, beliefs about BA. There was, for example, the general belief that awareness of body sensations in itself was adaptive, but the particular combination of the different aspects of BA (e.g., interpretation, attitude, reaction, and context) could render it maladaptive. Finally, there was an overarching layer of physical, temporal, mood-related, social, and cultural contexts which affected all other layers (e.g., body sensations were more intense and attended to when doing certain activities like sports or smoking; an obsessive attention to bodily signals was fostered in a culture that promoted a particular body image). The understanding of BA that emerged from the youth's discourse is in line with models of BA emphasizing its multifaceted nature (Cioffi, 1991; Farb et al., 2015; Mehling et al., 2012; Suksasilp & Garfinkel, 2022). Figure 5 illustrates a summary of the above explanation.

An important take-away from the present study's results is that BA is a multidimensional and complex concept in the eyes of this group of young people. As mentioned in the introduction, we set out to explore three dimensions of BA: interoceptive attention, self-report and interoceptive beliefs, and attributions of interoceptive sensations. Our results reveal that not only is the BA concept multifaceted, but so are its dimensions.

Regarding interoceptive attention, results show that the tendency to pay attention is affected by many factors. First, the saliency of the bodily stimulus is important. There is a greater tendency to attend to intense body sensations and ignore non-salient sensations. Second, the external context plays a role in participants' tendency to attend to their body sensations. A non-salient external context increases the tendency to attend to internal body sensations. For example, attention to the body becomes stronger before sleeping when there are fewer external stimuli competing for attention. Third, past experiences

seem to shape young people's tendency to attend to their bodily signals, with those who had participated in mind-body therapies and those who had experienced medical issues, having a greater tendency to attend to bodily signals, regardless of saliency and context.

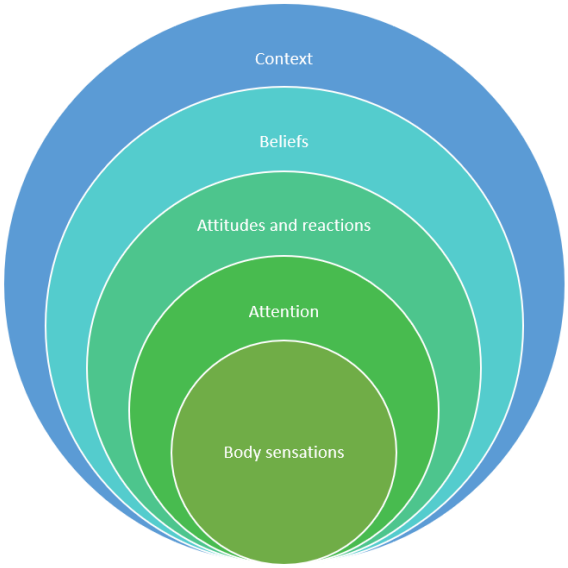

Figure 5. An illustrated summary of youth's understanding and experience of BA as a multifaceted construct

This suggests that the conscious tendency to attend to bodily signals is malleable and can be trained. These observations are in line with Cioffi's (1991) reflections on somatic attentional strategies. Finally, young people reported that their tendency to attend to body sensations was affected by their socio-cultural context, adding a relational and cultural layer to interoceptive attention that has been studied a bit in adults but less so in youth (Arnold et al., 2019; Freedman et al., 2021; Ma-Kellams, 2014; Zhou et al., 2021). Regarding relational contexts, participants reported attending to their body sensations less when interacting with friends, which is in line with the claim that social situations reduce BA by shifting attention externally rather than internally (Arnold et al., 2019). Future research could explore the impact of BA on social connection in youth, a period of life in which peer relationships take on a special importance (King et al., 2018; Klimes-Dougan et al., 2014; Silvers, 2022). Regarding cultural context, female participants in the young adult FGs explained the impact that cultural messages about beauty ideals had on their BA. Future research could further assess cultural differences in BA in youth. For instance, would youth from East Asian cultures where BA is more emphasized (Ma-Kellams, 2014), have more tendency to attend to their body sensations than youth in Western cultures?

Results also inform the dimension of self-report and interoceptive beliefs, a broad category including a person's subjective experiences of and beliefs about body sensations and BA (Suksasilp & Garfinkel, 2022). This dimension has been previously criticized for being ambiguous, overly focused on accuracy (i.e., how accurately people think they perceive body sensations), and not paying enough attention to how (i.e., with what attitude) people pay attention to body sensations (Mehling, 2016). The aspect of attitude emerged in all FGs, underlining its importance in youth's experience and understanding of BA. A variety of attitudes were mentioned (e.g., hypervigilant, mindful, avoidant, trusting, etc.). These attitudes were linked to youth's beliefs about BA's adaptivity. There was a general belief that BA is maladaptive when it is characterized by a ruminative and hypervigilant attitude, but that it is adaptive when one pays attention openly and receptively. According to various participants, this open and receptive attitude can provide important information about oneself. These reflections on attitude and adaptivity echo Mehling and colleagues' conceptual framework for adults aiming to distinguish between adaptive and maladaptive forms of BA in a clinical setting (Mehling, 2016; Mehling et al., 2009, 2012). Empirical research in adults has indeed shown that heightened BA can lead to both negative (e.g., hypochondriasis, somatization, and anxiety disorders; Aronson et al., 2006; Barsky et al., 1988; Barsky & Klerman, 1983; Cioffi, 1991; Olatunji et al., 2007) and positive outcomes (e.g., increased subjective well-being, pain attenuation, and enhanced emotion regulation ; Ferentzi et al., 2019; Gard et al., 2012; Hölzel et al., 2011), and a key feature explaining these opposing outcomes may be attentional style or attitude (Mehling, 2016).

Regarding the third dimension, attributions of interoceptive sensations (i.e., people's appraisal of perceived bodily signals; Suksasilp & Garfinkel, 2022), the present study found a diversity of appraisals in youth. These appraisals can be summarized into three categories: body sensations indicating a physiological need or a medical issue, body sensations indicating an emotional state, and a miscellaneous category of body sensations associated with neither of the latter two (referred to as undefined sensations). This appraisal or automatic categorization motivated the response to perceived body sensations. Generally, physiological needs were listened to (e.g., sleeping when sleepy), emotion-related sensations were analyzed, avoided, suppressed, or accepted, and undefined sensations were analyzed and sometimes led to preoccupations. The two categories that youth reported struggling with most were emotion-related sensations and undefined sensations. Difficulties with the appraisal and coping of emotion-related sensations can be understood in the context of developmental literature showing that brain regions involved in higher-order emotion regulation are still developing during adolescence and emerging adulthood making youth more vulnerable to emotion dysregulation (Ahmed et al., 2015; Casey & Caudle, 2013). Results further show that the way young people interpret and respond to perceived body sensations may differ across individuals. For instance, for a transgender participant, certain body sensations were appraised as reminders of their sex assigned at birth, leading to negative thinking and a negative mood. To shed more light on individual differences in attributions of

interoceptive sensations, future research could conduct qualitative and quantitative studies in specific groups of youth, such as in LGBTQIA+ youth and in youth with psychological difficulties such as eating and anxiety disorders.

On top of informing the three dimensions of BA mentioned in the introduction, the FG results provided information on potential developmental and gender differences in BA. As the data was not specifically collected or analyzed to assess developmental or gender differences, the differences explained below can be seen as observations that need to be tested in future research.

Regarding developmental tendencies, we observed that young adults exhibited a more nuanced and complex understanding of BA. This is visible in the number of themes that emerged from the young adult discourse versus the adolescent discourse (7 versus 4). Although the overarching themes overlapped between the two groups, they were more developed in the young adult group. Overall, the young adult discourse reflected a greater BA across contexts as well as a greater ability to attribute meaning to these sensations. Greater self-reported BA in young adults versus adolescents may be attributed to different reasons such as developmental changes (Li et al., 2017; May et al., 2014) and greater exposure to BA-enhancing experiences in young adulthood (e.g., BA trainings, body-based psychotherapy, etc.). Little is known about the developmental trajectory of BA during adolescence and the transition to young adulthood. Preliminary research suggests different developmental trajectories for different interoceptive processes. Children (as young as the age of six), adolescents, and adults activate the same brain regions during a heartbeat detection task measuring interoceptive accuracy (Klabunde et al., 2019). However, brain regions associated with the metacognition of interoceptive processes continue to develop with age (Klabunde et al., 2019; D. Li et al., 2017), which is in line with the present study's observations. Another potential reason for the observed difference could be that young adults have a richer vocabulary to talk about BA than adolescents which would indicate a difference in verbal capabilities but not necessarily interoceptive abilities. In short, the present research suggests an increased and more contextualized self-reported BA in young adults than in adolescents, in this sample. However, this observation needs to be empirically tested using quantitative approaches with self-report measures but also behavioral and neural measures to control for verbal capabilities.

We also observed gender differences in the understanding, experience, and description of BA. This is evidenced by the fact that five of the sub-themes were only present in the women's discourse. Furthermore, female participants used more nuanced and differentiated vocabulary to describe their bodily experiences. Based on the themes, female participants displayed a greater awareness of the kinds of sensations they paid attention to (e.g., not simply intense but also novel and problematic), a more trusting attitude toward their body sensations, a greater history with medical and emotional issues and body therapies that helped, and a greater awareness of the connection and distinction between the mind and the body. Hence, in this sample, female participants reflected

higher BA. These findings are in line with research on gender differences in interoception in adults which shows that women have higher interoceptive sensibility than men (Longarzo et al., 2021), particularly when it comes to noticing body sensations and linking them to emotions (Grabauskaitė et al., 2017). These gender differences have been theorized to derive from the fact that women experience more hormonal and physical changes throughout their lives than men (e.g., menstruation, pregnancy, menopause) making them more attentive to internal bodily signals (J. Murphy, Viding, et al., 2019). The FG results support this theory as young women spontaneously discussed menstruation as an important time in which they paid attention to their bodily signals. Hence, the present study's observations are in line with previous findings on gender differences in interoception in adults but future qualitative and quantitative studies should test this hypothesis in a representative population of youth.

Finally, the researchers made observations on the way young people spoke about BA. The language used was simple and concrete. Words such as "body sensations" were not immediately understood by all participants, so the facilitator needed to provide explanations and concrete examples. Often terms like "emotions" and "body sensations" were used interchangeably. These observations on language may have implications for future research described next.

Overall, our results show that the phenomenological experience and understanding of BA in youth is multidimensional, concrete, may be increasingly nuanced with age, and may be influenced by gender. This has implications for future theoretical frameworks and self-report measures for youth. The first implication is that it is important for future theoretical frameworks and self-report measures to be multidimensional to capture the complexity of the BA construct. Three important dimensions that arose from the FGs with youth were: the tendency to pay attention to body sensations and the many factors influencing this, the attitude with which one pays attention and its importance in determining whether BA is adaptive or not, and the diversity of reactions to body sensations depending on how they are appraised. A second implication is that since there may be gender and developmental differences in BA, which need to be confirmed in future studies, future and existing BA self-report measures for youth should be tested for measurement invariance across age and gender. A third implication is that since youth may lack the vocabulary to talk about BA, future self-report measures must use concrete and simple language, with short explanations for psychological terms such as "emotion" and "body sensations". By using theoretical frameworks and self-report measures tailored for youth, research will be able to better understand the developmental trajectories of BA in youth. This in turn could paint a clearer picture of the role of BA in the development, treatment, and prevention of psychopathology in youth.

These results must be considered in light of the present study's limitations; mainly that the FGs were done online, so important non-verbal information such as body language was lost; and communication amongst FG participants was sometimes affected by technological difficulties. Second, the FG facilitators were all women, which may have

favored open expression in the female groups but hindered free expression in the male groups. Third, inherent to the qualitative nature of the study, results are not generalizable, and the sample is not representative of diverse groups and gender identities. Future research could explore similar questions in youth of other ethnicities, nationalities, socio-economic status, and gender identities. Furthermore, quantitative research approaches could be used to address the issues of generalizability and sample representation.

Future directions for the current line of research include using the findings that emerged from the present study to inform interoceptive theoretical frameworks for youth and to develop a self-report instrument to measure BA in youth. This will further the understanding of the development of BA in this age group, the link between BA and mental illness, and the role of BA in psychological interventions in youth.

Chapter 4.

A Mindful Body Awareness Questionnaire for Youth: Development of a body awareness questionnaire tailored to a population of adolescents and young adults

Background. Body awareness (BA) is a multifaceted construct defined as attending to and being aware of body sensations. It can be adaptive or maladaptive depending on the attitude with which one pays attention to body sensations. Adaptive BA is characterized by a mindful attitude and has been associated with increased subjective well-being and reduced psychological symptom severity. Despite its crucial role in mental health and psychological interventions, there are no questionnaires measuring adaptive BA designed specifically for adolescents and young adults (AYAs). Hence, the objective of this research was to develop a short BA questionnaire tailored to AYAs (ages 14-24).

Method. To achieve this aim, we: (1) conducted focus groups with AYAs and psychologists working with this age-group, to gain insights into the dimensionality of BA in this population, (2) drafted a questionnaire and pilot tested it to assess item comprehension (N = 30), (3) refined the questionnaire using Exploratory Factor Analysis (N = 454), and (4) evaluated the psychometric properties of the questionnaire in a large sample of AYAs (N = 752).

Results and Conclusions. The research resulted in an 18-item questionnaire called the Mindful Body Awareness Questionnaire (MBAQ) consisting of three dimensions with sound psychometric properties: equanimity (i.e., relating to body sensations in a non-judgmental, open, and non-reactive way), listening (i.e., approaching body sensations and considering them important sources of information), and non-avoidance (i.e., facing rather than avoiding body sensations). The MBAQ may be a useful measure for researchers and practitioners who would like to study BA in AYAs.

Reference

Pérez-Peña, M., Notermans, J., Barbot B., & Philippot, P. (2024). A Mindful Body Awareness Questionnaire for Youth: Development of a Body Awareness Questionnaire Tailored to a Population of Adolescents and Young Adults [Manuscript submitted for publication]. Department of Psychology, UCLouvain.

4.1 Introduction

Body awareness (BA), or one's ability to sense, interpret, and integrate body sensations, is an integral part of life (Khalsa et al., 2018). Research has shown that it plays an important role in physical health and psychological well-being (Quadt et al., 2018). Despite its essential influence on overall health, there are few measures of BA developed for adolescents and young adults between the ages of 14 and 24 (AYAs), a stage of life marked by many physical, psychological, and social changes (Dahl et al., 2018). Adolescence and young adulthood are also periods of psychological vulnerability with 50% of mental health disorders beginning by the age of 14, and 75% beginning by the age of 24 (World Health Organization [WHO], 2021). Unfortunately, the dearth of psychometrically sound, age-appropriate measures has limited the advancement of BA research in AYAs.

What Is Body Awareness?

The term BA, as used in the present paper, is part of the larger umbrella term known as interoception. Interoception has been recently defined as "the top-down and bottom-up processes by which an organism senses, interprets, and integrates signals from within itself and below the skin, across conscious and nonconscious levels" (Desmedt et al., 2023, p. 12). While various theoretical models of interoception have been developed in the past decades (e.g., Desmedt et al., 2023; Khalsa et al., 2018), the present paper uses Suksasilp and Garfinkel's (2022) recent model to situate the BA construct. This model adopts a multi-dimensional view of interoception with each dimension representing a different level of processing presented on a continuum from lower levels of processing (e.g., central nervous system activity) to higher levels of processing (e.g., interpretation of body sensations). The present research focuses on higher-order processing dimensions accessible to conscious awareness and best measured by self-report questionnaires, namely, one's beliefs about body sensations (i.e., self-report and interoceptive beliefs), one's tendency to pay attention to body sensations (i.e., interoceptive attention) and one's interpretation of body sensations and why they arise (i.e., attribution of interoceptive sensations). We use Mehling et al.'s (2011) definition of BA which integrates these three dimensions: the subjective, phenomenological and conscious experience of body sensations shaped by complex psychological processes such as attention, attitude, interpretation, and beliefs.

Body Awareness and Mental Health Outcomes

From a clinical psychological perspective, the role of BA in mental well-being must be seen from a nuanced perspective. The literature distinguishes between two categories of BA: BA that contributes to well-being (known as adaptive) and BA that contributes to ill-being (known as maladaptive; Mehling et al., 2009). This distinction is determined by how one pays attention to body sensations (i.e., one's attentional, emotional, and

cognitive reactions to perceived bodily signals; Mehling et al., 2012). Paying attention to body sensations in an anxiety-driven, judgmental, and avoidant manner may be maladaptive, whereas paying attention to body sensations in a mindful, open, and accepting manner may be adaptive (Flasinski et al., 2020; Mehling, 2016; Trevisan et al., 2021).

BA is differentially related to mental health outcomes depending on its attentional style. Adaptive BA (as measured by the Body Awareness Questionnaire; Shields et al., 1989) has been positively associated with subjective well-being (i.e., positive mood, relaxation, activity, sleep quality) and negatively associated with symptom reports in a population of young adults (Ferentzi et al., 2019). Adaptive BA has also been associated with positive body image in adolescents. Specifically, adolescents between the ages of 13 and 16 who had a better capacity to regulate attention to their body sensations, attend to these sensations with an attitude of trust, and use these sensations to regulate distress, (as measured by the Multidimensional Assessment of Interoceptive Awareness [MAIA]; Mehling et al., 2012), were more able to appreciate and respect their bodies (Todd et al., 2019).

Maladaptive BA, on the other hand, has been associated with negative mental health outcomes. For example, BA characterized by distrust in body sensations (as measured by the MAIA; Mehling et al., 2012) was associated with eating disorder symptoms (Brown et al., 2020). Furthermore, in a mixed sample of autistic and non-autistic 6 to 18-year-olds, maladaptive BA (as measured by an adapted version of the Awareness subscale of the Porges Body Perception Questionnaire [BPQ]; Porges, 1993) was significantly correlated with anxiety and was the best predictor of anxiety symptoms (Palser, Fotopoulou, et al., 2018). This result can be explained by the fact that excessive attention to anxiety-related body sensations may increase anxiety, which in turn may amplify the physiological signals of anxiety, creating a vicious cycle (Trevisan et al., 2021). If this excessive attention is also accompanied by threatening and catastrophic interpretations, as is often the case in anxiety disorders, increased attention to body sensations may lead to greater distress (Palser, Fotopoulou, et al., 2018).

The above findings suggest that BA plays an important role in AYAs' well-being, with adaptive BA leading to positive outcomes, and maladaptive BA leading to negative outcomes. Despite its important role in promoting AYAs' well-being, very little is known about BA in AYAs.

The Scarcity of BA Measures for AYAs

An important potential reason for the dearth of BA research in AYAs is the scarcity of validated measures developed for this age group. Many existing studies have used BA questionnaires developed for adults to answer their research questions about adolescents. For example, Todd et al. (2019) used the MAIA for adults (Mehling et al., 2012) to study the link between body image and BA in adolescents. Similarly, Palser et al. (2018) adapted

the Awareness subscale of the BPQ (Porges, 1993) originally developed for adults, to study BA in a population of autistic children and adolescents. As a final example, Perkins et al. (2021) used the Interoceptive Deficits Subscale of the Eating Disorders Inventory (EDI-3; Garner, 2004), developed for adults, to assess interoceptive deficits in adolescents with eating disorders. However, the dimensionality of the three versions of the EDI, was not confirmed in a sample of adolescent girls (García-Grau et al., 2010). Using adult BA measures in AYAs may not be appropriate as BA may differ with age and have different implications across stages of life (J. Murphy et al., 2017).

The above-mentioned examples reflect a need for BA self-report measures for AYAs. The general trend in interoception literature (and in psychology more generally) is to group children with adolescents, and young adults with older adults in the development of self-report measures (e.g., Jones et al., 2020; Vlemincx et al., 2021). However, this way of grouping developmental stages disregards the longstanding debate of the age boundaries that define adolescence (Sawyer et al., 2018). Adolescence is an evolving construct that can be generally defined as the period of life between childhood and adulthood (Jaworska & MacQueen, 2015). Adolescence begins with puberty, which generally has its onset at the age of 10 for girls and at the age of 12 for boys (Dahl et al., 2018). The end of adolescence is less clear-cut as it is not only defined by biological changes but also by the taking up of adult roles (e.g., a full-time job, starting a family, etc.; Dahl et al., 2018; Jaworska & MacQueen, 2015), which has been recently argued to start in the mid-20s and referred to as emerging adulthood (Arnett, 2000). The present study adopts this conceptualization of adolescence and emerging adulthood and focuses on the age range of 14-24 years.

To our knowledge, there are only two BA self-report measures validated in a population of youth. The first is the MAIA youth, which measures BA in a multidimensional way, and was adapted and validated in children and adolescents between the ages of 7 and 17 (Jones et al., 2020). The second one is the Bodily Awareness subscale of the Emotion Awareness Questionnaire revised (EAQ-R), which measures the dimensions of emotion awareness in children and adolescents including the "the physiological aspects of the emotion experience" (Rieffe et al., 2008, p. 757).

Both measures have important limitations. The MAIA for youth was initially developed for an adult population and was then adapted for youth by changing specific words and phrasing in the items (A. Jones et al., 2020b). However, the language and items themselves may remain overly complex as they reflect the experiences and wording of adults who were experienced in body-based practices. The Bodily Awareness subscale of the EAQ-R adopts a narrow conception of maladaptive BA that does not consider the nuances, dimensions, and adaptive qualities of BA. It asks participants to report on their awareness of body sensations during a negative emotional experience (Rieffe et al., 2008). All items in the subscale are reverse scored meaning that less awareness of the physiological experience of emotions is considered an indicator of emotional awareness. This conceptualization of BA does not consider *how* one pays attention to body sensations,

which, as described above, is a key aspect in determining whether BA is adaptive or maladaptive. In short, there is a need for BA measures specifically tailored for AYAs, with a language that is accessible, items that reflect AYAs' lived experiences of BA, and with a focus on the adaptive aspects of BA.

A New Measure of Mindful Body Awareness

Given the beneficial effects of adaptive BA on AYAs' mental health and given the scarcity of BA conceptualizations and measures for AYAs, the present study aims to introduce a construct of adaptive BA relevant to AYAs, and to develop a questionnaire measuring this construct. Our construct of interest is mindful body awareness (MBA), an adaptive BA inspired by the BA trained in mindfulness-based interventions (MBIs). MBIs are programs that involve a systematic training in mindfulness meditation practices (R. S. Crane et al., 2017) and have been shown to improve adaptive BA (e.g., Bornemann et al., 2014; Pérez-Peña et al., 2022). MBIs train a particular kind of BA characterized by a "being" mode of mind, which involves a direct and intimate experience of body sensations in the present moment, defusing from cognitive evaluations of these sensations, and allowing body sensations to be exactly as they are (Segal et al., 2018).

We define MBA as paying attention to emotion and non-emotion related body sensations with an open and curious attitude and integrating this information into complex psychological processes, such as self-regulation. The first part of this definition (i.e., attention and attitude) is inspired by Bishop et al.'s (2004) operational definition of mindfulness and by Lindsay and Creswell's (2017) Monitor and Acceptance Theory, which posit that mindfulness has two main components: (1) ongoing attention to present-moment experience (i.e., attention monitoring) and (2) an attitude of non-judgment, openness, and equanimity toward present-moment experience (i.e., acceptance). The MBA construct applies these two components of mindfulness to the experience of body sensations exclusively and does not include other internal (e.g., thoughts) or external experiences (e.g., sights).

The second part of the MBA construct definition (i.e., integration into complex psychological processes) is inspired by MBI and interoception literature. MBIs teach skills that go beyond mindfulness, such as the ability to listen to body sensations and use body sensations to self-regulate and to choose what action to take next (Lindsay & Creswell, 2017; Segal et al., 2018). Concerning the interoception literature, other conceptualizations of adaptive BA include components such as listening to the body, using BA for self-regulation, and trusting the body as dimensions of the BA construct (Mehling et al., 2012). Moreover, these are the dimensions that consistently and significantly improve after MBIs and that explain the positive effects of a mindfulness training on psychological symptoms (Bornemann et al., 2014; Pérez-Peña et al., 2022). Therefore, the dimension of integration of bodily information with the intention to self-regulate was deemed an important part of the MBA definition. In short, the MBA construct we seek to measure includes aspects of attention, attitude, and self-regulation.

The Present Study

We used a systematic mixed methods approach to develop the Mindful Body Awareness Questionnaire. The first step involved conducting focus groups with AYAs and psychologists who work with AYAs to access youth's experience, understanding, description, and vocabulary of BA. The results of these groups informed the dimensionality of the MBA construct and the language of the items. A pool of items was then developed and tested in an iterative process involving cognitive interview testing, exploratory factor analysis, confirmatory factor analysis, and validity and reliability tests, culminating in a final version of the MBAQ.

The questionnaire was developed, pre-tested, and validated on three different samples in three studies described below. All studies were approved by the Ethical Committee of the first author's university (Projet2020-07; approved on January 29th, 2020). All participants electronically signed informed consent forms prior to the start of each study, including permission to publish the results and to audio-record and transcribe interviews where applicable. In addition, participants below the age of 18 sent signed parental consent forms. All studies were conducted in French. Therefore, the sections below present the English translation of the French items. The French items can be found in Appendix D S11: French and English items of the chosen MBAQ three-factor model with 18 items alongside their standardized CFA factor loadings.. An overview of the three studies' methods, samples, and procedures can be found in Table 7.

Table 7. Overview of methods and procedures

Sample	1	2	3
Source	Social media & acquaintances	Social media & psychology students	Social media & psychology students
N	30	454	752
% female	63	85	65.4
Mean age	17.2	20.91	19
Age range	14-24	16-24	14-24
% adolescent (14-17 years old)	63	2.2	36
% Belgian	83	87	51.9
% Secondary school	63	14.5	48.7
% French as mother tongue	100	92	89.9
Method/analysis	Cognitive interview testing; mixed methods	Item analysis; EFA	CFA, MG-CFA, internal consistency, test-retest reliability, criterion validity

Note. N = sample size; EFA = Exploratory Factor Analysis; CFA = Confirmatory Factor Analysis; MG-CFA = Multi-group Confirmatory Factor Analysis

4.2 Study 1: Item Development and Pre-Selection

Conceptual Framework

Focus groups with AYAs and psychologists who work with AYAs were conducted to explore youth's subjective understanding, experience, and description of BA. The results of the focus groups (FGs) with AYAs can be found in Pérez-Peña et al. (2023). In short, the themes that emerged from the FG analysis can be summarized into five general dimensions: (1) attention to body sensations, (2) types of body sensations, (3) attitudes and reactions to body sensations, (4) beliefs about BA, and (5) an overarching physical and socio-cultural context encompassing the aforementioned elements. This framework informed the subsequent selection and drafting of questionnaire items.

Among the five general dimensions outlined above, two were consistent with the components of the MBA construct described in the MAT (Lindsay & Creswell, 2017): attention to body sensations, and attitudes and reactions to body sensations. Since the research team deemed these two dimensions as too large and open-ended for the drafting and pre-selection of items, the dimensions were further sub-divided based on relevant themes that emerged in the AYAs' FGs (see Pérez-Peña et al., 2023).

The attention to body sensations dimension was kept as a single dimension. The dimension of attitudes and reactions to body sensations was divided into two distinct dimensions, namely (1) attitudes and reactions to body sensations and (2) regulatory aspects. Attitudes and reactions were included in the same general dimension because the concepts overlapped and often occurred simultaneously (e.g., an attitude of trusting co-occurred with a reaction of listening to bodily signals). However, despite the link between attitude and reactions, the FG thematic analyses revealed that the two did not fully overlap conceptually as an attitude is more passive and involves a way of witnessing (e.g., a trusting attitude to body sensations), whereas a reaction is more active and involves an action (e.g., listening to one's sensations of fatigue and resting). Correspondingly, the general dimension of attitudes and reactions was sub-divided into two sub-dimensions: (1) attitudes toward body sensations and (2) reactions to body sensations.

The regulatory aspects dimension refers to a specific reaction to body sensations involving self-regulation through BA as described in Mehling et al.'s (2012) conceptualization of BA. It was separated from the reactions to body sensations sub-dimension because, as presented in the introduction, this self-regulatory aspect is an important component of adaptive BA (Mehling et al., 2012) and of our MBA construct. Furthermore, there were distinct FG themes and sub-themes referring to the self-regulatory aspects of BA, such as being able to connect one's bodily state with one's psychological state (e.g., body sensations of tension and pressure as indicators of stress), and the ability to use body sensations to regulate oneself (e.g., using physical movement to reduce emotional arousal). Inspired by these themes, the research team sub-divided the regulatory aspects dimension into two sub-dimensions: (1) linking psychological states

and body sensations and (2) using BA to regulate oneself. The resulting initial conceptual framework can be found in Table 8.

Table 8. The initial conceptual framework

1)	**Attention**: the ability to regulate attention to and from emotion and non-emotion related body sensations.
2)	**Attitudes and reactions to body sensations**: the attitude one has towards body sensations, which then translates to a reaction of exploring with curiosity as opposed to distracting oneself, avoiding or grasping.
	a. ***Attitudes***: The way one pays attention to body sensations (e.g., with openness and curiosity or with hypervigilance).
	b. ***Reactions***: the way one reacts to body sensations (e.g., accepting, distracting, etc.).
3)	**Regulatory aspects**: The capacity to use body awareness to identify and regulate psychological states (e.g., fatigue, moods, emotions, etc.) and make decisions on how to act. This dimension builds on the reactions aspect of body awareness and focuses on adaptive ways of reacting to regulate oneself.
	a. ***Linking psychological states and body sensations***: making the connection between how one feels (e.g., an emotion) and the sensations in one's body.
	b. ***Using the body to self-regulate***: using body awareness to regulate psychological states (e.g., using awareness of breath to calm oneself down).

Method

Item Development and Pre-Testing

The research team created an initial pool of items that reflected the dimensions and sub-dimensions described in Table 8. The item pool was created on the basis of two sources: (1) items that were drafted by the research team based on the language used by AYAs in the FGs, and (2) items retrieved (and some adapted) from relevant BA and mindfulness questionnaires (see Appendix D S1). Items were developed and refined by the research team, which included experts in the field of mindfulness, youth, emotions, and BA.

The 72 resulting items included 29 items hypothesized to reflect the attention dimension, 27 items hypothesized to reflect the attitudes and reactions to body sensations dimension and 16 items hypothesized to reflect the regulatory aspects dimension (see Appendix D S2) for the number of items per subdimension). Some items (n = 23) were phrased in a counter-indicative fashion to reflect the language used by AYAs in the FGs and to avoid acquiescence bias. The items were reviewed by a panel of professionals, including researchers in the fields of interoception, psychometrics, adolescence, and mindfulness; by clinical psychologists specialized in working with youth and in the use of mindfulness-based approaches; and by one young person. Items were reviewed for language, phrasing, and content validity. This review process led to a pool of 51 items: 12 items belonged theoretically to the attention dimension, 22 items to the attitudes and

reactions to body sensations dimension, and 17 items to the regulatory aspects dimension. This pool of items was then pre-tested in a sample of French-speaking AYAs.

Participants

French-speaking AYAs between the ages of 14 and 24 (N = 30; mean age = 17.2, SD = 2.44), were recruited via social media and via phone calls to the research group's acquaintances. Participants received a 10-euro store voucher for their participation. See Table 7 for more information on participant characteristics.

Measures and Procedure

The pre-test took place online due to the COVID-19 pandemic between March and April 2021. The chosen web conference platform was Zoom (Zoom Video Communications Inc., 2016) as it met the relevant criteria for a secure and user friendly platform for interviews (Archibald et al., 2019). The pre-test lasted one hour and consisted of two main steps: an online administration of the initial pool of 51 items and six demographic questions on Qualtrics (Qualtrics, 2020), and an interview. BA items were rated on a scale from 0 (never or very rarely true) to 4 (very often or always true). After each item, a multiple-choice question asked whether the item was very easy to understand (coded as 1), somewhat easy to understand (coded as 2), a little difficult to understand (coded as 3), or very difficult to understand (coded as 4). After completion of the questionnaire, the researcher identified the items rated as most difficult to understand by the participant, and asked in-depth questions on why these items were difficult. Lastly, participants were asked to give general feedback on the questionnaire.

Analyses

The answers to the multiple-choice questions asking about item comprehension were averaged per item to create an item non-comprehension index, with higher scores reflecting greater difficulties understanding the item. The qualitative data was analyzed by first carefully listening to the interviews while taking notes. The notes were then used to identify and summarize patterns in participants' perspectives on the items. The pattern of results was used to modify the pool of items.

Results and Discussion

Quantitative results revealed that, overall, items were rated easy to understand, with an average item non-comprehension index of 1.23 (SD = 0.24). The following modifications were made: (1) one item was removed because of a high non-comprehension index score (2.37); (2) two items were removed based on participants' qualitative feedback. Participants reported finding them too confusing, and (3) five items were modified for simplicity and concreteness, as participants' qualitative feedback suggested these items were too abstract or complex.

Qualitative results revealed that most items were comprehensible but some were problematic, so they were omitted or adapted. They were problematic because they were too ambiguous, abstract, or complicated (i.e., included unfamiliar vocabulary). Relevant modifications were made such as using simpler words, giving concrete explanations for difficult terms at the beginning of the questionnaire, adding examples, and shortening the items as much as possible. See Appendix D S3 for a detailed list of the most difficult items to understand and for a more detailed summary of the pre-test's qualitative results. After the first pre-test, the item pool consisted of 48 items: 11 items belonged theoretically to the attention dimension, 22 items to the attitudes and reactions to body sensations dimension, and 15 items to the regulatory aspects dimension.

4.3 Study 2: Item Analysis and Item Pool Reduction

The next step in the MBAQ development process consisted of conducting an item analysis for item pool reduction and exploring the resulting item pool's factor structure with exploratory factor analysis (EFA).

Method

Participants

French-speaking AYAs were recruited by posting recruitment ads on social media and by sending recruitment emails to students at the Faculty of Psychology of the first author's university. Participation was compensated by the opportunity to participate in a raffle of various 10-euro prizes. One out of twenty participants received a 10-euro prize. Participation in the raffle was optional. Those who wanted to participate in the raffle were asked to give their name and contact information at the end of the survey. A total of 628 young people clicked on the survey link. Out of these, 174 were excluded for not completing any of the questionnaire items ($n = 169$), or for not agreeing with the consent form ($n = 5$), leaving a total sample of 454 participants who were on average 20.91 years old (SD = 1.96). See Table 7 for more information on participants' demographic characteristics.

Measures and Procedure

The study consisted of administering an online questionnaire using Qualtrics. The questionnaire consisted of six demographic questions, and the preliminary version of the Mindful Body Awareness Questionnaire (MBAQ) resulting from Study 1. This first version consisted of 48 items, rated on a scale from 0 (never or very rarely true) to 4 (very often or always true).

Data Preparation and Analyses

The first part of the analyses consisted of analyzing each individual item for item performance to prune for the best items. An item analyses was performed using the *sjPlot* package (Lüdecke, 2023) in R (v4.2.1; R Core Team, 2021). Items were tested for variability (i.e., spread of responses per item) and difficulty (i.e., whether endorsement of the item is skewed towards the "never or very rarely true" or "very often or always true" pole) (Albano, 2020). The criteria used to gauge item performance were the following: values (P) of 0.30-0.70 for item difficulty and a relatively normal distribution of responses for item variability upon visual inspection (Lüdecke, 2023). Five items performed poorly on difficulty and/or variability. They were removed from further analyses and excluded from the item pool for the final MBAQ. We, hence, retained 43 items for inclusion in the EFA. See Appendix D S4 for the detailed item analysis results.

Next, an EFA was used to analyze the underlying factors in the 43 remaining items using the *psych* package in R (Revelle, 2022). Data were screened for multivariate assumptions (normality, linearity, homogeneity, and homoscedasticity). Multivariate outliers were detected using Mahalanobis distance and removed from further analyses. EFA analyses were conducted using guidelines outlined in Preacher and Maccallum (2003). First, data was tested for EFA adequacy using Bartlett's test and sampling adequacy using Kaiser-Meyer-Olkin (KMO) test. Next, a parallel analysis and scree plot examination were conducted to identify the number of salient factors in the data. The old and new Kaiser criterions were also considered. Based on this, three factor solutions were tested using EFA with maximum likelihood estimation and oblimin rotation given the expected factor dependence. Items that loaded onto more than one factor or had loadings lower than .40 were removed.

Results and Discussion

Regarding prerequisites for running the EFA, all multivariate assumptions were met. Sixteen multivariate outliers were detected and removed from further analyses. There were no missing data. Bartlett's test indicated correlation adequacy, $X^2(903) = 6223.86$, $p < .001$, and the KMO test indicated adequate sampling adequacy (KMO = 0.89).

Regarding factor number, the parallel analysis suggested to retain 7 factors; the scree plot examination suggested 3-4 factors; the old Kaiser criterion suggested 3 factors; and the new Kaiser criterion suggested 4 factors. Theory suggests 5 first-order factors (i.e., accounting for the subdimensions listed in Table 8). Given this combination of results, 3-, 4- and 5-factor solutions were considered. The 3-factor solution was retained because it was the most interpretable, and because the 4- and 5- factor solutions had factors containing only two items. For the final 3-factor solution, a total of 17 items were removed because they did not load onto any factor ($n = 16$), or they loaded onto two factors ($n = 1$). The final 3-factor solution consisted of 26 items. Factor loadings for all 26 items can be found in Appendix D S5. Factor 1 included 14 items that coherently capture the listening dimension, defined as approaching body sensations as useful sources of information to identify one's needs, emotions, and to self-regulate. Factor 2 was associated

with eight items that referred to equanimity, defined as a relationship of non-judgment, non-reactivity, and openness towards unpleasant body sensations. Finally, Factor 3 mainly loaded four items capturing non-avoidance, defined as facing (not ignoring or suppressing) body sensations. The internal consistency of all corresponding scales was high to acceptable with .86, .87, and .68 for Factors 1, 2, and 3 respectively.

In a subsequent analytic phase, the item pool was further reduced in an intent to reduce the length of the final MBAQ. Six items from Factor 1 were removed iteratively: five items were removed for having the lowest factor loadings, and one item was removed because it was too repetitive. Lastly, since Factor 3 had a lower internal consistency due to its concision, two items that loaded onto this factor in the first EFA (with factor loadings lower than .40 or that loaded onto two factors) were improved for phrasing and added to the subscale for inclusion in the final version of the MBAQ (resulting in a Cronbach alpha of 0.76; see Study 3). This led to a set of 22 items underlined by three factors: Factor 1 titled Equanimity (eight items), Factor 2 titled Listening (eight items), and Factor 3 titled Non-Avoidance (six items). The retained items and their factor loadings can be found in Table 9.

Table 9. 3-Factor Solution Loadings with Oblimin Rotation

Item	Factor 1 (Equanimity)	Factor 2 (Listening)	Factor 3 (Non-avoidance)
I can stay calm and not worry when I have feelings of discomfort or pain. (3)	**0.59**	0.04	-0.05
Certain unpleasant body sensations scare me. (R) (14)	**0.63**	-0.10	0.25
I get very worried if I feel pain or if I feel uncomfortable in my body. (R) (31)	**0.82**	-0.04	0.05
Unpleasant sensations in my body grab my attention very quickly. (R) (32)	**0.55**	-0.15	-0.26
When I have unpleasant feelings in my body I cannot stop thinking about them. (R) (36)	**0.72**	-0.03	0.04
When I feel pain in my body, I become upset. (R) (42)	**0.85**	0.02	-0.02
Certain body sensations I feel don't seem normal to me. (R) (43)	**0.49**	0.00	0.21
When I notice an unpleasant feeling in my body, I don't worry about it. (47)	**0.76**	0.07	-0.19
When I feel bad, but I don't know why, I pay attention to my body sensations to understand. (11)	-0.12	**0.53**	0.05
I focus on my body several times per day to pay attention to my body sensations. (17)	0.01	**0.51**	0.14
When I feel an intense emotion, paying attention to my body helps me realize what I need in that moment. (23)	-0.13	**0.67**	-0.08
I am attentive to my body sensations when I feel an emotion. (25)	-0.06	**0.55**	0.14
When I feel overwhelmed or carried away by an emotion, I concentrate on my body sensations to calm down. (29)	0.07	**0.64**	-0.05
I am confident that my bodily sensations will let me know what is good for me. (34)	0.02	**0.61**	-0.03

I listen to my body to help me choose what I need. (41)	0.01	**0.68**	0.05
The sensations in my body help me understand what I feel. (46)	0.02	**0.73**	0.03
I tend to notice feelings of physical tension or discomfort only when they become very intense. (R) (20)	0.04	-0.02	**0.50**
I ignore unpleasant sensations in my body until they become very strong. (R) (30)	-0.09	0.08	**0.66**
I ignore sensations in the body that I don't like. (R) (38)	-0.24	0.00	**0.52**
When I feel strong emotions in my body, I ignore them because I don't know how to face them. (R) (45)	0.13	0.14	**0.60**
I prefer not to pay attention to what I feel in my body. (R) (28)*	0.46	0	**0.42**
I ignore body sensations that I don't find useful. (R) (40)*	0.14	-0.18	**0.36**

Note. Factor loadings have been sorted and bolded for ease of reading. Items with an (R) next to them are reverse scored. * Factor loadings of these two items reported here were obtained from the original version of these items, which were further improved for the final MBAQ. The improved versions of these items are included in the table. The original French items and their references (where applicable) can be found in S4: Item analysis results. Item numbers are in parentheses.

4.4 Study 3: Psychometric Evaluation of the MBAQ Among AYAs

The final study involved a psychometric evaluation of the MBAQ, including structural validity using confirmatory factor analysis (CFA), assessment of internal consistency, test-retest reliability, and criterion validity.

Method

Participants

French-speaking AYAs between the ages of 14 and 24 were recruited by posting recruitment ads on social media, by sending recruitment emails to the psychology students subject pool from the first author's university, and by sending recruitment emails to specific secondary schools. Participants in the subject pool were compensated with one course credit. All other participants were offered the opportunity to participate in a raffle of four prizes: one 50-euro prize, two 20-euro prizes, and one 10-euro prize. As in Study 2, participation in the raffle was optional. A total of 971 young people clicked on the survey link, out of which 219 were excluded for the following reasons: not completing any of the questionnaire items (n = 181), not agreeing with the consent form (n = 3), not meeting the inclusion criteria (n = 9) and taking an unrealistically short amount of time to complete the survey (i.e., less than 4 minutes; n = 5). Multivariate outliers (n = 21) were further removed. The sample after exclusions consisted of 752 participants. Demographic characteristics for the final sample can be found in Table 7 and demographic characteristics per age group can be found in Appendix D S6, respectively.

Measures

The questionnaires used in Study 3 are listed below. Cronbach's alphas for all questionnaires and their subscales per age group and for the entire sample can be found in Appendix D S7. All AYAs completed the same measures for BA, pain catastrophizing, emotional distress, and cognitive emotion regulation because the French measures had been validated in both adolescents and young adults (i.e., pain catastrophizing and cognitive emotion regulation) or because only the French adult version was available and was used for both samples (i.e., BA and emotional distress). Regarding mindfulness and social desirability questionnaires, different age-appropriate questionnaires were used to measure these constructs. Short descriptions of the questionnaires are included herein. See Appendix D S8 for a more detailed description of each measure.

Mindful Body Awareness Questionnaire (MBAQ). We used the version of the MBAQ resulting from Study 2 (see Table 9) comprising 22 items and investigating three dimensions, namely Equanimity, Listening, and Non-avoidance. Answers are rated on a five-point Likert scale from 0 (Never) to 4 (Always).

Multidimensional Assessment of Interoceptive Awareness. (MAIA: Mehling et al., 2012; Michael et al., 2016). The MAIA is a 32-item questionnaire that measures eight facets of interoceptive awareness: Noticing, Not-Distracting, Not-Worrying, Attention Regulation, Emotional Awareness, Self-Regulation, Body-Listening and Trusting. Answers are rated on a six-point Likert scale from 0 (Never) to 5 (Always). Cronbach's alphas ranged from .56 to .85 in the entire sample.

Pain Catastrophizing Scale. (PCS: Sullivan et al., 1995; Tremblay et al., 2008). The PCS is a 13-item scale assessing three pain-related reactions: rumination, magnification, and helplessness on a five-point Likert scale from 0 (Never) to 4 (Always). Cronbach's alphas ranged from .74 to .88 in the entire sample.

Depression, Anxiety, and Stress Scale-21. (DASS-21: Lovibond & Lovibond, 1995; Donald, 2012). The DASS-21 is a 21-item questionnaire assessing three dimensions of emotional distress: depression, anxiety and stress. Items are rated on a four-point Likert scale from 0 (did not apply to me at all) to 3 (applied to me very much or most of the time). Cronbach's alphas ranged from .80 to .92 in the entire sample.

Cognitive Emotion Regulation Questionnaire. (CERQ: Garnefski & Kraaij, 2007; d'Acremont & Van der Linden, 2007). The CERQ is a 36-item questionnaire assessing nine distinct strategies to cope with emotionally stressful situations: acceptance, positive refocusing, refocusing on planning, positive reappraisal, and putting into perspective, self-blame, rumination, catastrophizing, and blaming others. Items are rated on a five-point Likert scale from 1 (Almost never) to 5 (Almost always). Cronbach's alphas ranged from .72 to .90 in the entire sample.

Mindfulness. The Five-Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2008; Heeren & Philippot, 2011) is a 39-item questionnaire measuring mindfulness in adults

on a five-point Likert scale ranging from 1 (Never or very rarely true) to 5 (Very often or always true). It includes five factors, namely Observing, Describing, Acting with awareness, Nonjudgement of inner experience, and Nonreactivity to inner experience. Cronbach's alphas in the present study's young adult sample ranged from .76 to .92.

The Child and Adolescent Mindfulness Measure (CAMM: Greco et al., 2011; Roux et al., 2019) is a 10-item questionnaire that assesses mindfulness as a unidimensional construct in children and adolescents. Items are rated on a five-point Likert scale ranging from 0 (Never true) to 4 (Always true). The Cronbach's alpha in the present study's adolescent sample was .77.

Social Desirability. The Other-Deception subscale of the Social Desirability-36 (DS36-OD: Tournois et al., 2000) measures adults' tendency to consciously deceive others and contains 18 items rated on a seven-point Likert scale ranging from 1 (Completely false) to 7 (Completely true). The Cronbach's alpha in the present study's young adult sample was .81.

The Lie subscale of the Eysenck Personality Questionnaire-Junior (EPQ-J: Eysenck & Eysenck, 1975; Rothen et al., 2008) measures children and adolescents' tendency to deceive and contains 18 items measured on a dichotomous scale of "yes" or "no". The Cronbach's alpha in the present study's adolescent sample was 0.51.

Procedure. Data collection was done separately for adolescents and young adults because age-appropriate criterion measures were administered per group. All participants received a Qualtrics link to complete the online survey which included seven demographic questions, the MBAQ, and measures to test criterion validity listed above. To limit respondent burden, participants were randomly assigned to a survey link that included a subset of measures. All participants completed the MBAQ, and a set of 1 to 6 additional measures according to age and phase of data collection. At the end of the survey, participants were asked whether they wanted to complete a short version of the survey two weeks later (i.e., the MBAQ and the social desirability scale) to assess test-retest reliability. Participants who agreed to do this were compensated with an extra chance to win the prize.

Analyses. After checking statistical assumptions for the main analyses, CFA was performed on the MBAQ to assess the hypothesized model's fit. Analyses were conducted with the *cfa* function in R's *lavaan* package (Rosseel, 2012). First, a three-factor model with correlated factors containing all 22 items was estimated using maximum likelihood. Since this model's fit indices and some factor loadings were below expectations, an alternative model was derived as discussed herein. The model was considered a good fit if the root mean square error of approximation (RMSEA) and the standardized root mean square residual (SRMR) were less than .08, the Tucker Lewis index (TLI) was greater than .90, and the confirmatory factor index (CFI) was greater than .90 (Ben-Shachar et al., n.d; Browne et al., 1993; Confirmatory Factor Analysis [CFA] in R with Lavaan, 2021). Regarding chi-square, we considered the test statistic, degrees of freedom, and associated

p-value. However, since the chi-square test is sensitive to sample size, this index was not given the most weight in the combination of indices considered (CFA in R with Lavaan, 2021). For comparison between models, the Akaike Information Criterion (AIC) was used, with a lower AIC indicating better model fit.

The model with the best fit indices, highest factor loadings, and lowest AIC was selected. Next, multi-group confirmatory factor analysis (MG-CFA) was conducted using R to determine whether the best-fitting model displayed measurement invariance across age (i.e., adolescents versus young adults) and gender groups (i.e., male versus female). A stepwise MG-CFA approach was used as described in Brown (2006). The first step consisted of conducting separate CFAs per group and examining whether model fit indices suggested adequate fit using the above-mentioned guidelines. If they did, we assessed the model's configural invariance (i.e., equivalence of factor structure across groups), metric invariance (i.e., equivalence of factor structure and factor loadings across groups), scalar invariance (i.e., equivalence of factor structure, factor loadings, and indicator intercepts across groups), and strict invariance (i.e., equivalence of factor structure, factor loadings, indicator intercepts, and error variances across groups). Equivalence was supported if model fit did not degrade significantly (i.e., change in CFI was less than .01) from the fit of the model previously tested (Beaujean, 2014; Brown, 2006).

Lastly, to assess the reliability and validity of the MBAQ, the following analyses were conducted. The Cronbach's alphas of the MBAQ's subscale scores were computed to assess internal consistency. The single random raters Intraclass Correlation Coefficient (ICC) was calculated to measure test-retest reliability. To evaluate criterion validity, correlations were computed between the MBAQ and the criterion measures of interoceptive sensibility, mindfulness, emotion regulation, pain catastrophizing, and emotional distress. Independence from social desirability was assessed by computing correlations between the MBAQ and social desirability. Correlations were computed using R's flexible correlation code (Apšvalka, 2022). See Appendix D S9 for more information on this correlation analytic method.

Results and Discussion

Confirmatory Factor Analysis

The data met assumptions for multivariate normality, sufficient sample size, a correct a priori model specification, and a random sample. The required sample size for the present study was calculated based on recommendations by Koran (2016) who states that for a CFA model with three factors, approximately seven indicators per factor and factor loadings of approximately .40, a minimum sample size of 251 is required for satisfactory convergence, bias, and power.

The model fit indices of the hypothesized 3-factor model were: $\chi^2(206) = 994.144$, $p < .001$; CFI = .85; RMSEA = .071, 90%CI [.067, .076]; SRMR = .08; AIC = 46415.54. The specific factor loadings of the model's items, which ranged from .29 to .85, can be found in Appendix D S10. Since only the RMSEA met the requirements stated in the Analyses section, one alternative model was run. The model was adjusted by removing items that didn't perform well in this sample (i.e., items 14, 5, 10, and 18 which had the lowest factor loadings). All fit indices improved upon removal of items with the lowest factor loadings, $\chi^2(132) = 658.38$, $p < .001$; CFI = .89; RMSEA = .073, 90%CI [.067, .078]; SRMR = .075; AIC = 37345.85. A model comparison analysis revealed that Model 2 was significantly better than Model 1 ($\chi^2(74) = 335.76$; $p < .001$). Model 2 had an acceptable model fit by meeting the requirements for two indices (RMSEA and SRMR), and by having the lowest chi square value, the highest CFI (which was very close to the cutoff score), the strongest factor loadings, and the lowest AIC. Hence, Model 2, a three-factor model with 18 items, was chosen. Means and standard deviations for the final MBAQ and criterion measures can be found in Table 10. Inter-scale correlations were .52 between Listening and Non-avoidance; -.26 between Equanimity and Listening; and -.41 between Equanimity and Non-avoidance. Table 11 shows the English translation of the items and standardized factor loadings of the chosen MBAQ model. An illustration of the model and the final MBAQ with scoring instructions can be found in Appendix D S12 and S13 respectively.

Table 10. Descriptive statistics among adolescents, young adults, and entire sample

	Adolescents (n = 267)			Young adults (n = 485)			Entire sample (n = 752)		
Scale and dimensions	N	M	SD	N	M	SD	N	M	SD
MBAQ Equanimity	267	1.96	0.78	485	1.93	0.78	752	1.94	0.78
MBAQ Listening	267	1.77	0.78	485	2.01*	0.80	752	1.92	0.80
MBAQ Non-avoidance	267	2.18	0.85	485	2.35*	0.87	752	2.29	0.86
MAIA Noticing	62	3.00	1.00	283	3.14	0.95	345	3.12	0.96
MAIA Not-Distracting	62	2.59	0.93	283	2.51	0.91	345	2.53	0.91
MAIA Not-Worrying	62	2.81	1.22	283	2.74	1.22	345	2.75	1.22
MAIA Attention Reg.	62	2.46	0.99	283	2.57	1.00	345	2.55	1.00
MAIA Emotional Awa.	62	3.16	0.87	283	3.17	1.08	345	3.17	1.05
MAIA Self-Reg.	62	2.23	1.23	283	2.32	1.15	345	2.30	1.16
MAIA Listening	62	1.88	1.24	283	2.32*	1.27	345	2.24	1.27
MAIA Trusting	62	2.90	1.35	283	3.08	1.31	345	3.05	1.32
FFMQ Observe	0	N/A	N/A	253	27.10	5.54	253	27.10	5.54

FFMQ Describe	0	N/A	N/A	253	23.97	7.58	253	23.97	7.58
FFMQ Act with Awa.	0	N/A	N/A	253	23.13	6.01	253	23.13	6.01
FFMQ Nonreactivity	0	N/A	N/A	253	19.43	4.92	253	19.43	4.92
FFMQ Nonjudge	0	N/A	N/A	253	22.51	6.82	253	22.51	6.82
FFMQ Total	0	N/A	N/A	253	116.13	20.17	253	116.13	20.17
CERQ Self blame	78	11.27	3.75	264	12.63	3.72	342	12.32	3.76
CERQ Acceptance	78	13.03	4.06	264	14.33*	3.40	342	14.03	3.60
CERQ Rumination	78	12.55	3.83	264	13.96*	3.62	342	13.64	3.71
CERQ Refocusing	78	10.83*	3.91	264	9.09	3.76	342	9.49	3.86
CERQ Planning	78	13.26	4.15	264	13.26	3.74	342	13.26	3.83
CERQ Reappraisal	78	12.36	4.09	264	12.47	4.19	342	12.44	4.16
CERQ Perspective	78	12.87	3.73	264	12.73	3.99	342	12.76	3.93
CERQ Catastrophizing	78	9.05	3.92	264	8.31	3.23	342	8.48	3.41
CERQ Blame others	78	8.71*	3.34	264	7.90	2.98	342	8.08	3.08
CERQ Positive	78	62.35	15.07	264	61.87	13.89	342	61.98	14.15
CERQ Negative	78	41.58	9.99	264	42.80	8.62	342	42.52	8.95
PCS Rumination	67	10.31*	2.98	254	9.39	2.96	321	9.58	2.99
PCS Magnification	67	5.75	2.84	254	5.96	2.99	321	5.92	2.95
PCS Helplessness	67	10.25	4.73	254	10.41	4.71	321	10.38	4.71
PCS Total	67	26.31	8.94	254	25.76	9.22	321	25.88	9.15
DASS Total	66	26.36	13.08	251	24.37	12.78	317	24.79	12.85
DASS Depression	66	8.74	5.73	251	8.25	5.40	317	8.36	5.47
DASS Anxiety	66	8.48*	5.34	251	6.97	4.51	317	7.28	4.73
DASS Stress	66	9.14	4.33	251	9.15	4.86	317	9.15	4.75
DS36-OD	0	N/A	N/A	361	81.98	14.23	361	81.98	14.23
CAMM	72	17.19	6.79	0	N/A	N/A	72	17.19	6.79
EPQ-J	80	6.21	1.58	0	N/A	N/A	80	6.21	1.58

Note. MBAQ = Mindful Body Awareness Questionnaire; MAIA = Multidimensional Assessment of Interoceptive Awareness; FFMQ = Five Facet Mindfulness Questionnaire; CERQ = Cognitive Emotion Regulation Questionnaire; PCS = Pain Catastrophizing Scale; DASS-21 = Depression, Anxiety, and Stress Scale-21; DS36-OD = Social desirability measure (Other-Deception scale); CAMM = Child and Adolescent Mindfulness Measure; EPQ-J = Eysenck Personality Questionnaire-Junior (Lie scale); N = sample size; M = mean; SD = standard deviation; * =

independent samples t-tests indicate this value is significantly higher in this age group in comparison to the other at $p < .05$.

Table 11. Standardized CFA factor loadings of the chosen MBAQ three-factor model with 18 items

Item	F1 (Equan.)	F2 (Listen.)	F3 (Non-av.)
I can stay calm and not worry when I have feelings of discomfort or pain. (2)	0.58		
*When I have unpleasant feelings in my body, I cannot stop thinking about them. (4)	0.58		
*I get very worried if I feel pain or if I feel uncomfortable in my body. (7)	0.80		
When I notice an unpleasant feeling in my body, I don't worry about it. (12)	0.70		
*When I feel pain in my body, I become upset. (16)	0.84		
*Certain unpleasant body sensations scare me. (19)	0.58		
*Unpleasant sensations in my body grab my attention very quickly. (21)	0.53		
The sensations in my body help me understand what I feel. (1)		0.59	
I am confident that my bodily sensations will let me know what is good for me. (9)		0.58	
When I feel bad, but I don't know why, I pay attention to my body sensations to understand. (11)		0.67	
I focus on my body several times per day to pay attention to my body sensations. (13)		0.59	
I listen to my body to help me choose what I need. (15)		0.70	
When I feel an intense emotion, paying attention to my body helps me realize what I need in that moment. (17)		0.71	
I am attentive to my body sensations when I feel an emotion. (20)		0.71	
*I ignore unpleasant sensations in my body until they become very strong. (3)			0.59
*I ignore sensations in the body that I don't like. (6)			0.58
*When I feel strong emotions in my body, I ignore them because I don't know how to face them. (8)			0.55
*I prefer not to pay attention to what I feel in my body. (22)			0.79

F = Factor. Equan. = Equanimity; Listen. = Listening; Non-av. = Non-avoidance. *Items with an asterisk are reverse scored. Item numbers are in parentheses. Items presented in this table are the English translation of the French items. Only French items have been validated and can be found in S13: The final MBAQ (in French and English).

Multigroup Confirmatory Factor Analysis

MG-CFA results are summarized in Table 12. Model fit indices of the CFAs ran with each age and gender group separately, revealed an acceptable fit, with two indices (i.e., the RMSEA and SRMR) meeting the required criteria for all models. In comparison to the CFI of the chosen model within the pooled sample, the CFI of the subsample models was slightly lower except in the case of the young adult model, for which the CFI was

slightly higher. Based on the CFI results, there was a slightly better adjustment within the young adult and male subsamples.

Invariance testing by age (i.e., under 18 vs. 18 or older) and gender groups (i.e., female vs. male) returned evidence of strict invariance with no significant model degradation (as evidenced by the change in CFI) across tests. These findings suggest that the MBAQ has strict measurement equivalence across age and gender groups. It was important to test this as prior studies have shown there may be gender (Grabauskaitė et al., 2017; Murphy et al., 2019; Pérez-Peña et al., 2023) and developmental differences (Murphy et al., 2017; Pérez-Peña et al., 2023) in interoception. These results suggest that these differences do not translate into a difference in the understanding of the MBAQ items. Hence, the same factorial structure of the MBAQ can be used in both age and gender groups.

Latent mean differences between groups were assessed. Results (see Table 10) showed that young adults reported significantly higher Listening and Non-avoidance than adolescents with small effect sizes (Cohen's d = -.30 and -.20 respectively). Equanimity levels did not differ between age groups (see Table 10). Regarding gender groups, men reported significantly higher levels of Equanimity ($M = 2.14$, $SD = 0.77$) than women ($M = 1.85$, $SD = 0.77$), $t(706) = -4.66$, $p < .001$, with a small effect size (Cohen's d = -0.38). Female ($M = 1.94$, $SD = 0.78$) and male ($M = 1.89$, $SD = 0.83$) participants reported similar levels of Listening, $t(706) = 0.82$, $p = .41$. Likewise, female ($M = 2.28$, $SD = 0.88$) and male participants ($M = 2.34$, $SD = 0.82$) reported similar levels of Non-avoidance, $t(706) = -0.79$, $p = .43$.

Table 12. Fit statistics and model comparison indices for the multi-group measurement invariance tests across age and gender groups.

Model	χ^2	*df*	CFI	RMSEA	SRMR	ΔCFI
Chosen model (for reference)	658.381	132	0.887	0.073	0.071	-
Models by age						
Adolescent model	313.455	132	0.872	0.072	0.075	-
Young adult model	485.888	132	0.891	0.074	0.078	-
Configural model	799.343	264	0.885	0.073	0.077	-
Metric model	803.754	279	0.887	0.071	0.077	.002
Scalar model	820.618	294	0.887	0.069	0.078	.000
Strict model	875.117	312	0.879	0.069	0.079	-.008
Models by gender						
Women model	515.275	132	0.878	0.077	0.078	-
Men model	280.149	132	0.882	0.072	0.076	-
Configural model	795.424	264	0.879	0.075	0.078	-
Metric model	821.121	279	0.877	0.074	0.08	-.002
Scalar model	853.843	294	0.873	0.073	0.082	-.004
Strict model	886.977	312	0.869	0.072	0.082	-.004

Reliability

Regarding internal consistency, the Cronbach's alpha coefficients were .84, .84, and .74 for the Equanimity, Listening, and Non-Avoidance subscales respectively, indicating good internal consistency across dimensions. With regards to test-retest reliability, 71 participants (n = 30 adolescents; n = 41 young adults) completed the survey a second time, two weeks later. Results showed that the MBAQ has moderate to good test-retest reliability (Koo & Li, 2016) across subscales, with: (1) a moderate to good test-retest reliability for Equanimity (ICC = .74, p < .001, [95%: .62-.83]); (2) a good test-retest reliability for Listening (ICC = .79, p < .001, [95%: .68-.86]); and a moderate test-retest reliability for Non-Avoidance (ICC = .66, p < .001, [95%: .50-.77]). This is in line with prior studies showing good temporal stability of self-reported interoception (Ferentzi et al., 2018; Vlemincx et al., 2021).

Criterion Validity

Regarding criterion validity, we hypothesized that the MBAQ subscales would be moderately to strongly positively correlated with another measure of adaptive BA, namely the MAIA. Likewise, we expected medium to strong positive correlations with mindfulness (as measured by the FFMQ and the CAMM), as our MBA construct is inspired by the attention and attitude cultivated in mindfulness practices (see Introduction). On the other hand, we hypothesized medium to strong negative correlations between the MBAQ subscales and pain catastrophizing (as measured by the PCS), a reactive and hypervigilant attitude to body sensations, opposed to the attitude we seek to measure in the MBAQ. Lastly, since MBA is an adaptive form of BA, and prior studies have found links between adaptive BA, emotion regulation, and mental well-being, we hypothesized medium positive correlations between the MBAQ subscales and adaptive emotion regulation, and medium negative correlations between the MBAQ subscales and emotional distress.

Criterion validity results can be found in Table 13. The three MBAQ subscales differentially correlated with a related measure of interoceptive sensibility, the MAIA. Equanimity had a strong positive correlation with Not-Worrying, a moderate negative correlation with Not-Distracting, and mostly weak correlations with the rest of the MAIA subscales. Listening, on the other hand, displayed moderate to strong correlations with the MAIA Noticing, Attention Regulation, Emotional Awareness, Self-Regulation, Listening, and Trusting subscales. Last but not least, Non-Avoidance was strongly positively correlated with MAIA Not-Distracting and had small to medium positive correlations with the rest of the MAIA subscales, with the exception of Not-Worrying for which it had a small negative correlation. Concerning mindfulness, all subscales displayed significant, small to medium, positive correlations with mindfulness, as measured by the FFMQ, but not by the CAMM. Only Non-Avoidance was significantly positively correlated with mindfulness as measured by the CAMM. Non-Avoidance was the subscale with the strongest positive correlations with mindfulness, in both adolescent and young

adult populations. Regarding pain catastrophizing, Equanimity had moderate to strong negative correlations with all dimensions of the PCS, whereas Listening and Non-Avoidance displayed mostly non-significant weak correlations. Correlations with cognitive emotion regulation were small to medium, mostly positive when it came to adaptive forms of cognitive emotion regulation, and negative when it came to negative forms of cognitive emotion regulation. Regarding emotional distress, MBAQ subscales displayed weak to moderate negative correlations with symptoms of emotional distress. Finally, independence from social desirability was established as all MBAQ subscales displayed weak to no correlations with measures of social desirability.

Overall, the pattern of correlations was weaker than initially hypothesized, but was in the expected direction pointing to a construct of BA that is multidimensional and adaptive. Criterion validity results support the existence of three coherent and distinct dimensions: Equanimity, Listening, and Non-Avoidance. Equanimity describes a specific attitude towards unpleasant body sensations characterized by a relaxed, open stance as opposed to a worried, emotionally reactive stance. The criterion validity of this dimension was supported by the strong positive correlations with MAIA Not-Worrying and the strong negative correlations with pain catastrophizing (PCS) and its three dimensions. Listening encompasses the regulatory aspects of the MBA construct and is characterized by a reaction of approaching or paying attention to body sensations to obtain information about one's needs and emotions, the first steps in self-regulating. This was supported by the strong positive correlations between Listening and the MAIA regulatory dimensions and medium positive correlations with adaptive cognitive emotion regulation strategies. Finally, the Non-Avoidance dimension is a specific attentional reaction to body sensations involving facing all sensations as opposed to avoiding them. The strong correlations between Non-Avoidance and MAIA Not-Distracting, MAIA Listening, and mindfulness, supported this definition.

Table 13. Criterion validity correlations for the MBAQ in an adolescent and young adult sample

	MBAQ Equanimity	MBAQ Listening	MBAQ Non-avoidance
MAIA Noticing	-.19***	.52***	.26***[2]
MAIA Not-Distracting	-.44***	.21***[2]	.54***[2]
MAIA Not-Worrying	.80***	-.13*[2]	-.14**[2]
MAIA Attention Reg.	.13*[1]	.55***	.24***[1]
MAIA Emotional Awa.	-.19***[2]	.55***	.28***[2]
MAIA Self-Reg.	.07[2]	.53***	.24***[2]
MAIA Listening	-.15**[2]	.71***[2]	.40***[2]
MAIA Trusting	.10[2]	.47***[2]	.33***[2]

FFMQ Observe	.01	.54***[2]	.27***[2]
FFMQ Describe	.06[2]	.31***[2]	.35***[2]
FFMQ Act with Awa.	.16*[2]	.07[1]	.28***
FFMQ Nonreactivity	.27***	.26***	.10[2]
FFMQ Nonjudge	.25***[2]	.17**[1]	.33***[1]
FFMQ Total	.23***	.38***	.45***
CERQ Self blame	-.05[2]	-.04[2]	-.17**[2]
CERQ Acceptance	.16**[2]	.12*[2]	.008[1]
CERQ Rumination	-.25***[2]	.23***[2]	.10[2]
CERQ Refocusing	-.06[2]	.18***[2]	.01[2]
CERQ Planning	.04[2]	.31***[2]	.12*[1]
CERQ Reappraisal	.11*[2]	.37***	.15**[2]
CERQ Perspective	.15**[2]	.18***	-.05[2]
CERQ Catastrophizing	-.27***[2]	-.06	-.11*[2]
CERQ Blame others	-.13*[2]	-.03[2]	-.05[2]
CERQ Positive	.13*[1]	.28***[2]	.06[1]
CERQ Negative	-.28***	.08	-.06
PCS Rumination	-.43***[2]	.13*[2]	.17**[2]
PCS Magnification	-.57***[1]	.08[1]	.07[1]
PCS Helplessness	-.43***[2]	-.02	-.02
PCS Total	-.56***	.05	.07[2]
DASS Total	-.24***[2]	-.11*	-.24***[2]
DASS Depression	-.12*[2]	-.21***[2]	-.22***[2]
DASS Anxiety	-.28***[2]	-.01[2]	-.19***[2]
DASS Stress	-.25***[2]	-.04[1]	-.21***[2]
HD	-.01	.16**	.16**
CAMM	.19	-.10	.36**[1]
EPQ-J	.10[2]	-.05	.07

Note. MBAQ = Mindful Body Awareness Questionnaire; MAIA = Multidimensional Assessment of Interoceptive Awareness; FFMQ = Five Facet Mindfulness Questionnaire; CERQ = Cognitive Emotion Regulation Questionnaire; PCS = Pain Catastrophizing Scale; DASS-21 = Depression, Anxiety, and Stress Scale-21; HD = Social desirability measure (Other-Deception scale); CAMM =

Child and Adolescent Mindfulness Measure; EPQ-J = Eysenck Personality Questionnaire-Junior (Lie scale); *$p < .05$, ** $p < .01$, *** $p < .001$. No superscript = Spearman skipped correlation. [1] = Pearson's correlation. [2] = Percentage-bend correlation.

4.5 General Discussion

The aim of the present paper was to introduce the notion of MBA and to describe the development and validation of a new adaptive BA questionnaire for AYAs (ages 14-24), the MBAQ. The conceptual framework and items were inspired by AYAs' experiences, perceptions, and language regarding BA. The final French version of the 18-item MBAQ showed acceptable to good reliability and validity, and strict measurement invariance across age and gender groups.

We aimed to create a questionnaire assessing adaptive BA characterized by an open, curious attention to body sensations and the integration of bodily information for self-regulation. The EFA findings, which were further confirmed by a CFA, revealed three coherent and distinct dimensions of MBA: Equanimity, Listening, and Non-Avoidance, each yielding good internal consistency and each supported by appropriate correlations with related constructs. The three dimensions of the MBAQ can be seen as different ways of mindfully relating to body sensations, each with its unique combination of attentional quality, attitude, and reaction (or lack thereof). Equanimity is a combination of an open attention with a relaxed attitude, and the absence of an additional cognitive or emotional reaction in the face of unpleasant body sensations. Listening is a combination of an intentional attention with a trusting attitude and a self-regulatory reaction. Non-Avoidance is a combination of deliberate and inclusive attention (i.e., all body sensations are welcome), and an absence of a particular cognitive or emotional reaction. These interpretations help make sense of the inter-scale correlations observed in the present study. Listening and Non-Avoidance are positively correlated as they both involve intentionally attending to all kinds of body sensations. Equanimity has weak to medium negative correlations with Listening and Non-Avoidance respectively because it focuses on a calm, non-reactive *attitude* rather than the attentional or regulatory *reactions* reflected in the other two dimensions.

Results are in line with the theoretical frameworks mentioned in the introduction. The Equanimity dimension is comparable to the acceptance component of the Monitor and Acceptance Theory (MAT), defined as "a mental attitude of nonjudgment, openness and receptivity, and equanimity towards internal and external experiences" (Lindsay & Creswell, 2019, p. 50). Since both Listening and Non-Avoidance have an important aspect of attending to body sensations, both could be considered part of the attention monitoring component of the MAT, defined as "ongoing awareness of present-moment sensory and perceptual experiences" (Lindsay & Creswell, 2019, p. 50). Prior studies have shown that attention monitoring skills and acceptance are unrelated or negatively correlated in non-meditators (Baer et al., 2006), and strongly positively correlated in

meditators (Baer et al., 2008), as meditators develop both sets of skills during meditation practice. This is in line with the subscale intercorrelations observed in the present study in a population of young non-meditators (i.e., Equanimity being weakly to moderately negatively correlated with Listening and Non-Avoidance).

Results also incorporate the self-regulatory aspects of the MBA construct discussed in the introduction. The Listening subscale, particularly, goes beyond mere attention to body sensations and includes integration of bodily signals to understand how one feels, what one needs, and how to best take care of oneself. This is in line with Mehling et al.'s (2012) conceptualization of interoceptive awareness that includes trusting body sensations, listening to the body for insights, and using the body to regulate oneself. It is also in line with later sessions of MBI trainings where participants are taught to use a short meditation called the breathing space, to ground themselves in their present-moment bodily experience, and from there choose what skillful action to take next (Kuyken et al., 2019, Segal et al., 2018).

In the context of interoception literature, the MBAQ operationalizes aspects of Suksasilp and Garfinkel's (2022) dimensions of self-report and interoceptive beliefs, interoceptive attention, and attribution of interoceptive sensations. As a subjective measure of a specific aspect of the interoceptive experience, it fits under the self-report and interoceptive beliefs category. Regarding interoceptive attention, it assesses it subjectively with the Non-Avoidance subscale by asking participants to report on whether or not they attend to their body sensations. Finally, it assesses attribution of interoceptive sensations by asking participants to report on the absence of negative appraisals of their body sensations (i.e., Equanimity subscale), and the presence of positive appraisals of their body sensations (i.e., Listening subscale). Hence, the MBAQ is a self-report measure that can be used to assess adaptive ways of attending to and relating with body sensations.

To our knowledge, the MBAQ is the first adaptive BA questionnaire developed for AYAs incorporating the experiences, language, and viewpoints of youth and psychologists working with them. It targets the limitations of existing BA questionnaires (e.g., MAIA for youth; Jones et al., 2020) as it is short (18 items), uses simple language, and is based on a 3-dimensional conceptual framework informed by mindfulness and interoception theory and by FGs with AYAs and psychologists working with them. The MBAQ contributes a developmentally appropriate measure that can be used to further BA research in AYAs, a stage of development where there are many gaps in our understanding (J. Murphy et al., 2017).

The MBAQ is also the first mindfulness-related questionnaire specifically assessing mindful ways of relating to body sensations in a population of AYAs. Existing mindfulness measures for youth (see Goodman et al., 2017 for a review of measures) assess a mindful awareness of all elements of present-moment experiences (e.g., thoughts, body sensations, emotions, sensory perceptions). Although some measures include items about noticing body sensations (e.g., the Comprehensive Inventory of Mindfulness Experiences-

Adolescents' Awareness of Internal Experiences subscale), it is not the sole focus of these questionnaires. Granting that questionnaires with a broadened scope are useful for assessing general mindfulness skills, they may be limited in their ability to assess specific skills trained in MBIs in a nuanced way. For instance, the skills of attending to and accepting body sensations are crucial elements of an MBI. They are the main focus of the first three sessions and are emphasized throughout the whole training program (Segal et al., 2018). Research also suggests that BA is a crucial working mechanism of MBIs that meaningfully interacts with other mechanisms such as unconstructive rumination (Hölzel et al., 2011; Pérez-Peña et al., 2022). Hence, it is important to have appropriate tools to measure it. Other BA questionnaires may not be appropriate, as they are not the most adapted for a population of youth and they do not focus on a mindful way of relating to body sensations based on mindfulness theory. The MBAQ provides a useful tool for advancing mindfulness, MBI, and BA research in youth. More specifically, it allows for a detailed empirical exploration of the active mechanisms involved in MBIs in youth, an area of research with many unanswered questions.

The links between the MBAQ dimensions and Lindsay and Creswell's (2017) MAT offer interesting opportunities for future research, particularly when it comes to distinguishing between maladaptive and adaptive forms of BA in youth. The MAT posits that attention monitoring skills alone, without acceptance skills, exacerbate negative and positive experiences, leading to maladaptive outcomes such as increased distress during negative experiences and increased impulsivity during positive experiences. Acceptance is needed to regulate reactivity and limit maladaptive outcomes (Lindsay & Creswell, 2019). This echoes Mehling's (2016) differentiation of attentional styles in interoceptive sensibility, with an anxious, hypervigilant attentional style leading to negative outcomes and a mindful attentional style leading to positive outcomes. Since the MBAQ has distinct dimensions pertaining to acceptance and attentional skills, it can be used to test these claims in youth. Future studies could test whether youth with high scores in Non-Avoidance and Listening, but low scores in Equanimity experience increased negative symptoms and whether youth with high scores on all dimensions, experience decreased negative symptoms and increased well-being. This would shed light on the link between different components of adaptive BA in youth and mental health.

Our findings must be interpreted considering the present study's limitations. First, all studies reported were performed on a healthy, European, French-speaking, mostly female, meditation-naïve student sample of AYAs, and results are thus not fully generalizable to other populations of AYAs. Future studies can conduct psychometric evaluations on clinical and culturally diverse samples as well as youth with varying levels of experience with mind-body practices to examine whether the same factor structure and correlations apply.

Second, young adults were overrepresented in the EFA and CFA samples due to data collection constraints. This was somewhat counterbalanced by the larger adolescent

sample in Study 1, which optimized items' comprehension and performance for both groups. However, it remains a limitation.

Third, the test-retest reliability was tested on a self-selected sample potentially leading to a biased sample. Despite encouraging findings, future studies can re-assess the MBAQ's test-retest reliability on another sample. Furthermore, test-retest reliability assessment had a delay of two weeks between questionnaire administrations, whereas other studies captured more construct-stability rather than time-sampling error, with retest delays of two months (Ferentzi et al., 2019), and six months (Vlemincx et al., 2021). Therefore, future studies may re-assess the MBAQ with longer test-retest delays and explore construct stability over time.

Fourth, the correlations between the MBAQ dimensions and symptoms of emotional distress were weak. This may be because they were conducted on a healthy sample with mild to moderate levels of emotional distress. Results may differ in a sample of youth with more severe clinical symptoms, and with specific clinical conditions where BA is affected (e.g., anxiety, eating disorders, or chronic pain). Future studies can validate the MBAQ in clinical populations of youth and re-assess correlations with emotional distress and symptomatology.

Fifth, two subscales had low internal consistency. The EPQ-J Lie subscale and the MAIA Not-Distracting subscale had Cronbach's alphas of less than .60 in a population of adolescents. This may attenuate the size of correlations obtained with these subscales (as relatedly outlined in the previously discussed limitation point). We therefore advise the reader to interpret these subscale's results with caution. Furthermore, due to lack of availability of validated French questionnaires for adolescents, two questionnaires validated in adults but not adolescents, were used (i.e., MAIA and DASS-21). Though these two questionnaires' internal consistency was mostly good in the present sample, the robustness of results obtained with them may still be affected.

Sixth, the Non-Avoidance and Equanimity subscales contain a majority of reverse scored items reflecting the language used in the FGs with AYAs, and the items used in related measures of BA and mindfulness. Though reverse scored items can help limit acquiescence bias, they can also affect the scale's reliability, and participants' understanding of the items (Suárez-Alvarez et al., 2018). Including reverse scored items may also lead to the questioning of the subscales' construct validity, as it has been criticized in mindfulness measures including only reverse scored items (Grossman, 2011). Does the absence of worrying necessarily translate to the presence of Equanimity? Does not avoiding body sensations necessarily translate to paying attention to body sensations? These are important construct validity questions that can be addressed in future studies by conducting psychometric explorations with positively phrased items.

Finally, the MBAQ is limited because it is self-report, so it is subject to self-perception and self-report biases (Goodman et al., 2017). For constructs like mindfulness and BA, self-report biases may be particularly problematic because it may be difficult for people

to accurately report on something they are not aware of (Grossman & Van Dam, 2011; Mehling et al., 2012). Since these limitations apply to all BA self-report measures, we encourage researchers to use different BA measurement modalities (e.g., both self-report and behavioral measures) in the same study.

4.6 Conclusion

In conclusion, a systematic, mixed-methods approach led to the introduction of the MBA construct and the development of the MBAQ, a measure of adaptive BA tailored for a population of youth between the ages of 14 and 24. The MBAQ contains three dimensions that reflect three ways of mindfully relating to body sensations. The questionnaire has good psychometric properties and allows further investigation in the fields of BA, mindfulness, psychological well-being, and body-based approaches in youth. Given its good test-retest reliability, the MBAQ can be used to monitor change in interventions involving BA training, such as MBIs, in AYAs. Furthermore, researchers can use it to investigate the role of adaptive BA in young people's psychological well-being and in potentially protecting young people from developing mental health conditions. Lastly, the MBAQ can be used in clinical practice as a tool to help concretize AYAs' difficulties in BA and to monitor a patient's progress in BA skills throughout therapy.

Chapter 5.

A French Version of the Difficulties in Emotion Regulation Scale Short Form (F-DERS-SF): Validation in an adolescent sample

Background. Emotion dysregulation (ED) is the inability to cope with emotional experiences and leverage them in line with one's goals. The short version of the Difficulties in Emotion Regulation scale (DERS-SF) is a commonly used measure of ED that has not yet been validated in a francophone adolescent sample. The aim of the present study is to validate a French version of the DERS-SF (F-DERS-SF) and assess its psychometric properties in a sample of adolescents.

Method. To achieve this, 139 adolescents aged 14 to 18 (M = 16.58; SD = 0.80) completed the F-DERS-SF, a mindfulness, and an emotional distress questionnaire. A sub-sample of participants (n = 33) completed the F-DERS-SF a second time after 15 days. Factor structure, test-retest reliability, internal consistency reliability, and convergent validity were assessed. In an exploratory fashion, two alternative models were run for comparison purposes.

Results. The correlated six-factor model of the original version displayed good model fit and excellent reliability and validity for all subscales except for the Awareness subscale. The alternative five-factor model excluding Awareness showed the best model fit and psychometric properties.

Conclusions. The F-DERS-SF can be used for research and clinical purposes in a population of adolescents. The present study's results suggest that all subscale scores can be used reliably except for the Awareness subscale. If the Awareness subscale is used, we advise a cautious interpretation of its results.

Reference

Pérez-Peña, M. & Philippot, P. (2023). A French Version of the Difficulties in Emotion Regulation Scale Short Form (F-DERS-SF): Validation in an adolescent sample [Manuscript submitted for publication]. Department of Psychology and Educational Sciences, UCLouvain.

5.1 Introduction

According to the World Health Organization (2021), one in seven adolescents suffers from a mental health disorder, with anxiety, depression, and behavioral problems being the most prevalent. The recent Covid-19 pandemic and the associated social confinement has aggravated adolescents' mental health burden with potentially long-term negative consequences (Jones et al., 2021; Meherali et al., 2021). Emotion dysregulation, or the inability to regulate one's emotional experiences, is an important risk factor that predicts poor mental health in youth (McLaughlin et al., 2011). It is also a vital target for intervention and prevention efforts (F. W. Paulus et al., 2021).

Emotion regulation (ER) is a combination of skills allowing an individual to cope with emotional experiences and leverage them in line with their goals. According to Gratz and Roemer (2004), this skillset includes being aware of one's emotions, understanding them, accepting them, behaving in accordance with one's goals when faced with emotions, and implementing ER strategies to modulate emotional experiences in a flexible and situationally appropriate way. Emotion dysregulation (ED) can be defined as the absence of one or more of these abilities. Research has revealed that ED is involved in the maintenance of a variety of psychological and psychiatric disorders in children, adolescents and adults (Beauchaine & Cicchetti, 2019; Faustino, 2021; F. W. Paulus et al., 2021).

Adolescence is a crucial period for ER development (Silvers, 2022). It is a time of great social, personal, professional, biological, and neurological changes, increased autonomy, and increased demands, which must all be met with a brain that is still under development (Casey et al., 2010). Neurologically speaking, brain regions involved in higher-order ER, such as the prefrontal areas, go through a speedy development during adolescence (Ahmed et al., 2015). For instance, adolescents are increasingly able to use cognitive reappraisal strategies effectively (i.e., changing the way they see an emotion-eliciting event to reduce negative affect and amygdala activity), whereas children under the age of 10 are not (Dougherty et al., 2015; Silvers et al., 2017). Socially speaking, adolescents face increasing relational complexity and in their search for autonomy, seek less help from their parents and more from their peers, meaning a process of emotional autonomy is taking place (King et al., 2018; Klimes-Dougan et al., 2014; Silvers, 2022). In face of the numerous changes and demands characterizing this period of life, many adolescents experience difficulties coping with their emotional experiences (Silvers, 2022), a risk factor for psychological problems down the road (McLaughlin et al., 2011).

Adolescence is also a time of increased vulnerability for ED. Studies show that anxiety, mood, substance-use, and psychotic disorders tend to arise during adolescence and emerging adulthood and the earlier the age of onset, the poorer the clinical outcomes (De Girolamo et al., 2012). Furthermore, adolescents who cope with negative emotions using denial or rumination, exhibit higher levels of problematic behavior and depressive symptoms (Silk et al., 2003), underlining the link between symptomatology and ED.

Casey and Caudle (2013) explain the high prevalence of ED during adolescence using the imbalance model of brain development, which posits that limbic brain structures develop more quickly than prefrontal brain regions leading to difficulties in ER and decision-making. Taken together, developmental factors may contribute to adolescents' increased vulnerability to ED, which in turn increases their risk for developing a mental disorder.

Despite the important role that ED plays in the development of adolescent psychopathology, there is a lack of ED research and measures for this developmental period. Adrian et al. (2011) conducted a thorough review of the methods used to measure ER in children and adolescents between 1975 and 2010, and found that the least amount of published ER research has been done on adolescents in comparison to infants and young children. Mazefsky et al. (2021) conducted a more recent review of existing ER and reactivity measures for children and adolescents, and found the existence of 87 measures, 59.77% of which are not recommended for use due to poor psychometric properties or lack of psychometric assessment. The authors further highlighted the need for cross-cultural validation of ER measures as most measures have been assessed in small, non-representative samples (Mazefsky et al., 2021). Hence, there is a need for the validation of high-quality instruments in different languages and cultures in order to advance the field of ER and ED research in adolescents.

The purpose of the present study is to address this gap by validating the Difficulties in Emotion Regulation Scale-Short Form (DERS-SF; Kaufman et al., 2016) in a French-speaking adolescent sample. The DERS-SF is an 18-item scale, a shortened version of the 36-item Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004). The DERS was initially developed as a multidimensional measure of ED in adults. Inspired by various influential ER theories (Hayes et al., 1999; Linehan, 1993; Thompson & Calkins, 1996; Thompson, 1994), the developers of the DERS came up with a multidimensional conceptualization of ED encompassing the various aspects of ER that people can have difficulties with, mainly emotional awareness, acceptance of emotions, goal-directed behaviors in the presence of negative emotions, and implementation of ER strategies (Gratz & Roemer, 2004). Since its initial development, the DERS has been validated in a wide variety of populations, including adolescents (Charak et al., 2019; Mcvey et al., 2022; Neumann et al., 2010; Perez et al., 2012; Weinberg & Klonsky, 2009) and has been translated into many languages (Cho & Hong, 2013; Giromini et al., 2012; J. Li et al., 2018; Sarıtas-Atalar et al., 2015; Tejeda et al., 2012), including French (Côté et al., 2013; Dan-Glauser & Scherer, 2013). Kaufman and colleagues (2016) decided to develop a streamlined version of the DERS in order to reduce respondent burden, limit item repetitiveness, and increase questionnaire administration efficiency. They created the DERS-SF by choosing the items with strongest factor loadings and fewest cross-loadings per sub-scale across studies (Skutch et al., 2019). The DERS-SF has excellent psychometric properties and has been validated in adult and adolescent samples (Hallion et al., 2018; Kaufman et al., 2016). Other short versions of the DERS have also been developed (i.e., DERS-16 and DERS-18) and studies have shown that the three existing short versions are

equally valid and reliable (Skutch et al., 2019). We chose to validate Kaufman and colleagues' (2016) short version because it retains sub-scale scores (unlike the DERS-16), it has been validated in multiple languages and cultures (Benda, 2017; Gouveia et al., 2022; Moreira et al., 2020; Navarro et al., 2021; Rossi et al., 2023; more so than the DERS-18), it has been validated in various adolescent samples (Kaufman et al., 2016; Moreira et al., 2020), and it has demonstrated strict gender invariance (Gouveia et al., 2022).

The reasons for choosing to validate the French version of the DERS-SF (F-DERS-SF) are threefold. First of all, as described above, the DERS-SF is based on a very complete, multidimensional conceptualization of ED. Existing ER self-report measures that have been translated into French lack the comprehensive scope of the DERS-SF. For example, the Emotion Regulation Questionnaire for Children and Adolescents focuses solely on the implementation of two specific ER strategies, reappraisal and suppression (Gullone & Taffe, 2012; Lahaye et al., 2010). As a second example, the Cognitive Emotion Regulation Questionnaire focuses on adaptive and maladaptive cognitive ER strategies but does not include behavioral ER strategies (d'Acremont & Van der Linden, 2007; Garnefski et al., 2001). The field could benefit from a questionnaire that includes the many aspects of ED. Second of all, the English version of the DERS-SF has been proven to have excellent psychometric properties in a sample of anglophone adolescents (Kaufman et al., 2016), speaking to its potential validity in adolescent samples of other cultures. Lastly, one of the advantages of the DERS-SF is that it is relatively short, thereby reducing respondent burden and potentially increasing response rates (Edwards et al., 2002).

The present study's goal is to validate the French version of the DERS-SF proposed by Kaufman and colleagues (2016). This shortened French scale will allow further research on emotion dysregulation that is comparable across multiple languages and cultures. The present study aims to assess the psychometric properties of the F-DERS-SF in a francophone sample of adolescents. Three questions will be examined. First, we will investigate whether the F-DERS-SF has the same six-factor structure as the original DERS-SF. We expect that the F-DERS-SF will have similar model fit and similar factor loadings as the original DERS-SF. Second, we will examine the internal consistency and test-retest reliability of the F-DERS-SF. We expect results will be comparable to those of the original scale. Finally, we will examine construct validity by assessing the F-DERS-SF's correlations with symptoms of emotional distress (i.e., anxiety, depression, and stress) and mindfulness (i.e., attention to present-moment experience with an attitude of curiosity, openness, and acceptance; Bishop et al., 2004). In line with prior studies, we expect to find significant positive correlations of the F-DERS-SF sub-scale scores with symptoms of emotional distress (Hallion et al., 2018). Moreover, we hypothesize significant negative correlations between the F-DERS-SF sub-scales and mindfulness, a skill that promotes adaptive emotion regulation and has been consistently negatively associated with emotion regulation difficulties (Chambers et al., 2009; Feldman et al., 2007; Hill & Updegraff, 2012; Moreira et al., 2020; Roemer et al., 2015). If some aspects of the model's

psychometric properties are poor, exploratory analyses will be conducted assessing alternative models and comparing them with the hypothesized model. By examining the above-mentioned questions, the present study will contribute to assessing the cultural robustness of the DERS-SF. To our knowledge, this is the first study to assess the psychometric properties of the F-DERS-SF in a French-speaking adolescent population.

5.2 Methods

Participants and Procedure

The final sample consisted of 139 participants between the ages of 14 and 18 (M = 16.58; SD = 0.80). With regards to gender, 63.3% of participants were female, 30.2% were male, 2.88% were non-binary, and 3.60% identified as other. The sample was predominantly French (n = 80; 57.6%) and Belgian (n = 43; 30.9%) with 91.4% reporting French as their mother tongue. The majority of participants were in secondary school (n = 121; 87.1%) and most did not have prior experience with mind-body practices such as yoga or meditation (n = 78; 56.1%).

Participants were recruited by posting recruitment ads on Facebook and Instagram and by sending recruitment flyers to different scout groups, youth movements, and schools. Interested participants accessed a link to an online Qualtrics survey where they answered demographic questions and completed three questionnaires (see Measures). The survey took approximately 8-10 minutes to complete. At the end of the survey, participants were asked if they would like to fill in a part of the survey a second time in 15 days. Those who responded yes were sent a Qualtrics link to the F-DERS-SF 15 days after the first administration. This second survey took less than 5 minutes to complete. Participants were compensated with participation in a raffle where one participant won 50 euros, two participants won 20 euros, and one participant won 10 euros.

Parental consent forms were obtained from adolescents between the ages of 14 and 15 but not from adolescents between the ages of 16 and 18 because they are considered responsible enough to make their own decisions regarding participation in an online research study (UCLouvain, 2023). All participants were asked to fill in an electronic informed consent form at the beginning of the online survey. The study was approved by the Ethical Committee of the Psychological Sciences Research Institute at the University of Louvain.

Measures

Difficulties in Emotion Regulation Scale

The DERS-SF (Kaufman et al., 2016) contains 18 items that load onto six sub-scales of three items each: (1) Limited Access to Effective ER Strategies (Strategies; e.g., "When

I'm upset, I believe there is nothing I can do to make myself feel better"); (2) Nonacceptance of Negative Emotional Responses (Nonacceptance; e.g., "When I'm upset, I become embarrassed for feeling that way"); (3) Difficulties Controlling Impulsive Behaviors When Distressed (Impulse; e.g., "When I'm upset, I lose control over my behavior"); (4) Difficulties Engaging in Goal-Directed Behaviors When Distressed (Goals; e.g., "When I'm upset, I have difficulty getting work done); (5) Lack of Emotional Awareness (Awareness; e.g., "I care about what I am feeling"); and (6) Lack of Emotional Clarity (Clarity; e.g., "I have difficulty making sense out of my feelings"). Participants are asked to indicate how often each phrase applies to them on a 5-point Likert scale ranging from 1 (almost never) to 5 (almost always). Higher values reflect greater difficulties with emotion regulation. A total score can be obtained by summing or averaging all items, and sub-scale scores can be calculated by summing or averaging the relevant items per sub-scale. The initial DERS-SF validation study revealed excellent psychometric properties in an adolescent sample, with the following Cronbach's alphas: Strategies (0.87), Nonacceptance (0.87), Impulse (0.88), Goals (0.90), Awareness (0.79), Clarity (0.86), and total score (0.91). Since hierarchical models were not tested in the present study, claims cannot be made about the total score and the total score was hence excluded from the analyses. Items on the F-DERS-SF were extracted from the French Canadian 36-item DERS (Côté et al., 2013) and the Swiss French 36-item DERS (Dan-Glauser & Scherer, 2013). Three researchers who are fluent in French and English read the aforementioned scales' items carefully and selected the most clearly articulated items that best reflected the meaning of the original English items. The phrasing of certain items was slightly modified to increase comprehensibility for an adolescent audience and to better reflect the original items' meaning. In general, selected and adapted items were most heavily inspired by the Swiss DERS items. More specifically, six items were extracted from the Swiss DERS unchanged, two items were extracted from the Canadian DERS unchanged, and the remaining 10 items were slightly adapted versions of the existing items. Adaptations included using simpler words to make the items more accessible to adolescents and minor language modifications to make the translation as close to the original item as possible. See Appendix E S2 for a detailed overview of which F-DERS-SF items were extracted from which DERS version and of the adaptations made.

Child and Adolescent Mindfulness Measure

The Child and Adolescent Mindfulness Measure (CAMM) was developed by Greco et al. (2011) and validated in French by Roux et al. (2019). It measures mindfulness as a unidimensional construct characterized by present-moment, non-judgmental awareness (Greco et al., 2011). The CAMM consists of 10 items assessed on a scale of 0 (never true) to 4 (always true). A total score is obtained by reverse coding all items and summing them. Higher scores indicate higher levels of mindfulness. The CAMM has been shown to have good psychometric properties with an internal consistency of 0.77 in a French-speaking adolescent sample (Roux et al., 2019). The Cronbach's alpha in the present study was of 0.80.

Depression Anxiety and Stress Scale

The Depression, Anxiety and Stress Scale (DASS-21) measures emotional states of depression, anxiety, and stress (Lovibond & Lovibond, 1995). It includes 21 items and consists of three subscales: (1) depression (i.e., symptoms of dysphoria, hopelessness, lack of interest, etc.); (2) anxiety (i.e., autonomic arousal, anxious affect, situational anxiety); and (3) stress (i.e., irritability, difficulties relaxing, nervous arousal). Items are assessed on a scale ranging from 0 (did not apply to me at all) to 3 (applied to me very much, or most of the time). Scores are obtained by summing the relevant items per dimension and all items for the total score. The DASS-21 has well-documented psychometric properties (Lovibond & Lovibond, 1995) in adolescent samples (Szabó, 2010) and across cultures (Mellor et al., 2015). The long version of the scale, DASS-42, has been validated in a French-speaking young adult sample (Ciobanu et al., 2018). Overall, the psychometric properties were good. The present study used the French version of the DASS-21 developed by Donald Martin's team from the University of Ottawa (Donald, 2012). Though this French version of the DASS-21 has yet to be validated, it has been successfully used in prior studies (e.g., Arcand et al., 2023) and internal consistency in the present study's sample was very good (i.e., 0.93 for the total score, 0.87 for the depression sub-scale, 0.83 for the anxiety sub-scale, and 0.83 for the stress sub-scale).

Statistical Analyses

Preliminary analyses of the data included: checking the data for accuracy, excluding participants who did not meet the inclusion criteria or did not consent to participate in the study, conducting a missing data analysis, screening the data for outliers using Mahalanobis distance, calculating descriptive statistics and scores, and checking statistical assumptions for the main analyses.

Next, Confirmatory Factor Analysis (CFA) was performed on the F-DERS-SF to assess model fit and compare the results with those of the original DERS-SF. Analyses were conducted with the cfa function in R's lavaan package (Rosseel, n.d). A six-factor model with correlated factors was measured using maximum likelihood estimation as was done in the original DERS-SF article (Kaufman et al., 2016). A combination of indices was computed to assess model fit: chi-square, root mean square error of approximation (RMSEA), Tucker Lewis Index (TLI), and Confirmatory Factor Index (CFI). The model was considered a good fit if the RMSEA was less than .08, the TLI was greater than .90, and the CFI was greater than .90 (Ben-Shachar et al., n.d; Browne, 1993; Lin, 2021). Regarding chi-square, we considered the test statistic, degrees of freedom, and associated *p*-value (a non-significant *p*-value indicates good model fit). However, since the chi-square test is sensitive to sample size, this index was not given the most weight and instead the results of the combination of indices was considered (Lin, 2021). The CFA results, including the factor loadings and the model fit indices, were compared to those of the original DERS-SF.

In order to assess the reliability and validity of the F-DERS-SF, we conducted the following analyses. The Cronbach's alphas of the F-DERS-SF's sub-scale scores were computed to assess internal consistency reliability. The single random raters Intraclass Correlation Coefficient (ICC) was calculated to measure test-retest reliability in accordance with Koo and Li's (2016) guidelines. To measure convergent validity, we computed correlations between the F-DERS-SF and a measure of emotional distress (i.e., DASS-21) as well as correlations between the F-DERS-SF and a measure of mindfulness (i.e., CAMM).

Finally, in an exploratory fashion, two alternative models were computed and compared to the hypothesized model. These models were based on alternative models tested in prior studies (Bardeen et al., 2012, 2016; Benfer et al., 2019; Moreira et al., 2020). The first alternative model was a 5-factor model excluding the Awareness subscale and the second alternative model was a 5-factor model that combined the Awareness and Clarity subscales into one factor. The three models were then compared on the basis of their model fit indices, psychometric properties, and Akaike information criterion (AIC) values.

5.3 Results

Preliminary Analyses

A total of 178 participants clicked on the Qualtrics survey link. One participant was directly excluded because they did not consent to participate in the study. There was 24% of missing data with a missing at random (MAR) pattern. We removed 37 participants because they did not complete any of the questionnaires. Pairwise deletion was chosen to deal with the missing data because it is the recommended technique for cross-sectional data with an MAR pattern (Bennett, 2001). One multivariate outlier was detected using Mahalanobis distance and it was removed. This led to a total sample size of 139 participants.

The data met the statistical assumptions for correlation and CFA analyses. For correlations, the assumptions of continuous variables, linearity, normality, related pairs, and no outliers were met. For CFA, the assumptions for multivariate normality, sufficient sample size, a correct a priori model specification, and a random sample were met. The required sample size for the present study was calculated based on the recommendations of Koran (2016) who states that for a CFA model with 6 factors, 3 indicators per factor and factor loadings of approximately .80, a minimum sample size of 100 is required for satisfactory convergence, bias, and power. This sample size is also supported by sample size recommendations in Anderson and Gerbing (1984) and Jackson et al. (2013) The current sample's descriptive statistics can be found in Table 14. Descriptive statistics among girls, boys, and entire sample

Table 14. Descriptive statistics among girls, boys, and entire sample

	Girls (*n* = 88)			Boys (*n* = 42)			Entire sample (*n* = 139)		
Scale and dimensions	N	M	SD	N	M	SD	N	M	SD
F-DERS-SF Strategies	88	3.17*	1.11	42	2.54	1.14	139	2.98	1.15
F-DERS-SF Nonacc.	88	2.75*	1.16	42	2.33	1.05	139	2.69	1.20
F-DERS-SF Impulse	88	2.52*	1.28	42	1.87	0.99	139	2.37	1.26
F-DERS-SF Goals	88	3.76	1.04	42	3.44	1.23	139	3.65	1.12
F-DERS-SF Aware.	88	2.24	0.98	42	2.41	0.98	139	2.33	0.98
F-DERS-SF Clarity	88	2.66	0.97	42	2.65	0.98	139	2.70	1.00
CAMM Total	80	17.34	7.43	39	19.21	7.55	128	17.63	7.61
DASS-21 Depression	76	10.57	5.83	35	9.71	5.36	120	10.49	5.65
DASS-21 Anxiety	76	10.11*	5.19	35	7.46	5.51	120	9.48	5.42
DASS-21 Stress	76	11.21*	4.86	35	8.66	4.77	120	10.62	5.07
DASS-21 Total	76	31.88	13.82	35	25.83	14.23	120	30.58	14.34

Note. N = sample size; M = mean; SD = standard deviation; F-DERS-SF = French Difficulties in Emotion Regulation Scale Short-Form; CAMM = Child and Adolescent Mindfulness Measure; DASS-21 = Depression, Anxiety, and Stress Scale-21; Nonacc. = Nonacceptance; Aware. = Awareness; * = independent samples t-tests indicate this value is significantly higher in girls than in boys at $p < .05$.

Confirmatory Factor Analysis

CFA analyses on the F-DERS-SF model yielded the model fit indices found in Table 18 (see Model 1). Most of these values, with the exception of the significant chi-square, indicate good model fit with the data. Furthermore, these results are comparable to the model fit indices of the original validation of the DERS-SF in an adolescent sample (RMSEA = .06 [90 %: .05–.08]; TLI = .94; CFI = .96; χ^2 (120) = 245.695, $p < 0.01$; Kaufman et al., 2016)[1]. The range of item factor loadings (see Table 18) was acceptable and comparable to the range of factor loadings of the original DERS-SF (.74-.94; Kaufman et al., 2016). Table 15 shows the factor loadings for the F-DERS-SF model.

Within-measure sub-scale correlations were also calculated and are presented in Table 16. The correlations are mostly comparable to those of the original DERS-SF validation in an adolescent sample. There are two main differences in the results. First, the magnitudes of the correlations were generally larger in the original validation study than in the present study. Second, the present study found no significant correlations

[1] Although the significant $\chi 2$ indicates poor model fit, the $\chi 2$ / df value is 2.05 which reflects good model fit (Giromini et al., 2012).

between the Awareness subscale and most of the other subscales with the exception of Clarity, whereas the original validation study showed significant small correlations between the Awareness subscale and the Strategies, Nonacceptance, Impulse, and Clarity subscales.

Psychometric Properties

The internal consistency and test-retest reliability of the F-DERS-SF were both assessed. The Cronbach's alpha coefficients per subscale are reported in Table 15 and ranged from .69 to .91. Overall, results indicate a good internal consistency of the F-DERS-SF and its subscales. The only subscale with a relatively low Cronbach's alpha coefficient is Awareness ($\alpha = .69$). Results are mostly comparable to those of the original DERS-SF validation study, except in the case of the Awareness subscale which had a much better Cronbach's alpha coefficient in the original study ($\alpha = .79$; Kaufman et al., 2016).

Regarding test-retest reliability analyses, 33 participants completed the survey a second time. Results showed that the F-DERS-SF sub-scales have moderate to good test-retest reliability (Strategies: ICC = .80, $p < .001$, [95%: .64-.90]; Non-acceptance: ICC = .67, $p < .001$, [95%: .43-.82]; Impulse: ICC = .81, $p < .001$, [95%: .64-.90]; Goals: ICC = .65, $p < .001$, [95%: .40-.81]; Awareness: ICC = .83, $p < .001$, [95%: .68-.91]; Clarity: ICC = .71, $p < .001$, [95%: .49-.84]). Test-retest reliability was not measured in the original DERS-SF validation study in an adolescent sample.

Table 15. Confirmatory factor loadings for the F-DERS-SF in an adolescent sample

Item	Factor Loadings
Strategies (α = .79)	
10. When I'm upset, I believe that I will end up feeling very depressed.	.70
15. When I'm upset, I believe there is nothing I can do to make myself feel better.	.82
18. When I'm upset, it takes me a long time to feel better.	.71
Nonacceptance (α = .81)	
7. When I'm upset, I become embarrassed for feeling that way.	.78
12. When I'm upset, I feel guilty for feeling that way.	.85
16. When I'm upset, I become irritated at myself for feeling that way.	.69
Impulse (α = .91)	
9. When I'm upset, I become out of control.	.85
14. When I'm upset, I have difficulty controlling my behavior.	.88
17. When I'm upset, I lose control over my behavior.	.91

Goals (α = .86)	
8. When I'm upset, I have difficulty getting work done.	.74
11. When I'm upset, I have difficulty focusing on other things.	.88
13. When I'm upset, I have difficulty concentrating.	.84
Awareness (α = .69)	
1. I pay attention to how I feel.*	.57
4. I care about what I am feeling.*	.90
6. When I'm upset, I acknowledge my emotions.*	.52
Clarity (α = .78)	
2. I have no idea how I am feeling.	.68
3. I have difficulty making sense out of my feelings.	.81
5. I am confused about how I feel.	.72

Note. * = reverse scored item

Table 16. Within-measure subscale correlations for the F-DERS-SF in an adolescent sample (*N* = 139)

	Strategies	Nonacceptance	Impulse	Goals	Awareness	Clarity
Nonacceptance	.40**	-				
Impulse	.54**	.23**	-			
Goals	.53**	.28**	.50**	-		
Awareness	.11	.15	.00	-.06	-	
Clarity	.49**	.36**	.31**	.32**	.33**	-

Note. Strategies = F-DERS-SF Limited Access to Strategies for Regulation subscale; Nonacceptance = F-DERS-SF Nonacceptance of Emotional Experiences subscale; Impulse = F-DERS-SF Impulse Control Difficulties subscale; Goals = F-DERS-SF Difficulty Engaging in Goal-Directed Behavior subscale; Awareness = F-DERS-SF Lack of Emotional Awareness subscale; Clarity = F-DERS-SF Lack of Emotional Clarity subscale. *p < .05, **p < .01

Convergent Validity

Correlations for the F-DERS-SF with the CAMM and DASS-21 are presented in Table 17. Results show significant medium to strong negative correlations between all sub-scales of the F-DERS-SF and mindfulness skills as measured by the CAMM. Results also show medium to strong positive correlations between most sub-scales of the F-DERS-SF and depression, anxiety, stress, and emotional distress as measured by the DASS-21. The only exception is the Awareness subscale that is not correlated with anxiety, stress, or emotional distress.

Table 17. Convergent validity correlations for the F-DERS-SF in an adolescent sample

	Strategies	Nonacceptance	Impulse	Goals	Awareness	Clarity
CAMM Total	-.60**	-.65**	-.45**	-.48**	-.24**	-.63**
DASS-21 Depression	.67**	.37**	.50**	.45**	.25**	.52**
DASS-21 Anxiety	.55**	.39**	.44**	.34**	.08	.41**
DASS-21 Stress	.57**	.37**	.60**	.46**	.14	.44**
DASS-21 Total	.67**	.42**	.58**	.47**	.18	.52**

Note. CAMM = Child and Adolescent Mindfulness Measure; DASS-21 = Depression, Anxiety, and Stress Scale-21; *p < .05, **p < .01

Exploratory Analyses

Since the Awareness subscale displayed questionable psychometric properties, two alternative models were computed and compared to the correlated 6-factor model (Model 1). The first alternative model was a correlated five-factor model excluding the Awareness subscale (Model 2) and the second was a correlated five-factor model that combined the Awareness and Clarity subscales into one subscale (Model 3). The goodness of fit statistics can be found in Table 18. Model 2 has the best goodness of fit statistics followed by Model 1. Model 3 has the worst fit.

The alternative models' within-scale correlations, internal consistency reliability, test-retest reliability, and convergent validity were also assessed. The detailed results on all these aspects for both models can be found in Appendix E S3 and S4. Below we highlight the most important observations. Model 2 displayed the same subscale internal consistency reliability, test-retest reliability, convergent validity, and within-scale correlations as Model 1. The only difference was that since the Awareness subscale was removed, only results of the subscales with stronger psychometric properties were retained. Regarding Model 3, psychometric results for the Strategies, Nonacceptance, Impulse, and Goals subscales were the same as in Model 1. The only difference was the Awareness-Clarity subscale which displayed the following psychometric properties. It showed significant positive correlations with most sub-scales except the Goals subscale, had the lowest internal consistency of the five subscales ($\alpha = .74$), and was significantly correlated with emotional distress (and all its dimensions) and mindfulness in the expected directions, suggesting good convergent validity. However, factor loadings for Model 3 were quite low, particularly for the Awareness items that were included as part of the Awareness-Clarity subscale.

Table 18. Goodness of fit statistics of the hypothesized model and two alternative models

	Goodness of fit statistics						
	χ^2	*df*	CFI	TLI	RMSEA [90%CI]	Factor loadings	AIC
Model 1: Correlated six-factor model (18 items)	189.96*	120	.94	.92	.065 [.05, .08]	.52 - .91	7380.88
Model 2: Five-factor model excluding Awareness (15 items)	123.48*	80	.96	.95	.063[.04, .08]	.66 - .91	6093.20
Model 3: Five-factor model combining Awareness and Clarity into one subscale (18 items)	258.66*	125	.89	.86	.088[.07, .10]	.27 - .91	7439.58

Note. *p < .01

5.4 Discussion

The present study sought to assess the psychometric properties of a French version of the DERS-SF in an adolescent sample. The scale's factor structure, internal consistency reliability, test-retest reliability, and convergent validity were assessed and compared to those of the original DERS-SF. Overall, results showed that the F-DERS-SF has a comparable factor structure to the original DERS-SF, as well as very good internal consistency reliability, test-retest reliability, and convergent validity. The only subscale with questionable psychometric properties was the Awareness subscale. Hence, exploratory analyses were conducted to test alternative models and results showed that the best-fitting model was a correlated five-factor model excluding Awareness.

Specifically, the present study's findings provide evidence for a correlated six-factor model of the F-DERS-SF with model fit indices and factor loadings comparable to those of the original DERS-SF in an adolescent sample (Kaufman et al., 2016). These results are in line with other cross-cultural validation studies of the DERS-SF in Spanish (Navarro et al., 2021) and Portuguese samples (Gouveia et al., 2022; Moreira et al., 2020), suggesting that the factor structure is robust across cultures.

Regarding the within-scale correlations, findings are less clear-cut. In line with the original study's results, we found that most subscales correlated significantly with each other. The only exception was the Awareness subscale which was only correlated with Clarity but none of the other dimensions. This is in line with findings presented in a Spanish validation of the DERS-SF (Navarro et al., 2021) but diverges from the original study's results showing significant correlations between Awareness and four other dimensions (Kaufman et al., 2016). Other studies, such as a psychometric study of the DERS-SF in Portuguese adolescents found significant negative correlations between Awareness and the other dimensions (Moreira et al., 2020). This has led to questioning whether the Awareness dimension is part of the emotion dysregulation construct measured by the DERS and DERS-SF (Bardeen et al., 2012).

The present study's findings further suggest that the F-DERS-SF is a reliable scale. Test-retest reliability was good and most internal consistency indices were above satisfactory levels. The only exception was the Awareness dimension with an alpha coefficient of .69, which is slightly lower than the acceptable threshold of .70. This diverges from the original study in which Awareness had an alpha coefficient of .79 in an adolescent sample (Kaufman et al., 2016). However, these findings are consistent with those of other studies in which the Awareness dimension exhibits lower internal consistency than in the original study (e.g., α = .70 in Gouveia et al., 2022; α = .75 in Hallion et al., 2018). One potential explanation for the lower internal consistency of Awareness is that it is the only subscale consisting of reverse coded items only. Although they have their benefits (e.g., limiting passive and repetitive response patterns), reverse coded items may also lead to weaker psychometric properties such as lower scale reliability (Weijters & Baumgartner, 2012). In fact, Bardeen et al. (2016) changed the DERS's Awareness items from negatively phrased to positively phrased, subjected the modified scale to an Exploratory Factor Analysis, and found that the newly phrased items loaded onto the same factor as the Clarity items. This led to the creation of a modified DERS scale (M-DERS) with five factors: Strategies, Goals, Nonacceptance, Impulse, and Identification (Awareness and Clarity dimensions combined), which exhibited adequate model fit (Benfer et al., 2019). However, to our knowledge, such analyses have not yet been applied to the DERS-SF scale. Future research could assess whether positively phrased items might improve the reliability of the Awareness sub-scale in the DERS-SF, and whether this leads to a change in the scale's factor structure. Another potential reason for the scale's relatively low internal consistency is that the items may not clearly convey the meaning of the subscale, particularly in translated versions. For instance, the exact phrasing of two of the Awareness items has important differences across the three French-language versions (i.e., the Swiss DERS, Canadian DERS, and F-DERS-SF), suggesting that the phrasing of the original English items is not sufficiently specific and leaves room for varied interpretations (Côté et al., 2013; Dan-Glauser & Scherer, 2013).

Concerning convergent validity, the present study found correlations between the F-DERS-SF and emotional distress and mindfulness in the expected directions. All subscales were significantly negatively correlated with mindfulness. Mindfulness is defined as "paying attention on purpose, in the present moment, and non-judgmentally to the unfolding of experience" (Kabat-zinn, 2003, p. 145) and has been positively associated with adaptive ER (Hölzel et al., 2011; Roemer et al., 2015). For example, prior studies have shown significant associations between mindfulness and increased engagement in goal-directed behaviors (Roemer et al., 2015), reduced passive and impulsive ER strategies (Nyklíček, 2011), and increased reappraisal (Hölzel et al., 2011). Furthermore, mindfulness-based interventions, therapeutic trainings that involve a systematic training in mindfulness skills, have been shown to reduce the use of dysfunctional ER strategies in adolescents (Deplus et al., 2016) and improve ER abilities in children (Rowland et al., 2023). Hence, the negative associations between mindfulness

and difficulties regulating emotions make sense and provide evidence for construct validity of the F-DERS-SF.

The second measure used to assess convergent validity was emotional distress encompassing stress, anxiety, and depression. As expected, most subscale scores of the F-DERS-SF were significantly positively correlated with emotional distress and its three dimensions. The only exception was Awareness which had mild but significant positive correlations with depression, but no correlation with anxiety or stress. This is in line with findings by Hallion et al. (2018) who found significant correlations between all subscales of the DERS and depression, anxiety, and stress, but no correlation between Awareness and any of the dimensions of emotional distress. The authors interpret this as meaning that the Awareness dimension may be assessing a different construct. Being aware of one's emotions is different from one's reactions to emotions, which is what the other subscales seem to be focusing on (e.g., reacting impulsively, engaging in goal-directed behaviors, etc.). Another potential explanation is that the Awareness subscale does not consider *the way* in which one is aware of emotions, and hence would be differentially related to psychological symptoms depending on one's attitude during emotional awareness. For instance, if one is aware in an accepting, non-judgmental way, this would be positively correlated with adaptive ER and negatively correlated to emotional distress, but if one is aware in a judgmental, critical way, this would be negatively correlated with adaptive ER and positively correlated with emotional distress (Tull et al., 2007). Hence, aggregated among sample participants, these opposite tendencies might neutralize each other and result in a null correlation. Overall, our results provide evidence for the construct validity of the F-DERS-SF as most subscales are positively correlated with emotional distress. Awareness is the only exception.

Finally, the present study found significant gender differences in difficulties regulating emotions. Overall, girls reported more difficulties regulating emotions than boys. More specifically, girls reported more difficulties accepting their emotions, controlling impulses in the presence of emotions, and accessing strategies to regulate their emotions. Regarding difficulties in engaging in goal-directed behavior, being aware of emotions, and having emotional clarity, there were no significant differences between boys and girls. These findings are partially consistent with findings by Neumann et al. (2010) who found that adolescent girls reported greater nonacceptance and less access to ER strategies than adolescent boys. They also found that adolescent girls reported greater emotional awareness than adolescent boys, which was not the case in our sample. This difference in findings may be attributed to different reasons, for instance the difference in comprehension of the reverse coded items in different cultural samples. Another potential explanation is the difference in age of the two samples (i.e., mean age of 16.58 in the present study and 14.34 in the study by Neumann and colleagues). Age is positively associated with emotional awareness and perhaps as adolescents get older, their emotional awareness abilities improve and apparent gender differences at earlier ages start to disappear as adolescent boys' emotional maturity lags behind adolescent girls' (Mankus

et al., 2016). Overall, our findings suggest that adolescent girls have significantly more difficulties in certain aspects of ER than adolescent boys. However, these findings must be interpreted with caution, as the sample has imbalanced gender proportions (i.e., twice as many girls as boys).

In summary, the present study adapted a French version of the DERS-SF and validated it in a sample of francophone adolescents. Results indicate that the F-DERS-SF has good psychometric properties comparable to those of the original scale. The only point of concern is the Awareness subscale which has relatively lower internal consistency reliability and a different pattern of within-scale and convergent validity correlations than the other subscales. For this reason, the present study assessed two alternative models in an exploratory fashion and found that the model excluding Awareness displayed the best fit indices and psychometric properties. Future research with larger samples could assess various alternative models of the F-DERS-SF such as the models assessed in the present study as well as more complex bifactor hierarchical models with and without the Awareness subscale, and identify which model is best as was done in the study by Moreira et al. (2020) for the Portuguese version of the DERS-SF.

Our results must be interpreted in light of the present study's strengths and limitations. To our knowledge, this is the first study to assess the validity of a French version of the DERS-SF in a francophone sample of adolescents. Furthermore, the present study does a thorough assessment of all the scale's psychometric characteristics (i.e., factor structure, internal consistency reliability, convergent validity, and test-retest reliability) and computes two alternative models for comparison. Some of the limitations of the present study include the limited sample size that prevented us from computing more complex alternative models such as hierarchical models that would have permitted assessing the validity of the total score. A second limitation is that the sample consisted of more female adolescents than male adolescents, limiting its representativeness. Third, participants who took the test a second time for test-retest reliability analyses, did so on a voluntary basis with an extra compensation. This may have led to a biased sample for these specific analyses. Finally, though convergent validity was assessed, divergent validity was not evaluated.

5.5 Conclusions

To conclude, the F-DERS-SF has very good psychometric properties and can be used for research and clinical purposes in a population of adolescents (see Appendix E S1 to access the F-DERS-SF scale and instructions on how to score and cite the scale). The present study's results suggest that all subscale scores can be used reliably except for the Awareness subscale. If the Awareness subscale is used, we suggest a cautious interpretation of its results for two reasons: (1) it was the subscale with the poorest psychometric properties and (2) the factorial model that excludes it displays the best fit indices and psychometric properties. Future studies are needed to better understand how to situate

the Awareness sub-scale in the F-DERS-SF, perhaps following the methodologies used in Moreira et al. (2020) or Bardeen et al. (2016). Future research with hierarchical models is needed to test the reliability of the F-DERS-SF total score as done in Hallion et al.(2018) and Moreira et al. (2020).

Chapter 6.

The Impact of a School-Based Mindfulness-Based Intervention on Body Awareness and Emotion Regulation in Adolescents

Background. Adolescence is a time of psychological vulnerability. Research suggests that mindfulness-based interventions (MBIs) may help prevent and alleviate the mental health burden in this vulnerable population. However, there is inconclusive evidence on the impact of MBIs in a school setting and more research is needed on the mechanisms of change of MBIs in this context and population. Hence, the present study investigated the impact of a school based MBI on two potential mediators, body awareness (BA) and emotion regulation (ER). We hypothesized that the MBI would increase adolescents' BA, which would in turn improve their ER, thereby explaining the reduction in emotional distress observed after an MBI.

Method. The present study is a randomized-controlled trial in which participants (N = 47) were randomized to a 9-week MBI group or a 9-week health psychoeducation (HP) group. Participants' BA, ER, and emotional distress were measured using self-report questionnaires and a behavioral task one week before, one week after, and three months after the intervention.

Results. Results showed a significant reduction in difficulties regulating emotions at post-assessment in the MBI group relative to the HP group. The MBI also had a protective effect on impulse control difficulties in comparison to the HP group. Both groups showed a significant improvement in anxiety symptoms and behaviorally measured BA over time. No effect was found on self-reported BA, emotional distress, depression, or stress.

Conclusions. Findings support the use of MBIs to promote adaptive ER in adolescents in a school setting. However, more research with larger samples is needed to replicate these results.

Reference

Pérez-Peña, M., Van der Gucht, K., & Philippot, P. (2023). The impact of a school-based mindfulness-based intervention on body awareness and emotion regulation in adolescents [Manuscript submitted for publication]. Department of Psychology, UCLouvain.

6.1 Introduction

Adolescence is a highly dynamic stage of life characterized by biological and physical changes, a search for autonomy, identity development, increased academic and employment pressures, and increased relational complexity (Ahmed et al., 2015; Dahl et al., 2018). These challenges must be met with a brain that is still under development making adolescents more prone to emotional reactivity, risk-taking, instability, and the development of mental health disorders (Ahmed et al., 2015; Silvers, 2022). In fact, mental health conditions affect 14% of adolescents worldwide which is preoccupying because suffering from mental health problems at a young age increases the likelihood of experiencing psychological problems at a later age (Dunn & Goodyer, 2006; Gustavson et al., 2018; World Health Organization [WHO], 2021).

Recent research has investigated the potential of mindfulness-based interventions (MBIs) for preventing and alleviating the mental health burden in this vulnerable population. Though several studies have investigated the impact of MBIs on various mental health outcomes in adolescents from both clinical and non-clinical populations (e.g., Dunning et al., 2022), few studies have examined potential mechanisms of action. Hence, the present study aims to shed light on two developmentally relevant potential outcomes and mechanisms of MBIs in adolescents: body awareness (BA) and emotion regulation (ER).

MBIs are group-based psychological interventions that teach people the skill of mindfulness. Mindfulness can be broadly defined as attending to present moment experiences in an open, accepting, and curious way (Bishop et al., 2004). Standardized MBIs for adults have been adapted for use with adolescents (e.g., Deplus & Lahaye, 2015; Tan & Martin, 2013), and many more MBIs have been developed for youth in the school context (e.g., Learning to Breathe by Broderick, 2013 and .b by Kuyken et al., 2013) or to target specific conditions (e.g., MBI adapted for adolescents with attention-deficit/hyperactivity disorder and their parents; Bögels et al., 2008).

MBIs have gained vast popularity in recent years and research has examined their effects on adolescent mental well-being. A meta-analysis of 18 randomized controlled trials (RCTs) in participants between the ages of 12 and 25 with clinical and nonclinical levels of depressive symptoms, found that Mindfulness-Based Stressed Reduction (MBSR; Kabat-Zinn, 1990) reduced depression post-intervention (Chi et al., 2018). A more recent meta-analysis of 66 RCTs in participants from clinical and nonclinical samples aged 18 or younger found significant positive effects of MBIs on executive functioning, attention, anxiety/stress, and negative and social behaviors in comparison with passive controls (Dunning et al., 2022). However, in comparison with active controls, MBIs only significantly improved anxiety/stress and mindfulness with small effect sizes. Furthermore, no significant effects were found at follow-up. These meta-analytic results suggest that MBIs may be promising for specific outcomes in youth, but since the

evidence is of low quality and highly heterogeneous, more research is needed to make robust conclusions (Dunning et al., 2022).

Regarding MBIs implemented in the school setting, findings are also mixed. A systematic review containing 28 studies of MBIs for youth in school settings, demonstrated significant reductions in outcomes such as behavioral problems, depression, anxiety, and affective disturbances (Felver et al., 2016). However, only a third of evaluated studies were RCTs, which was identified as a key methodological limitation in the school-based mindfulness literature. A comprehensive meta-analysis assessing the effectiveness of MBIs for mental health in schools across 24 studies, found that MBIs were helpful in improving mental health outcomes post-intervention in comparison to control groups with small to moderate significant effects (Carsley et al., 2018). Effects were strongest in late adolescence (15-18 years old) and in studies where interventions combined various mindfulness activities (Carsley et al., 2018). More recently, results from a parallel group, cluster-RCT (84 schools, $N = 8376$) in the United Kingdom revealed that a universal MBI was not superior to normal social-emotional education in terms of risk of depression, social-emotional-behavioral functioning, and well-being; however, it was more cost-effective (Kuyken et al., 2022). Lastly, a recent meta-analysis of nine RCTs in a school setting, found significant effects of MBIs on stress (not depression or anxiety) in comparison to inactive controls (Fulambarkar et al., 2023). However, effects were no longer significant in comparison to active controls (Fulambarkar et al., 2023). Given these mixed findings, more research is needed on the effect of MBIs in a school setting and on the moderators and mediators of MBIs' effects in order to better understand "what works, for whom, and how" (Dunning et al., 2019; Montero-Marin et al., 2022).

Two potential mechanisms of MBIs that are relevant to study in adolescence are BA and ER. BA is the subjective, phenomenological and conscious experience of body sensations shaped by complex psychological processes such as attention, attitude, interpretation, and beliefs (W. E. Mehling et al., 2011). In the present paper, we are interested in a form of adaptive BA known as mindful body awareness (MBA), which is defined as paying attention to body sensations with an open and curious attitude and integrating this information into complex psychological processes, such as decision-making and self-regulation (Pérez-Peña et al., 2023). ER is a combination of skills allowing an individual to cope with emotional experiences and leverage them in line with their goals (Gratz & Roemer, 2004). Some of these skills include being aware of one's emotions, understanding them, accepting them, behaving in accordance with one's goals when faced with emotions, among others. BA and ER are intimately linked as body sensations are an intrinsic part of the emotional experience (Craig, 2008). Furthermore, having an accepting awareness of body sensations during emotional experiences enhances emotional awareness and ER (Farb et al., 2015; Hölzel et al., 2011).

It is pertinent to investigate these two interconnected psychological processes for the following reasons. Both BA and ER are transdiagnostic processes involved in a range of mental health disorders (Beauchaine & Cicchetti, 2019; Khalsa & Lapidus, 2016) making

them interesting targets for both treatment and prevention efforts. Furthermore, both BA and ER are under development during adolescence meaning adolescents often experience more difficulties with them (J. Murphy et al., 2017; Silvers, 2022). Since these processes are under development during adolescence, this is a key time to implement psychological interventions that train BA and ER skills as the adolescent brain is more plastic and open to learning (Ahmed et al., 2015). Moreover, adolescence is a very specific time of life in which numerous bodily, emotional, and identity changes occur (Dahl et al., 2018). Considering these age-related specificities, findings on MBIs and BA and ER in adults may not be generalizable to adolescents. Lastly, various theoretical models assert that both BA and ER are important outcomes and mechanisms of MBIs (Davidson et al., 2012; Deplus et al., 2014; Hölzel et al., 2011).

To date, more empirical research has been conducted on the effects of MBIs on ER in adolescents than on the effects of MBIs on BA in adolescents. Regarding ER, theoretical models posit that MBIs impact adolescents' ER by teaching them to openly explore their emotional experiences leading to greater emotional awareness and replacement of automatic emotional behaviors with behaviors in line with a young person's values (Deplus et al., 2014). Moreover, Davidson et al. (2012) propose that contemplative practices strengthen the neural systems responsible for ER at an age when the prefrontal cortex and subcortical structures are particularly plastic. Empirical research has found mixed evidence for these theoretical claims. Several studies support these claims as MBIs have been found to significantly impact ER in a wide range of adolescent school populations (e.g., general, ethnic minorities, low-resource populations, cross-cultural, etc.). However, most of these studies used a quasi-experimental design (Broderick & Metz, 2009; Daly et al., 2015; Fung et al., 2016; Metz et al., 2013) meaning the effects may be overestimated. A few studies with an RCT design have confirmed these findings (Alampay et al., 2020; Lau et al., 2020). Recent neurobiological research supports these self-report findings as a reduction in default mode network connectivity (involved in the construction of discrete emotion; Tabibnia, 2020) was found after mindfulness-based fMRI neurofeedback in adolescents with depressive symptoms (Zhang et al., 2023). There are, however, other studies that have found no effect of an MBI on ER in a secondary school setting (Campbell et al., 2019; Lam & Seiden, 2020). Therefore, more research is needed to clarify the role of ER in MBIs in adolescents.

Surprisingly, even though BA has long been proposed as a working mechanism of MBIs and as a core feature of the mindfulness construct (Farb et al., 2015; Hölzel et al., 2011; Mehling et al., 2009), the topic has received little research attention. From a program perspective, BA plays a big role in the practices taught in MBIs. MBIs involve a systematic training in mindfulness meditation practices that include awareness of posture, breathing, and the whole body during sitting meditation, awareness of different parts of the body during the body scan meditation, and awareness of the body moving during mindful movement (Kabat-Zinn, 2013; Segal et al., 2018). Moreover, during MBIs, trainers instruct participants to attend to their bodies with a "being" mode of mind, which

involves a direct and intimate experience of body sensations in the present moment, defusing from cognitive evaluations of these sensations, and allowing body sensations to be exactly as they are (Segal et al., 2018). From this place of clearly seeing, experiencing, and accepting once's internal bodily state, in later sessions, the trainer guides participants in how to use the body to self-regulate and choose what skillful action to take next (Segal et al., 2018).

Existing empirical research on the topic is scarce, limited to adults, and has yielded mixed results depending on the BA dimension assessed. Studies in clinical and healthy adult populations found that after an MBI, participants reported significantly higher levels of adaptive BA (Bornemann et al., 2014; De Jong et al., 2016; Fissler et al., 2016; Pérez-Peña et al., 2022). In all cited studies, participants' capacity to regulate themselves using BA significantly improved after an MBI. Moreover, in most studies, there was a significant improvement in participants' capacity to regulate attention to body sensations with an attitude of trust and of willingness to listen (Bornemann et al., 2014; Fissler et al., 2016; Pérez-Peña et al., 2022). Furthermore, there is evidence that self-reported adaptive BA is not only an outcome of MBIs, but also a working mechanism by which these programs reduce psychological symptoms (De Jong et al., 2016; Fissler et al., 2016; Pérez-Peña et al., 2022). Neuroscientific research supports these self-report findings as there is evidence for increased insular activation, the brain region associated with interoception (Craig, 2003; Khalsa et al., 2018), after an MBI and in mindfulness meditators (Farb et al., 2007; Grant et al., 2010). Moreover, a recent RCT in adults with recurrent depression, found that an MBI significantly decreased salience network (i.e., brain network involved in attention, ER, and integration of emotional, interoceptive, and autonomic information) connectivity with the lingual gyrus (i.e., brain region associated with vision, emotional processing, and episodic memory) during rumination, and this neural change mediated the MBI's improvements in the ability to regulate attention to and from body sensations (van der Velden et al., 2023). This shows that an MBI has the capacity to impact both the psychological and neural processes involved in BA. Conversely, studies using behavioral measures of cardiac perception accuracy found no improved ability to accurately detect body sensations in meditators (Khalsa et al., 2008; Nielsen & Kaszniak, 2006) nor completers of an MBI (Parkin et al., 2014). Taken together, evidence suggests MBIs mostly improve adaptive BA in adults, but very little is known about this topic in adolescents.

Taken together, the cited research suggests that MBIs have a generally positive impact on adaptive BA and ER, but more research is needed in adolescents, a psychologically vulnerable time of life with its own specific challenges. Therefore, the present study aims to investigate the effect of an MBI (adapted for adolescents in a school context) on MBA and ER as well as the potential mediating role of MBA and ER in explaining the intervention's effects on adolescents' emotional distress.

The present study's specific aims are threefold: (1) to examine the impact of a school-based MBI on MBA and ER, (2) to assess whether MBA is a mediating mechanism by

which MBIs reduce emotional distress, and (3) since prior theory posits that BA has downward effects on ER skills (Hölzel et al., 2011; Pérez-Peña et al., 2022), to explore whether the impact of an MBI on emotional well-being is explained by a serial mediation pathway in which improved MBA is associated with improved ER. We hypothesized the following: (1) an MBI will significantly increase self-reported and behavioral MBA (all dimensions), significantly reduce emotion dysregulation (all dimensions), and significantly reduce emotional distress (all dimensions) in a population of adolescents; (2) the effect of an MBI on reduced emotional distress will be significantly mediated by an increase in MBA (all dimensions), and (3) the effect of an MBI on reduced emotional distress will be significantly mediated by an increase in MBA (all dimensions) and a reduction in emotion dysregulation (all dimensions). The present study's hypotheses, methods, and statistical analysis plan have been pre-registered on OSF (*https://osf.io/be7x2*). To our knowledge, this is the first study to examine the joint role of MBA and ER as outcomes and working mechanisms of MBIs in adolescents in a school setting, thereby contributing to the scarce literature on mechanisms of mindfulness in young people in this context.

6.2 Methods

Participants

Participants were recruited in two secondary schools that agreed to participate in the research project. A stirring committee was set up in each school with a main contact person at the school who had frequent contact with the principal investigator. The members of the stirring committees (mainly teachers) informed their students about the study by distributing flyers provided by the research team to their students. Flyers contained information about the study, the principal investigator's contact information, and the date and time of an information session about the project. The flyer contained a link where participants and their parents could sign up for the information session. Due to practical reasons, the information sessions were held online separately for each school. The link to the information session, the exact details of the session, and the information sheets and informed consent forms were emailed to participants who registered.

During the two information sessions, representatives of the research team presented the project in detail and answered students' and parents' questions. At the end of the information session, interested participants were encouraged to sign up for the study by sending the researcher the signed informed assent form (to be signed by the adolescent), and the signed parental consent form for participants younger than 18 (to be signed by the parent or legal guardian). Participation in the study was optional. Once the researcher received these documents, a first meeting was scheduled to conduct an intake interview with one of the psychologists leading the trainings.

The intake interview consisted of a short, individual, semi-structured interview done in-person, online, or by telephone depending on the participants' preferences and lasting 30 minutes or less. During the intake interview, one of the research team's psychologists asked the participant questions about their motivation to participate in the study and verified that the study's inclusion and exclusion criteria were met. Inclusion criteria included: being between 13 and 19 years old, understanding and speaking French, and having parental consent for participants younger than 18. Exclusion criteria included: evidence of a severe clinical disorder (e.g., severe depression, anxiety, substance misuse, etc.), unresolved trauma, ongoing psychotherapeutic or psychiatric treatment, and prior participation in a full (6 full sessions or more) MBI. If all criteria were met, participants subsequently completed baseline measures consisting of a series of questionnaires and an experimental task on the researcher's laptop (see below). Once all participants had completed the intake interviews and baseline measures, the researcher randomized participants to a Mindfulness-Based Cognitive Therapy (MBCT) group or a Health Psychoeducation active control (HP) group.

Forty-seven participants were screened and randomized to MBCT or HP (Figure 6). Participants received the MBCT and/or health psychoeducation training and all related materials for free. Furthermore, participants in the HP group, were offered the opportunity to attend an MBI after the end of the study if they so wished. The study was approved by the Ethical Committee of the Psychological Sciences Research Institute of the first author's university (Projet 2022-28 approved on 27 April 2022).

Measures

Socio-Demographic Variables

Participants were to provide information on gender, date of birth, school, school grade, school track, prior or current mindfulness practice (or other forms of meditation practice) as well as the duration of this practice, nationality, mother tongue, medication use, occupation of their parents, and the highest degree obtained by each parent.

Mindful Body Awareness Questionnaire

The Mindful Body Awareness Questionnaire (MBAQ) is a questionnaire that measures MBA and was developed in French for a population of adolescents and young adults (Pérez-Peña et al., 2023). The MBAQ contains 18 items investigating three dimensions, namely Equanimity (i.e., relating to body sensations in a non-judgmental, open, and non-reactive way), Listening (i.e., approaching body sensations as useful sources of information to identify one's needs, emotions, and to self-regulate), and Non-avoidance (i.e., facing rather than avoiding body sensations). Answers are rated on a five-point Likert scale from 0 (Never) to 4 (Always). Sub-scale scores are obtained by calculating the mean of the relevant items. The MBAQ has good psychometric properties and displays measurement invariance across age (adolescence and young adulthood) and

gender (Pérez-Peña et al., 2023). Internal consistency in the present study's sample was 0.77 for the Equanimity sub-scale, 0.79 for the Listening sub-scale, and 0.65 for the Non-Avoidance sub-scale.

Body Awareness Indirect Assessment

The Body Awareness Indirect Assessment (BAIA) is a computer task programmed on E-Prime software that measures attention to body sensations and integration of detected body sensations into complex psychological processes (e.g., learning). It was adapted from Isbell et al.'s (2015) visual change detection task by Pérez-Peña et al. (2023). The BAIA requires participants to sit in front of a computer and detect whether there is a change in visual stimuli presented on the screen by clicking on specific keyboard keys. Participants have bracelets connected to the laptop on their wrists. The bracelets generate a subtle vibration that provides the correct response on the task. Participants are not informed about the vibrations. The subtle vibrations represent a bodily signal. The test consists of 80 trials and lasts around 10 minutes. At the end of the test, during the debriefing, the experimenter asks participants whether they perceived the vibrations and if yes, whether they used the vibration to perform the task. Since the present study had three time points and the task was performed three times, the experimenter asked these questions in a general way at baseline and post-assessment and was more specific at follow-up assessment (see Appendix A for a detailed description and illustration of the task and Appendix F S1 for the specific questions asked per time point). Performance on the task is evaluated based on four outcome measures: (1) detection of the vibrotactile stimulation (explicit body perception or EBP), (2) reliance on the vibrotactile stimulation to perform the task (explicit body reliance or EBR), (3) reaction time on correct trials, and (4) a d prime sensitivity index. Since the preliminary validation of the BAIA showed that the third and fourth outcome measures were not valid measures of BA, only the first and second outcome measures were included in the present study (Pérez-Peña et al., 2023).

Vibration Sensitivity Task

The vibration sensitivity task (VST) is a 3-minute E-prime task developed by the research team with the goal of assessing the vibration amplitude each participant is capable of perceiving. As in the BAIA, in the VST, participants must sit in front of a computer screen with a haptic controller delivering vibrotactile stimulations on each wrist. The task is a yes-no detection task where participants are randomly presented with vibrations of different amplitudes via the haptic controller, and they must indicate whether they can perceive the vibrations by clicking on a specific key on the keyboard. Half of the trials have vibrations and half of the trials do not. The VST was performed right after the BAIA debriefing. Data from this task was used to calculate a vibration sensitivity index to be included as a control variable in the analyses. See Appendix A for more information on the VST.

Difficulties in Emotion Regulation Scale-Short Form

The Difficulties in Emotion Regulation Scale Short Form (DERS-SF) measures difficulties regulating emotions during moments of distress (Kaufman et al., 2016). It is a shortened version of the widely used 36-item DERS (Gratz & Roemer, 2004). The DERS-SF includes 18 items investigating six dimensions: (1) Non-acceptance of Emotional Responses (Non-acceptance; i.e., the tendency to not accept one's reactions to distress), (2) Difficulties Engaging in Goal-Directed Behavior (Goals; i.e., difficulties concentrating and completing tasks when experiencing negative emotions), (3) Impulse Control Difficulties (Impulse; i.e., difficulties controlling one's behavior when experiencing negative emotions), (4) Lack of Emotional Awareness (Awareness; i.e., tendency to not attend to and not acknowledge emotions), (5) Limited Access to Emotion Regulation Strategies (Strategies; i.e., the belief that there is not much one can do to regulate negative emotions when they arrive), and (6) Lack of Emotional Clarity (Clarity; i.e., unclarity about the emotions one experiences). Answers are rated on a five-point Likert scale ranging from 1 (Almost never) to 5 (Almost always). The French version of the DERS-SF displayed excellent psychometric properties for all subscales except the Awareness subscale in an adolescent sample (Pérez-Peña & Philippot, 2023). The current French validation of the DERS-SF has not yet validated the use of a total score with hierarchical models. However, the present study included all subscales and the total score in the analyses as they all displayed good enough internal consistency reliability. As recommended in Pérez-Peña and Philippot (2023), the total score and Awareness subscale results were interpreted with caution. Internal consistency in the present study's sample was as follows: Non-acceptance (0.69), Goals (0.86), Impulse (0.88), Awareness (0.62), Strategies (0.65), Clarity (0.79), and the total score including all subscales (0.86).

Depression, Anxiety, and Stress Scale-21

The Depression, Anxiety and Stress Scale (DASS-21) measures emotional states of depression, anxiety, and stress (Lovibond & Lovibond, 1995). It includes 21 items and consists of three subscales: (1) depression (i.e., symptoms of dysphoria, hopelessness, lack of interest, etc.); (2) anxiety (i.e., autonomic arousal, anxious affect, situational anxiety); and (3) stress (i.e., irritability, difficulties relaxing, nervous arousal). Items are assessed on a scale ranging from 0 (did not apply to me at all) to 3 (applied to me very much, or most of the time). Scores are obtained by summing the relevant items per dimension and all items for the total score. The DASS-21 has well-documented psychometric properties (Lovibond & Lovibond, 1995) in adolescent samples (Szabó, 2010) and across cultures (Mellor et al., 2015). The long version of the scale, DASS-42, has been validated in a French-speaking young adult sample (Ciobanu et al., 2018). Overall, the psychometric properties were good. The present study used the French version of the DASS-21 developed by Donald Martin's team from the University of Ottawa (Donald, 2012). Though this French version of the DASS-21 has yet to be validated, it has been successfully used in prior studies (e.g., Arcand et al., 2023) and internal consistency in the present

study's sample was good (i.e., 0.92 for the total score, 0.88 for the depression sub-scale, 0.78 for the anxiety sub-scale, and 0.82 for the stress sub-scale).

Frequency of Home Practice

The frequency of mindfulness home practice was measured using a mindfulness smartphone application (app) and by self-report. The mindfulness app was developed for the present study and contained each session's guided meditations allowing participants to practice at home. The app kept track of participants' use, namely how many times participants clicked on the audio meditations and whether they completed the meditations or not. Regarding self-report, participants in both groups were directly asked how frequently they practiced formally and informally at post- and follow-up assessments.

Engagement to the Program

Engagement to the program was measured as number of sessions attended. Instructors kept track of the number of sessions attended by their participants. This information was used for statistical exclusion criteria further described below.

Satisfaction with the Intervention and the Mindfulness Application

To assess participants' subjective experience of the interventions and the app, participants were asked to rate on a sliding scale from 0 to 100 how important the intervention (MBCT or HP) was for them (with 0 being not at all important and 100 being extremely important), how satisfied they were with the intervention (with 0 being completely dissatisfied and 100 being completely satisfied), and how satisfied they were with the mindfulness app (with 0 being completely dissatisfied and 100 being completely satisfied). This was followed by three open questions: (1) What benefits and difficulties did you experience as a result of the MBCT/HP? (2) Do you think the MBCT/HP should be part of the school curriculum as an optional class? (3) What were the advantages and disadvantages of using the app as a support for the MBCT? And (4) Please feel free to share any other comments you may have about the MBCT/HP and/or the app.

Procedure

Eligible participants were randomized to MBCT or HP per school as participants had to attend the training in their respective schools. Each school had different policies for the implementation of the study. School 1 required the trainings to happen after school, whereas School 2 preferred to do the trainings during school hours. School 1 offered the training to all secondary school students within the study's age range whereas School 2 only offered it to 9th and 10th grade students as it was deemed appropriate for their curriculum. In School 1, there were only six eligible participants. Since intervention groups consisting of three participants were deemed too small, all students in this school were allocated to an after school MBCT group. School 2 had 41 eligible participants. Since

participants from the same grade needed to stay together due to scheduling constraints, randomization was done per class. Stratified randomization by gender was conducted with Microsoft Excel (Lavery, 2017; Watts, 2014). The intervention group received a 9-week MBCT, and the active control group received a 9-week HP program. Interventions were taught in small groups of 6-11 students for ease of facilitation. Three small groups received the MBCT program, and two small groups received the HP program. Body awareness, difficulties regulating emotions, and emotional distress symptoms were assessed at baseline (1-7 days before the intervention), post-intervention (7-10 days after the intervention), and follow-up (3-4 months after the intervention).

Interventions and Program Fidelity Assessment

The MBCT program consisted of nine 90-minute sessions held once a week for 9 weeks. The program adhered to a standardized protocol developed from the MBCT manual (Segal et al., 2018) and adjusted to an adolescent population (Deplus & Lahaye, 2015). The program's key objectives are: (1) to enhance self-regulation of emotions, (2) to increase awareness of one's present moment experience; and (3) to teach an attitude of openness and acceptance toward one's experience. Each session consisted of guided experiential mindfulness exercises (e.g., focus on the breath, body scan, breathing space, mindful yoga, walking meditation), sharing of experiences and inquiry, reflections in small groups, psychoeducation (e.g., emotions, stress, self-care), and review of home practices. The program has already been pilot tested in a population of adolescents and was effective (i.e., reductions in impulsivity facets, depressive symptoms, and dysfunctional ER strategies) and well-accepted by adolescents (Deplus et al., 2016). Participants in the MBCT group had access to a mindfulness app containing information about mindfulness and guided meditations to support their home practice. See Appendix F S2 for more detailed overview of the MBCT program used in the present study.

The HP program was similar to the MBCT condition in terms of investment and interest, but with no impact on mindfulness or body awareness processes. It consisted of nine 90-minute sessions in which health topics related to internet dependence, sleep and tiredness, nutrition, physical activity, substance use, stress management, and conflict management were discussed. Pictures, games, and discussions were used to help adolescents adopt healthy behaviors. Participants also completed the same amount of homework assignments as in the MBCT condition. This HP intervention was based on HP interventions that have been successfully used in prior studies with adolescents (Roux et al., 2021). See Appendix F S3 for more detailed overview of the HP program used in the present study.

Both interventions were taught by clinical psychologists. In the case of the MBCT program, the intervention was taught by clinical psychologists who were in the process of completing a mindfulness teacher training. Each group was led by one or two different psychologists depending on group size. Mindfulness instructors received seven sessions of supervision throughout the study to discuss difficulties they encountered and get

feedback from an experienced mindfulness instructor. Adherence to the intervention protocols was assessed by an observer who was present at all the intervention (MBI and HP) sessions. Observers had a checklist with the activities, amount of time per activity, and objectives per activity per session for both interventions. Observers had to write whether activities were completed, and objectives attained per session.

Statistical Analyses

Differences in baseline characteristics and scores between the MBCT and HP groups were assessed by using independent sample t-tests for continuous variables and Chi-square or Fisher's exact tests (in cases where contingency tables contained values below 5) for categorical variables. Means and standard deviations of all continuous variables and frequencies of all categorical variables were calculated per group and measurement occasion. Baseline correlations between outcome variables were also computed.

Multilevel models were used to assess intervention effects using a similar analytical approach as Van der Gucht et al. (2017). Estimated models contained three levels: Time points (level 1) nested within individuals, and individuals (level 2) nested within groups with different instructors (level 3). First, the "null models" containing only the outcome variables but no predictors, were estimated to obtain information on the amount of variance explained at each level. Next, we examined the effect of MBCT on all dimensions of MBA, emotion dysregulation, and emotional distress, relative to the HP group in separate models containing the following predictors: (1) the dummy-coded assessment time as a level 1 variable (with 0 being the pre-intervention phase, 1 being the post-intervention phase, and 2 being the follow-up assessment), (2) the treatment condition as a level 2 variable (with 0 representing the HP group and 1 representing MBCT), and (3) their cross-level interactions. The interaction was our parameter of interest. For models with BAIA categorical outcome variables, logistic multilevel models were computed with EBP and EBR as outcome variables, the same predictors as described above, plus vibration sensitivity as a co-variable. All multilevel models had random effects on instructor groups and individuals, meaning intercepts were allowed to vary in different instructor groups and per individual.

There were a few deviations from the pre-registered statistical plan. First, multilevel models were used instead of ANCOVA and simple logistic regression to account for the fact that the data is nested (i.e., time points are nested within participants and participants are nested within instructor groups). Second, school was not included as a covariate or as a level in the multilevel models because there were very few people in School 1, so the effect of school was deemed negligible. Third, longitudinal mediation models with BA as mediator and serial mediation models with BA as first mediator and ER as second mediator, were not computed because there was no significant time by condition interaction effect on BA or emotional distress, and because we did not achieve the necessary power to conduct these analyses. Lastly, since despite randomization, there were significant baseline differences between intervention groups for certain variables (see

Table 21), multilevel models including baseline levels as a co-variable were run for these specific outcome variables to adjust for baseline differences.

6.3 Results

Participant Characteristics

A total of 47 participants were screened for eligibility and randomized to MBCT (n = 27) or HP (n = 20). Of these 47, 21 completed the MBCT intervention and post-assessment measures, and 19 completed the HP intervention and post-assessment measures. In both groups, one participant was lost to follow-up leading to 20 MBCT participants and 19 HP participants who completed the follow-up assessment. As stated in the pre-registration, participants who completed less than 4 sessions and who began psychological therapy during the study were excluded from analyses, leading to a final sample of 19 participants in the MBCT group and 18 participants in the HP group. Among these 37 participants, there were two (one in the MBCT group and one in the HP group) who began psychological therapy after the intervention and before the follow-up assessment. Therefore, their follow-up assessment time points were excluded from the analysis. For details on the flow of participants throughout the study, see Figure 6. The sample size of 37 participants was enough to detect small to medium effects on BA (f = 0.20) based on an a-priori power analysis described in detail in the pre-registration.

Participant characteristics are shown in Table 19. Across groups, participants were on average 14 years old (SD = 0.81) and were mostly female (62%). All participants were secondary school students with a majority following general education (75.7%) and a minority following technical (10.8%) and artistic (5.4%) education. Most participants were Belgian (97%) and most reported French as their mother tongue (92%). Most participants' parents had completed university studies (65% of mothers and 49% of fathers). The majority of participants (92%) had no prior experience with mind-body practices such as meditation or yoga. The 8% that had prior experience with mind-body practices no longer practiced them. Finally, only 3% of participants took psychotropic medication and only 8% of participants were following psychological therapy, both of which remained constant throughout the study. There were no significant differences between the MBCT and HP groups regarding demographic characteristics (see Table 19).

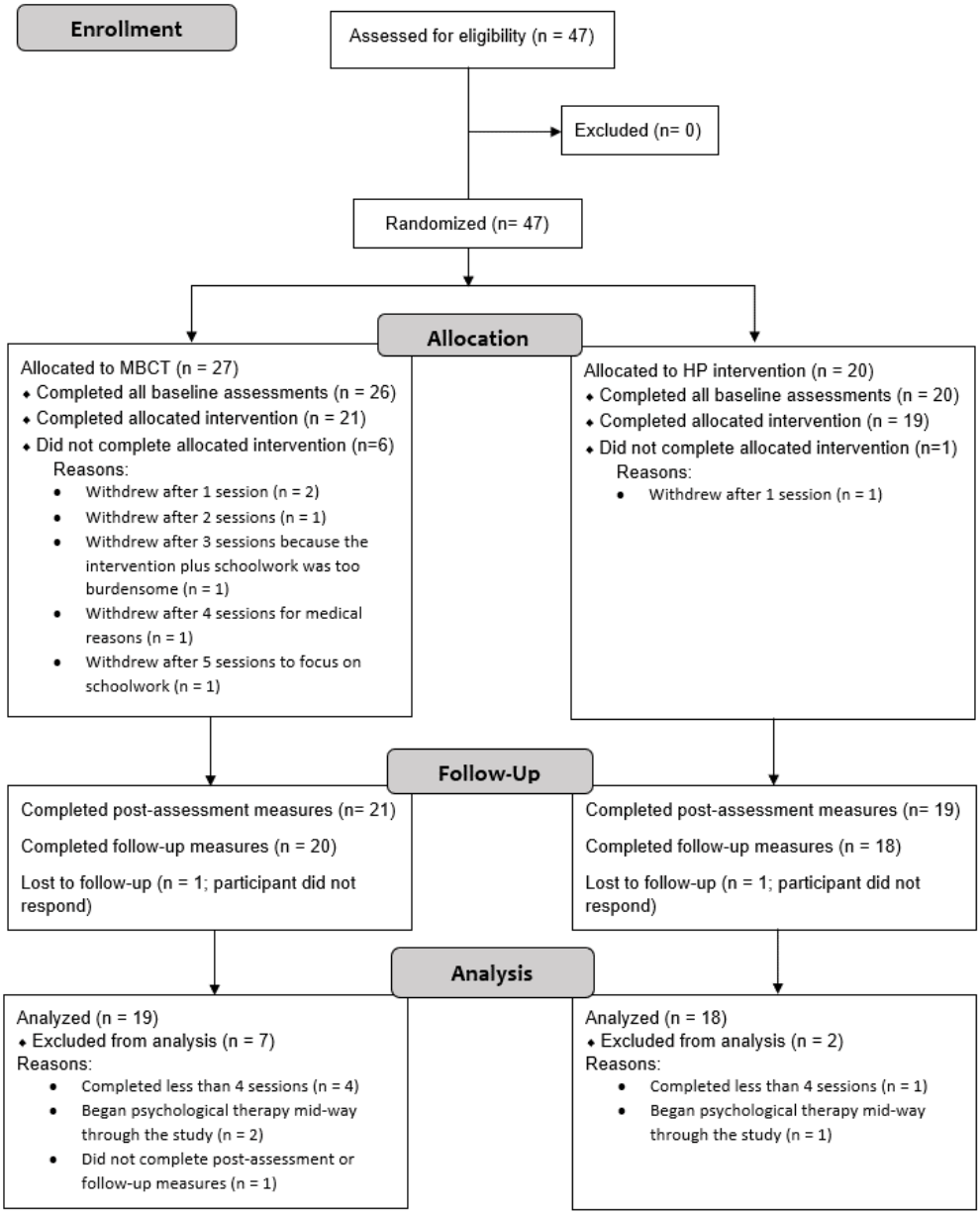

Figure 6. Participant flow throughout the study

Table 19. Baseline Demographic and Clinical Characteristics per Group

	MBCT (n = 19)	CONTROL (n = 18)	t/χ^2-test/Fisher's exact test		
			t/χ^2	df	p
Age (*M, SD*)	14.32 (0.82)	14.28 (0.83)	0.14	34.9	0.89
Female gender (%)	57.9	66.7	0.04	1	0.83
French as mother tongue (%)	89.5	94.4	-	-	1.00
Belgian nationality (%)	94.7	100	-	-	1.00
Educational track (%)			-	-	0.79
General	78.9	72.2			
Technical	5.3	16.7			
Artistic	5.3	5.6			
Other	10.5	5.6			
Year of studies (%)			0.04	1	0.85
3rd secondary (9th grade)	47.4	38.9			
4th secondary (10th grade)	52.6	61.1			
Mother education (%)			-	-	1.00
Primary	5.3	0			
Secondary superior	5.3	11.1			
Non-university superior	21.1	22.2			
University	63.2	66.7			
Not applicable	5.3	0			
Father education (%)			-	-	0.84
Secondary inferior	5.3	5.56			
Secondary superior	15.8	11.1			
Non-university superior	26.3	27.8			
University	42.1	55.6			
Not applicable	10.5	0			
Have prior experiences with meditation practice (%)	15.8	0	-	-	0.23
Current use of medication (%)	5.3	0	-	-	1.00
Ongoing therapy* (%)	10.5	5.6	-	-	1.00

Note. *These participants were included in the analyses because their ongoing psychotherapy treatment was a long-term treatment that was in place several months or years before the start of the study and remained constant throughout the study.

There were no significant differences between the two groups in baseline outcome variable scores, except in the case of the DERS-SF total score, Impulse, Goals, and Clarity subscales, in which the MBCT group scored significantly higher than the HP group (see Table 21). Baseline correlations between outcome variables can be found in Appendix F S5.

Regarding missing data, four participants did not have questionnaire or BAIA data at follow-up assessment because they were lost to follow-up (n = 2), or their data was excluded because they began therapy (n = 2). One participant was missing EBP and EBR data at baseline and one participant was missing EBR data at follow-up because of technical errors in data encoding. The data was Missing at Random (MAR) which is defined by Dziura et al. (2013) as data missing because of features of the study design or dropouts based on recorded reasons. All available data was used for the analyses, as

multilevel model analyses do not require complete data sets to estimate parameters successfully (Field & Wright, 2011).

Among the sub-sample of participants who dropped out or were excluded from the analyses (n = 10), nine of them completed baseline questionnaires. These nine participants were on average 14.22 years old (*SD* = 0.83) and were mostly female (66.7%). All participants were secondary school students with a majority following general education (88.9%). All participants were Belgian and all reported French as their mother tongue. Most participants' parents had completed university studies (44.4% of mothers and 55.6% of fathers). Most participants (77.8%) had no prior experience with mind-body practices such as meditation or yoga. Finally, no participants took psychotropic medication and 55.6% of participants were following psychological therapy or started psychological treatment during the study. The sub-sample of participants who dropped out or were excluded, did not differ from participants who completed the study and were included in the analyses in terms of age, gender, mother tongue, nationality, educational track, year of studies, prior experience with mind-body practices, parents' level of education, or medication use. There was only a significant difference in psychological treatment at baseline or throughout the study according to Fisher's exact test ($p = .004$), There was a greater proportion of participants following psychological therapy among the participants who dropped out or were excluded than among the participants who completed the study. This is to be expected as change in psychological therapy status throughout the course of the study was one of the exclusion criteria. Concerning baseline levels of the outcome variables measured in the present study, there were no significant differences between the participants who dropped out or were excluded and participants who completed the study and were included in the analyses.

Frequency of Home Practice

According to data from the mindfulness app, 47% of participants in the MBCT group used the app (i.e., clicked on the sessions, added notes, or clicked on the meditations) after downloading it. However, use was minimal and infrequent as participants who used the app interacted with it on average twice throughout the study. Participants reported that they preferred to do the meditation without guidance or using other online channels such as YouTube. Self-reported results showed that only few participants did the prescribed amount of home practice in the MBCT and HP groups (see Table 20).

Table 20. Frequency of Home Practice in the MBCT and HP groups

	During MBCT (reported at T2)		During the Follow-Up Period (reported at T3)		During HP (reported at T2)	
Frequency of Home Practice	Formal % (*n*)	Informal % (*n*)	Formal % (*n*)	Informal % (*n*)	Homework completion	% (*n*)
6-7 times/w	5.26 (1)	15.8 (3)	5.88 (1)	5.88 (1)	All sessions	5.56% (1)
4-5 times/w	21.1 (4)	21.1 (4)	0	0	> 50% of sessions	22.2% (4)
2-3 times/w	42.1 (8)	31.6 (6)	5.88 (1)	17.6 (3)	< 50% of sessions	55.6% (10)
Once/w	31.6 (6)	26.3 (5)	23.5 (4)	17.6 (3)	No sessions	5.56% (1)
< once/w	0	5.26 (1)	47.1 (8)	41.2 (7)		

Note. Times/w = times per week. Formal % (*n*) = percentage and number of people in MBCT group who did formal home practices (e.g., body scans, sitting meditations, etc.); Informal % (*n*) = percentage and number of people in MBCT group who did informal home practice (i.e., doing things mindfully throughout the day such as eating mindfully, brushing your teeth mindfully, etc.). % (*n*) = percentage and number of people in HP group who completed their homework assignments. T2 = several days after the intervention. T3 = 2-3 months after the intervention.

Engagement to the Program

On average, across MBCT groups, participants attended 6.9 out of 9 sessions or 77% of the sessions. Across HP groups, engagement was higher as participants attended 8.1 of the 9 sessions or 90% of the sessions. These calculations include participants who withdrew from the study.

Satisfaction with the Intervention and the Mindfulness Application

Participants in the MBCT group reported being 76% satisfied with the intervention, finding it 59% important in their lives, and 74% of them thought MBCT should be offered as an optional class in school. Participants in the HP group reported being 81% satisfied with the intervention, finding it 56% important, and 94% thought HP should be offered as an optional class in school.

Overall, participants reported many benefits and some difficulties after following the interventions. MBCT group participants wrote that the training led to an improved concentration, diminished stress during school evaluations and more generally, an increased sense of relaxation, an increased attention to "little things", and an increased ability to view things from different angles. The most frequently reported difficulties were lack of time and motivation to do the mindfulness home practice. HP participants reported benefitting from an increased open-mindedness and the development of better habits in various domains after the HP training. Many of them also reported difficulties remembering to do the homework and respecting the objectives they set for themselves during the training sessions.

Regarding the mindfulness app, MBCT group participants reported 66% satisfaction with the app. They reported that the app was easy to use, practical, and a good way to start practicing mindfulness. However, they found the meditations repetitive and boring, and

the sound quality of some audios could be improved. Participants suggested that the app could be improved by adding notifications or reminders to practice and by adding a variety of meditations with many different voices.

Table 21. Means and Standard Deviations or Percentages of Variables, Stratified by Group and Measurement Occasion

		MBCT			CONTROL		
Variable		Baseline (*n* = 19) *M (SD)*	Post (*n* = 19) *M (SD)*	Follow-up (*n* = 17) *M (SD*	Baseline (*n* = 18) *M (SD)*	Post (*n* = 18) *M (SD)*	Follow-up (*n* = 16) *M (SD)*
MBAQ							
	Equanimity	1.98 (0.73)	2.24 (0.71)	2.16 (0.67)	2.17 (0.61)	2.36 (0.59)	2.14 (0.82)
	Listening	1.56 (0.68)	1.70 (0.58)	1.70 (0.68)	1.57 (0.69)	1.38 (0.60)	1.66 (0.64)
	Nonavoid.	2.39 (0.90)	2.17 (0.62)	2.62 (0.67)	2.44 (0.62)	2.49 (0.82)	2.31 (0.76)
F-DERS-SF	Total	2.72 (0.63)$_a$	2.49 (0.71)	2.40 (0.67)	2.29 (0.56)$_b$	2.42 (0.57)	2.24 (0.63)
	Strategies	2.56 (0.89)	2.14 (0.94)	2.08 (0.74)	2.15 (0.79)	2.33 (0.91)	1.94 (0.95)
	Nonaccept.	2.25 (0.89)	2.07 (1.03)	2.00 (1.07)	2.11 (1.01)	1.94 (1.04)	1.90 (0.93)
	Impulse	2.18 (1.14)$_a$	2.00 (1.17)	1.94 (1.16)	1.54 (0.72)$_b$	2.04 (1.08)	1.71 (0.79)
	Goals	3.75 (0.94)$_a$	3.49 (1.13)	3.20 (1.18)	3.04 (1.01)$_b$	3.35 (1.15)	3.02 (1.30)
	Awareness	2.67 (0.79)	2.61 (0.66)	2.65 (0.61)	2.69 (0.79)	2.69 (0.65)	2.56 (0.80)
	Clarity	2.91 (1.05)$_a$	2.61 (0.96)	2.55 (1.04)	2.22 (0.93)$_b$	2.15 (0.86)	2.33 (0.96)
DASS-21	Total	20.74 (12.36)	17.42 (9.71)	17.41 (13.61)	14.11(9.12)	16.61 (11.94)	12.50 (7.87)
	Depression	6.00 (4.77)	4.37 (3.74)	5.71 (5.46)	3.94 (4.48)	4.33 (4.65)	3.19 (3.53)
	Anxiety	6.58 (4.68)	6.05 (3.70)	4.65 (4.55)	4.50 (3.19)	5.28 (4.43)	3.63 (2.63)
	Stress	8.16 (4.61)	7.00 (3.74)	7.06 (4.72)	5.67 (3.01)	7.00 (4.19)	5.69 (2.78)
BAIA							
	EBP (%)	26.3	57.9	82.4	22.2	33.3	62.5
	EBR (%)	15.8	47.4	70.6	11.1	22.2	37.5
	Vib. Index	NA	NA	2.27 (0.26)	NA	NA	1.95 (1.21)

Note. This table reflects between-group t-test or Fisher test comparisons of baseline scores to assess differences between groups at baseline. Variables without any subscript do not differ between the MBCT and HP groups at baseline. Per row, variables sharing different subscripts, significantly differ at $p < .05$. Nonavoid. = Non-avoidance. Strategies = Limited Access to Strategies for Regulation subscale; Nonaccept. = Nonacceptance of Emotional Experiences subscale; Impulse = Impulse Control Difficulties subscale; Goals = Difficulty Engaging in Goal-Directed Behavior subscale; Awareness = Lack of Emotional Awareness subscale; Clarity = Lack of Emotional Clarity; EBP = Explicit Body Perception; EBR = Explicit Body Reliance; Vib. index = vibration sensitivity index.

Program Fidelity

The proportion of the total number of activities completed by the trainers over the total number of activities they should have completed according to the protocol was calculated and is reported as a percentage. MBCT instructors completed 94% of the activities in the protocol and HP program instructors completed 87% of the activities in the protocol.

Effects of MBCT on Mindful Body Awareness

All random-intercept multilevel models met assumptions for normality, homoscedasticity, normality of random effects, and no outliers. Results can be found in Table 22.

Table 22. Multilevel model estimates

	Est. (*SE*) Intercept	Est. (*SE*) – T2	Est. (*SE*) – T3	Est. (*SE*) – Condition	Est. (*SE*) – T2:Condition	Est. (*SE*) – T3:Condition	Est. (*SE*) – Vibr. Sens.
MBAQ Equan.	2.17 (0.16) *p* = .00*	0.19 (0.15) *p* = .20	-0.04 (0.15) *p* = .77	-.18 (0.23) *p* = .48	0.07 (0.21) *p* = .75	0.26 (0.22) *p* = .24	NA
MBAQ Listening	1.57 (0.15) *p* = .00*	-0.19 (0.15) *p* = .20	0.05 (0.15) *p* = 0.73	-0.02 (0.21) *p* = .95	0.33 (0.20) *p* = .11	0.01 (0.21) *p* = .98	NA
MBAQ Nonavoid.	2.44 (0.17) *p* = 0.00*	0.04 (0.15) *p* = .78	-0.09 (0.16) *p* = .56	-0.05 (0.24) *p* = .85	-0.27 (0.21) *p* = .21	0.27 (0.22) *p* = .23	NA
BAIA EBP	-7.52 (6.14) *p* = .22	1.11 (1.10) *p* = .31	3.58 (1.25) *p* = .004*	0.32 (2.02) *p* = .88	1.79 (1.61) *p* = .27	1.60 (1.90) *p* = .40	2.33 (2.61) *p* = .37
BAIA EBR	-14.83 (10.3) *p* = .15	2.46 (1.82) *p* = .18	4.64 (2.07) *p* = .025*	0.64 (2.66) *p* = .81	1.52 (2.41) *p* = .53	2.10 (2.80) *p* = .45	4.47 (4.35) *p* = .30
F-DERS-SF Total	0.81 (0.08) *p* = 0.00*	0.06 (0.04) *p* = .19	0.00 (0.04) *p* = .97	0.15 (0.11) *p* = .25	-0.15 (0.06) *p* = .01*	-0.13 (0.06) *p* = .046*	NA
F-DERS-SF Impulse	1.54 (0.24) *p* = .00*	0.50 (0.19) *p* = .01*	0.31 (0.20) *p* = .12	0.64 (0.34) *p* = .16	-0.68 (0.26) *p* = .01*	-0.53 (0.27) *p* = .055	NA
F-DERS-SF Strategies	2.15 (0.21) *p* = .00*	0.19 (0.18) *p* = .32	-0.12 (0.19) *p* = .52	0.41 (0.29) *p* = .25	-0.61 (0.26) *p* = .02*	-0.37 (0.27) *p* = .17	NA
F-DERS-SF Goals	3.04 (0.26) *p* = .00*	0.31 (0.21) *p* = .13	-0.00 (0.21) *p* = .99	0.71 (0.37) *p* = .15	-0.58 (0.29) *p* = .049*	-0.52 (0.30) *p* = .09	NA
F-DERS-SF Nonaccept.	2.11 (0.25) *p* = .00*	-0.17 (0.17) *p* = .32	-0.04 (0.18) *p* = .82	0.12 (0.35) *p* = .75	-0.009 (0.23) *p* = .97	-0.20 (0.24) *p* = .42	NA
F-DERS-SF Awareness	2.68 (0.17) *p* = .00*	0.00 (0.18) *p* = 1.00	-0.09 (0.18) *p* = .62	-0.02 (0.24) *p* = .94	-0.05 (0.25) *p* = .83	0.12 (0.26) *p* = .64	NA
F-DERS-SF Clarity	2.25 (0.28) *p* = .00*	-0.07 (0.17) *p* = .67	0.11 (0.18) *p* = .54	0.60 (0.39) *p* = .22	-0.22 (0.24) *p* = .35	-0.40 (0.25) *p* = .11	NA
DASS21 Total	2.45 (0.19) *p* = .00*	0.11 (0.13) *p* = .39	0.01 (0.13) *p* = .95	0.42 (0.26) *p* = .20	-0.26 (0.18) *p* = .15	-0.28 (0.18) *p* = .13	NA
DASS21 Dep. (with outliers)	4.03 (1.16) *p* = .00*	0.39 (0.73) *p* = .59	-0.12 (0.76) *p* = .87	1.92 (1.61) *p* = .32	-2.02 (1.02) *p* = .05	-0.14 (1.06) *p* = .89	NA
DASS21 Dep. (no outliers)	4.13 (1.13) *p* = .00*	0.39 (0.73) *p* = .60	-0.16 (0.76) *p* = .83	1.09 (1.56) *p* = .54	-1.94 (1.03) *p* = .06	-0.26 (1.08) *p* = .81	
DASS21 Anxiety	4.50 (0.93) *p* = .00*	0.78 (0.75) *p* = .30	-0.61 (0.78) *p* = .44	2.08 (1.30) *p* = .21	-1.30 (1.04) *p* = .22	-1.37 (1.09) *p* = .21	NA
DASS21 Stress	5.70 (0.96) *p* = .00*	1.33 (0.92) *p* = .15	0.25 (0.96) *p* = .80	2.44 (1.34) *p* = .16	-2.49 (1.28) *p* = .056	-1.45 (1.33) *p* = .28	NA

Note: * $p < .05$; Est. = Estimate. SE = Standard error. T2 = post-assessment phase a few adays after the intervention. T3 = follow-up assessment 2-3 months after the intervention. Vibr. Sens. = Vibration sensitivity. Equan. = Equanimity; Nonavoid = Non-avoidance; EBP = Explicit Body Perception; EBR = Explicit Body Reliance; Impulse = Impulse Control Difficulties subscale; Strategies = Limited Access to Strategies for Regulation subscale; Goals = Difficulty Engaging in Goal-Directed Behavior subscale; Nonaccept. = Nonacceptance of Emotional Experiences

subscale; Awareness = Lack of Emotional Awareness subscale; Clarity = Lack of Emotional Clarity; Dep. = Depression.; Anx. = Anxiety; Out. = with outliers; No out. = without outliers.

From here on, T2 will be used to refer to the post-assessment phase and T3 to the follow-up assessment phase. There was no significant group by time interaction effects on Equanimity, Listening, or Non-Avoidance. Since the interaction was not significant, models were run with only time and condition as predictors. There was no significant effect of time or condition on Listening (T2: $p = .85$, T3: $p = .60$, and Condition: $p = .56$) or Non-Avoidance (T2: $p = .39$, T3: $p = .69$, and Condition: $p = .77$). There was a significant effect of time at T2 on Equanimity ($p = .03$), but no effect at T3 ($p = .42$) and no effect of condition was observed ($p = .66$).

Regarding the BAIA, there was no significant time by condition interaction effect on EBP. The model without the interaction revealed a significant effect of time at T2 ($p = .01$) and T3 ($p < .001$) but no effect of condition ($p = .36$) or vibration index ($p = .33$) suggesting a significant increase in EBP proportion in both groups across time. Similarly, there was no significant time by condition interaction effect on EBR. The model without the interaction revealed a significant effect of time at T2 ($p = .004$) and T3 ($p < .001$) but no effect of condition ($p = .29$) or vibration index ($p = .31$) suggesting a significant increase in EBR proportion in both groups across time.

Effects of MBCT on Difficulties Regulating Emotions

Most random-intercept multilevel models met assumptions for normality, homoscedasticity, normality of random effects, and no outliers. Results can be found in Table 22. The model with F-DERS-SF total score as dependent variable, violated the homoscedasticity assumption and was log transformed to correct the violation. Results showed significant time by condition interactions effect on F-DERS-SF total score at T2 and T3 indicating a reduction in emotion dysregulation across time in the MBCT group versus the HP group. There was also a significant time by condition interaction effect on Impulse, with an increase in impulse control difficulties in the HP group from baseline to T2 in comparison to the MBCT group. There was a significant time by condition interaction effect on Strategies at T2 with the MBCT group showing a decrease in difficulties accessing ER strategies from baseline to T2 in comparison to the HP group. Likewise, there was a marginally significant time by condition interaction effect on Goals at T2, with the MBCT group showing a decrease in difficulties engaging in goal-directed behaviors from baseline to T2. No significant time by condition interaction effect was observed on Non-Acceptance, Awareness, or Clarity. Models without the interaction effect showed no significant effect of time or condition on Non-Acceptance (T2: $p = .32$, T3: $p = .82$, and Condition: $p = .75$), Awareness (T2: $p = 1.00$, T3: $p = .62$, and Condition: $p = .94$), or Clarity (T2: $p = .12$, T3: $p = .44$, and Condition: $p = .33$).

Since there were significant baseline differences between intervention groups in F-DERS-SF total, impulse, goals, and clarity, multilevel models including baseline levels as a co-variable were run. Results remained the same as unadjusted models. The only

difference was that the DERS total "T3 by condition" interaction effect was no longer significant (p = .05), but the DERS total "T2 by condition" interaction effect remained equally significant. Results of adjusted models can be found in Appendix F S6.

Furthermore, significant improvements observed in the MBI group were corrected for regression to the mean effects (RTM; Barnett et al., 2005) using the approach described in Nielsen et al. (2007). All results remained significant after correcting for RTM, except for Goals. See Appendix F S7 for the results of these RTM analyses.

Standardized regression coefficients were calculated for significant and marginally significant models as indicators of effect size as recommended in Lorah (2018). Since the calculation of effect sizes for multilevel models with three levels is highly complex (Lorah, 2018) and since significant time by condition interaction effects were only observed from pre- to post-assessment, standardized regression coefficients were derived from simplified two-level random-intercept models containing post-intervention difficulties regulating emotions as the standardized outcome, intervention as a categorical variable coded 0 for the HP group and 1 for the MBCT group, and standardized pre-intervention levels as a co-variate. Results revealed the following standardized regression coefficients, with standard errors in parentheses, while controlling for baseline levels: -0.42 (SE = 0.29) for F-DERS-SF total score, -0.51 (SE = 0.28) for F-DERS-SF Strategies, -0.44 (SE = 0.29) for F-DERS-SF Impulse, and -0.33 (SE = 0.28) for F-DERS-SF Goals. These standardized regression coefficients can be interpreted as follows: for instance, the coefficient of -0.42 suggests that the MBCT group scored 0.42 standard deviations lower than the control group in overall difficulties regulating emotions.

Effects of MBCT on Emotional Distress

All emotional distress random-intercept multilevel models met assumptions for normality and normality of random effects, but one model violated the homoscedasticity assumption (i.e., DASS21 total score model) and all models violated the no outlier assumption. In the case of the DASS21 model that violated the homoscedasticity assumption, the dependent variable was log transformed. Since all models had outliers, analyses were performed with and without outliers. For the most part, results were the same with and without outliers except in the case of the DASS21 Depression model. Results are presented in Table 22. Results without outliers are only reported if they differed from results with outliers.

The DASS21 total model without outliers showed no significant time by condition interaction effect on emotional distress nor did the model with outliers. Likewise, the DASS21 model without the interaction effect with outliers showed no effect of time or condition on emotional distress (T2: p = .72; T3: p = .16; Condition: p = .34), nor did the same model without outliers.

The DASS21 depression model with outliers, showed an almost significant time by condition interaction effect with a decrease in depressive symptoms from baseline to post-

assessment in the MBCT group. However, this almost significant effect was weaker in the model without outliers. The DASS21 depression model without the interaction effect with outliers showed no effect of time or condition on depression (T2: $p = .22$; T3: $p = .72$; Condition: $p = .49$), nor did the same model without outliers.

The DASS21 anxiety model with outliers showed no significant time by condition interaction effect on anxiety symptoms, nor did the model without outliers. The model without the interaction effect with outliers showed a significant effect of time but not condition on anxiety (T2: $p = .84$; T3: $p = .02$; Condition: $p = .37$), with a decrease in anxiety from baseline to T3 in both the MBCT and HP groups. Results remained the same in the model without outliers.

Finally, there was no significant time by condition interaction effect on stress in the DASS21 stress model with and without outliers, although a tendential effect was observed in the T2 by condition interaction. Likewise, there was no significant effect of time or condition in the model without the interaction effect with and without outliers (T2: $p = .93$; T3: $p = .46$; Condition: $p = .39$).

See Appendix F S4 for a visual summary of all significant effects observed in the present study.

6.4 Discussion

The present RCT investigated the impact of MBCT on MBA, ER, and emotional distress in a healthy sample of school-aged adolescents. Participants completed either an MBCT or HP intervention, and outcome measures were evaluated at three time points: right before, right after, and three to four months after the interventions. Contrary to the initial hypotheses, there was no significant effect of MBCT on self-reported MBA in comparison to HP. There was a significant increase in behavioral measures of MBA and self-reported Equanimity, but contrary to our hypotheses, this effect was not distinct to MBCT as it was observed in both intervention groups. In accordance with the initial hypotheses, MBCT significantly decreased difficulties regulating emotions and limited access to ER strategies at T2 in comparison to HP. Furthermore, MBCT had a protective effect on impulse control difficulties which significantly increased in the HP group but remained constant in the MBCT group. The increase in difficulties in the HP group may be related to the fact that students were just finalizing the exam session at T2. These results suggest that MBCT protected students against this increase in impulse control difficulties during a stressful time. There was also a marginally significant trend towards a reduction in difficulties engaging in goal-directed behaviors during emotional experiences in the MBCT versus HP group at T2, but this effect was no longer significant when correcting for RTM. Lastly, contrary to our hypotheses, there was no significant impact of MBCT on symptoms of emotional distress, depression, or stress in comparison to the HP group. Nonetheless, a significant decrease in anxiety was observed in both groups. Due to the

absence of time by condition interaction effects on MBA and emotional distress, the mediating role of MBA was not further assessed. Results are discussed below.

Emotion Dysregulation

MBCT had significant positive effects on different aspects of emotion dysregulation at T2. Though difficulties regulating emotions continued to decrease at T3 in the MBCT group, this reduction was not significant. This may be because participants practiced very little between T2 and T3. These results support theoretical accounts that posit ER as an important component of MBIs (Davidson et al., 2012; Deplus et al., 2014; Hölzel et al., 2011). Results are also in line with prior studies (discussed in the Introduction) that found positive effects of an MBI on ER outcomes (Alampay et al., 2020; Broderick & Metz, 2009; Daly et al., 2015; Fung et al., 2016; Lau et al., 2020; Metz et al., 2013).

These findings are promising because emotion dysregulation is an important process variable contributing to the onset and maintenance of mental health conditions in adolescents (Pedrini et al., 2022). Given the positive effect of the MBI on ER abilities, the present study's results support the use of MBIs for preventing mental health difficulties via the improvement of ER skills in teens in a school setting. However, since the observed effects were moderate and the sample was small, more research with larger samples is needed to replicate these results. Moreover, future studies can assess whether decreases in emotion dysregulation mediate the effect of an MBI on the risk of developing mental health conditions and on overall well-being.

Interestingly, effects were observed even though participants did not practice much at home. This may mean that the sessions themselves and small amounts of mindfulness practice were enough to improve ER. However, this would be at odds with the mindfulness literature in adults and adolescents which suggests that home practice predicts positive treatment outcomes (Lloyd et al., 2018; Parsons et al., 2017; Quach et al., 2017). Another possibility is that the effects observed in the present study are due to the mindful ER psychoeducation aspects of the training. Future research is needed to assess the link between adherence to home practice and training outcomes in adolescents, and to shed light on how to increase adolescents' motivation to engage in home practice.

Taken together, results suggest that MBCT decreases adolescents' difficulties regulating emotions in the school context, which has meaningful implications for the use of MBIs in preventing mental health problems via enhancement of ER skills in teens.

Mindful Body Awareness and Emotional Distress

There was no significant effect of MBCT on MBA or emotional distress. Null effects on emotional distress are in line with prior studies (e.g., Bogaert et al., 2023). Though there were significant improvements in Equanimity, in the proportion of participants who detected and relied on the bodily signal in the behavioral measure, and in anxiety, this was observed in both groups and may be due to non-specific factors (e.g., motivation

and expectation of improvement; Lilienfeld et al., 2014) or test-retest effects. A third group that did not follow an intervention would be needed to ascertain whether the effects observed were due to the interventions or to other factors not specifically related to the interventions. The absence of the hypothesized effect of the MBCT on MBA and emotional distress may be explained by a lack of statistical power, the MBI program used, infrequent home practice, unhelpful group dynamics, the MBI instructor, measurement issues, and baseline levels.

The first possibility is that the effect on MBA and emotional distress may be smaller than expected, and the study is underpowered to detect such small effects. Our a-priori power analysis was performed to detect a small to medium effect size ($f = 0.20$) chosen based on prior studies assessing the impact of an MBI on BA in healthy adults (Bornemann et al., 2014) as no prior research has been done in adolescents. However, due to age-related specificities, the effect may be smaller in an adolescent population. Interoceptive and ER skills are still developing in adolescence (J. Murphy et al., 2017; Silvers, 2022), which may mean adolescents might have more difficulties learning MBA and ER skills than adults, possibly explaining why MBCT may have weaker effects. In fact, meta-analyses have shown that effect sizes on various mental well-being and mindfulness outcomes tend to be smaller in general adolescent samples in comparison to clinical samples and healthy adults (Carsley et al., 2018). Future research on the topic can power their studies for small effect sizes.

A second potential explanation for the null effects is that the MBI program was not properly tailored to youth in a school setting. The mindfulness program used in the present study was adapted from an adult program for a clinical population. The program may need to be modified further to be more suitable to youth in a school setting. Research suggests that the types of MBIs with most significant effects in schools are those that combine a variety of mindfulness and yoga activities rather than pre-designed programs (Carsley et al., 2018). This suggests that MBI curricula for youth in schools may need to be more playful, flexible, and varied to keep students engaged. Moreover, from a school context perspective, MBI sessions need to be shorter and may need to be delivered over longer periods of time to ensure enough dosage. From the perspective of youth, the MBI program content needs to be engaging and relevant to young people's needs which is why co-creation of MBI programs with adolescents may be an interesting future research direction (Kuyken et al., 2022).

The third possible explanation for the null results is that participants practiced very little between sessions. Only 15.8% of participants practiced the prescribed amount (i.e., daily) of informal mindfulness home practice and only 5.4% of participants practiced the prescribed amount (i.e., 6 out of 7 days) of formal mindfulness home practice. This finding is in line with prior studies in adolescents in a school setting (Bogaert et al., 2023; Tudor et al., 2022). Though calculating a correlation between frequency of home practice and MBA would be informative to assess whether more practice is associated with more gains in MBA, it is not meaningful to do this with our dataset as there is a lack of

variability in home practice frequency (i.e., 63% and 74% of participants practiced informal and formal mindfulness exercises less than 3 times per week respectively) and within-group samples are very small. Even though the link between home practice frequency and benefits of the intervention cannot be tested with the present study's data, other studies have found that adolescent participants who engaged in home practice reported significant improvements in well-being and mental health outcomes after an MBI (Kuyken et al., 2013; Quach et al., 2017). Since home practice is a prerequisite to fully benefitting from an MBI, future research can focus on finding ways to improve home practice engagement in teens. Four potential factors that are linked to home practice engagement and can be further explored in future studies are: (1) the implementation of MBI programs that are engaging and tailored to adolescents' needs, (2) voluntary (rather than compulsory) participation in MBI programs, (3) the creation of peer group practice opportunities, and (4) an MBI facilitator who encourages adolescents to practice.

A fourth explanation is unhelpful group dynamics, as has been observed in prior MBI studies in schools (Bogaert et al., 2023). Group processes, or the relationships between individuals in a group (Yalom & Leszcz, 2005), are a crucial component of MBIs. Group processes play an important role in keeping students motivated (particularly during the initial weeks which are the most difficult), supporting mindfulness learning, diminishing stigma, and fostering a sense of common humanity (Giommi et al., 2023; Malpass et al., 2012). However, in order for group processes to be beneficial, a positive culture and sense of safety must be created (Cormack et al., 2018). Such an atmosphere may be more difficult to create in a classroom setting where participants know each other, there are pre-existing group dynamics, and participants will continue to interact after the MBI program is over. The issue of group safety is of particular importance in adolescence, a time of life in which sensitivity to social evaluation, status, and prestige are particularly high (Dahl et al., 2018). Therefore, future studies need to carefully consider group dynamics in the implementation of MBIs in a school setting and in the elaboration MBI programs. More attention and time may need to be given to the creation of a safe environment in the programs.

A fifth possible explanation pertains to the MBI instructor. A meta-analysis of MBIs in schools showed that in between-group studies, MBIs have significantly small effects on mental health outcomes at post- (Hedges' g = .24; Carsley et al., 2018) and follow-up assessment (Hedges' g = 0.32), and these effects are only significant when the MBI is delivered by a trained teacher rather than an external facilitator. However, effects on mindfulness outcomes are only significant at post-assessment when the training is delivered by external facilitators (Hedges' g = 0.38; Carsley et al., 2018). The authors interpret this as meaning that schoolteachers who are trained to teach mindfulness may be more likely to frame the MBI content from a mental health angle (e.g., how participants can use breathing exercises to reduce anxiety) whereas external facilitators may be more likely to frame MBI content from a mindfulness angle (e.g., as tools to be

more present rather than to strive to change one's state). This suggests that the choice of facilitator plays an important role in determining the intervention effects. In the present study, external facilitators (i.e., psychologists who had received a mindfulness training) delivered the mindfulness training. Our results are therefore in line with prior studies that found no effect of a school based MBI on mental health when trainings were delivered by external facilitators. Future studies should be aware of the choice of facilitators, including their level of training, and the way content is framed during the MBI.

A sixth possible explanation pertains to the inherent difficulties of accurately measuring MBA and adequately interpreting MBA measures' results. There is much discussion in the literature on the complications of measuring interoceptive dimensions using self-report (Desmedt, Heeren, et al., 2022) and behavioral measures (Desmedt, Luminet, et al., 2023). Although the two measures used in the present study were age-appropriate, multi-modal, and previously validated in other adolescent samples, they still have their limitations. As with all self-reported measures of BA, the MBAQ is subject to the limitation that participants cannot accurately report on a phenomenon they may not be aware of (W. E. Mehling et al., 2012). This makes questionnaire results difficult to interpret as participants could be victims of the Dunning-Kruger effect, a cognitive bias in which people who are unskilled in a given domain tend to overestimate their abilities in that domain and people who are skilled in a domain tend to underestimate their abilities (Kruger & Dunning, 1999). If applied to the present study, this could mean that after the training, participants' awareness of the limitations of their MBA abilities may have increased, leading them to report equal or lower scores than at baseline. To overcome the limitations of the MBAQ, the BAIA was included as an indirect and concrete assessment of MBA. However, the BAIA has only undergone a preliminary validation (Pérez-Peña et al., 2023), and certain weaknesses need to be addressed before its validity is confirmed.

Considering the limitations of different types of BA measures and the complexity of interoceptive constructs, future studies can use a combination of measures and a mixed-methods approach to assess the impact of an MBI on MBA. A qualitative component may be a useful addition because it could help deepen the interpretation and provide clarifications for quantitative results. For instance, individual interviews could be conducted by a mind-body therapist before and after the training as an additional way to evaluate the participant's MBA and to complement and contextualize questionnaire results.

A final explanation for the null effects, particularly in the case of emotional distress outcomes, is that baseline levels of emotional distress were relatively low in this sample leaving little room for improvement. Baseline levels of depression, anxiety, and stress were mild, moderate, and normal, respectively. It is commonly observed in school based MBI trials that most participants have low rates of mental health problems (Tudor et al., 2022). For this reason, it may be more appropriate for future school based mindfulness studies

to use outcomes assessing general well-being or relative risk of developing mental health issues (Tudor et al., 2022).

Overall, the present study's results found that BA and emotional distress were not significant outcomes of MBIs in adolescents in a school context. Other outcome and process variables may be more relevant in an adolescent population in a school context, such as mindfulness skills, cognitive reactivity, and outcomes assessing risk of developing mental health conditions (Tudor et al., 2022). More studies are needed with larger samples to replicate this finding before a more informed conclusion can be made. Furthermore, attention needs to be paid to implementation factors.

Strengths and Limitations

The present study has strengths in terms of novelty, research design, intervention characteristics, and outcome measures. To our knowledge, it is the first study to assess the role of MBA in school based MBIs for adolescents. In terms of research design, it followed all the recommendations listed in Felver et al. (2016), namely, an experimental RCT design, an active control condition, and statistical methods that account for nestedness in the data. The present study had a strong active control condition that was more appreciated by participants than the MBI, controlling for many non-specific factors. Moreover, the present study endorsed open science practices as the hypotheses, design, methods, and statistical plan were pre-registered on OSF before data collection. Regarding intervention characteristics, it used an intervention that has been priorly tested and validated in adolescents. Concerning outcome measures, both mental health and process variables were examined. Moreover, the measures used were multi-modal (i.e., self-report and behavioral) and developed for or validated in adolescents. The study also included a follow-up assessment allowing for testing of longer-term effects of the MBI. Another strength was that students were allowed to participate on a voluntary basis, supporting motivational processes. Lastly, the study was done in participants in mid to late adolescence, an age when adolescents are more receptive to MBIs because of their increased brain plasticity and self-reflective capacities (Ahmed et al., 2015; Carsley et al., 2018; Chi et al., 2018).

Despite its strengths, the present study has several limitations. First, the sample size was too small to detect small effects and to conduct moderation, mediation, and within-group analyses. Second, in the school with the most participants, the MBI was proposed as an alternative to a class, which may have motivated students to participate in the study for the wrong reasons. The lack of motivation may have affected their implication in the program. Third, there was higher attrition in the MBCT group (i.e., 7 out of the 27 participants dropped out or were excluded from analyses) than in the HP group (i.e., 2 out of 20 participants dropped out or were excluded from analyses). Whether unequal attrition rates between study arms lead to biased results or not depends on the type of missingness of the data and on the statistical analyses used (Bell et al., 2013). In the present study, the type of missingness was MAR and the statistical analyses used were multilevel

models. Research suggests that multilevel models are an appropriate analytical approach for MAR data as they account for differential attrition and yield unbiased estimates for treatments effects (Bell et al., 2013). Furthermore, participants who dropped out or were excluded did not differ from participants who completed the study on demographic characteristics or baseline levels of outcome variables, suggesting that the bias resulting from unequal attrition rates was low. Lastly, the MBA behavioral measure had only been pre-validated meaning its validity is still questionable and the French DASS21 used has not yet been validated in adolescents, potentially impacting the results.

6.5 Conclusion

To conclude, the present study found that an MBI delivered in a school context, significantly improved ER skills, and buffered against deterioration of impulse control difficulties in comparison to a HP program of equal duration. However, MBA and emotional distress did not significantly change in the MBI group in comparison to the HP group. Results do not provide evidence for the hypothesis that MBA is an important outcome and mechanism of MBIs in adolescents. However, findings do provide evidence for the important role of ER in MBIs for teens, a transdiagnostic variable that may be key for targeting and preventing mental health conditions in this vulnerable population. Future research with larger samples is needed to replicate these results.

Chapter 7.
General Discussion

7.1 Summary of Findings

Given the increased vulnerability to mental health conditions during adolescence and emerging adulthood and the great need for evidence-based prevention and treatment programs for this age group, the present dissertation aimed to examine the impact of mindfulness-based interventions (MBIs) on two interrelated psychological processes that could protect young people from developing mental health conditions, body awareness (BA) and emotion regulation (ER). Our initial hypothesis was that an MBI would lead to improvements in adaptive BA which would in turn improve ER skills, and the two mechanisms in tandem would explain the reduction in emotional distress observed after an MBI.

The journey to accomplishing this aim, involved three steps. First, given the lack of research on the role of BA in MBIs, a pre-registered analysis of existing data in adults was done to test whether BA was impacted by an MBI and whether BA played a mediating role on the MBI's effects on psychological symptoms. Next, since there was a scarcity of adequate ER and particularly BA measures for French-speaking young people, the second step consisted of a systematic development and/or validation of BA and ER measures tailored to this population. Lastly, these measures were used to conduct an RCT in adolescents in a school setting, assessing the impact of an MBI on BA, ER, and symptoms of emotional distress, as well as the potential mediating role of BA and ER.

The proof-of-concept study in Chapter 2 provided initial evidence for our general hypothesis in a population of adults suffering from anxiety and mood disorders. Findings showed a significant improvement on most dimensions of self-reported adaptive BA and ER self-efficacy after an MBI. Furthermore, the significant reduction in psychological symptoms observed after the MBI was mediated by increases in self-reported BA, particularly the aspects of regulating attention to and from body sensations, trusting the body is a safe place, attending to body sensations to self-regulate, and listening to the body for insights. Exploratory serial mediator models expanded on these findings by showing that improvements in adaptive BA were associated with improvements in other psychological processes, including ER self-efficacy, and this interplay of mechanisms explained the reduction in psychological symptoms. Findings from Chapter 2 suggest that an MBI trains participants to allocate attention to their body with a spirit of listening and self-regulating, providing the necessary defusion from experience to allow for more

functional processes to take place (e.g., adaptive ER), and to reduce the use of dysfunctional strategies (e.g., unconstructive rumination).

Given the promising results in Chapter 2, the journey towards testing the general hypothesis in a population of young people began. However, adequate measures needed to be developed and validated first. Chapters 3 and 4 described the systematic development and validation of an adaptive BA questionnaire for young people. More specifically, Chapter 3 dove into qualitative data illustrating the understanding, experience, and description of BA in adolescents and young adults (AYAs). Findings revealed that the phenomenological experience and understanding of BA in AYAs is multidimensional, concrete, may be increasingly nuanced with age, and may be influenced by gender. Important aspects that arose from the qualitative data were the tendency to pay attention to body sensations and the many factors influencing this, the attitude with which one pays attention and its importance in determining whether BA is adaptive or not, and the diversity of reactions to body sensations depending on how they are appraised, including using BA for self-regulation.

Chapter 4 merged these qualitative findings with mindfulness and interoception theory to introduce the concept of mindful body awareness (MBA) and develop a self-report measure for it. MBA is an adaptive BA characterized by paying attention to emotion and non-emotion related body sensations with an open and curious attitude and integrating this information into complex psychological processes, such as self-regulation. After cognitive interview testing, exploratory factor analysis, and confirmatory factor analysis (including multi-group analyses) in three separate samples, the research resulted in an 18-item questionnaire called the Mindful Body Awareness Questionnaire (MBAQ) consisting of three dimensions with sound psychometric properties and measurement equivalence across age and gender groups. The three dimensions were: equanimity (i.e., relating to body sensations in a non-judgmental, open, and non-reactive way) reflecting the attitudinal aspects; listening (i.e., approaching body sensations and considering them important sources of information about one's needs, emotions, and overall state) reflecting the regulatory aspects; and non-avoidance (i.e., facing rather than avoiding body sensations) reflecting the attentional aspects.

To overcome the limitations of self-report measurements of BA (e.g., reporting on something participants may not be aware of), Appendix A describes the development and preliminary validation of the Body Awareness Indirect Assessment (BAIA), a new task designed to measure the attentional and integration aspects of the MBA construct. Findings provided mixed evidence for the validity of the task. Two of the BAIA's outcome measures did not reliably measure BA as they were contaminated by a confounding variable. The other two outcome measures may be promising measures of BA, but future studies with a modified validation design are needed to ascertain their validity. Recommendations are discussed in Appendix A. The internal report on the BAIA is included in the Appendix section rather than the body of the dissertation because results

obtained were inconclusive and more research is needed on the BAIA before it can be recommended.

Given the limited availability of ER measures for francophone adolescents, Chapter 5 presented the validation of a short version of the Difficulties in Emotion Regulation Scale (F-DERS-SF). The F-DERS-SF is a comprehensive measure of ER that considers attentional, attitudinal, cognitive, and behavioral skills involved in ER. Results found that the F-DERS-SF displayed good psychometric properties for all dimensions except for the Emotional Awareness dimension which must be further assessed in future research. Future research recommendations were discussed.

Finally, Chapter 6 used the measures developed in Chapters 4, 5, and Appendix A to conduct a randomized-controlled trial (RCT) with the aim of testing our general hypothesis in a population of adolescents in a school setting. Results partially supported our hypothesis, as a significant improvement was found in ER but not in BA in the MBI group in comparison to the active control group. More specifically, the MBI decreased adolescents' difficulties regulating emotions, improved access to ER strategies, protected against a deterioration of their impulse control difficulties and had a marginally significant positive effect on difficulties engaging in goal-directed behaviors in comparison to an active control group. Implications of these findings and future research directions were discussed.

Overall, the findings provide partial evidence for our general hypothesis that an MBI reduces emotional distress symptoms by improving adaptive BA and ER skills. This hypothesis was supported in a population of adults with mood and anxiety disorders, in which the MBI's reduction in symptomatology was mediated by an improved adaptive BA and ER self-efficacy. However, the hypothesis was not fully supported in a population of healthy adolescents in a school setting, in which the MBI led to improvements in ER but not in adaptive BA. The following sections discuss the conclusions, implications, future directions, and limitations of these findings.

7.2 Conclusions

The Role of Body Awareness and Emotion Regulation in MBIs in Adults

Findings from Chapter 2 suggest that both adaptive BA and ER self-efficacy (as well as other transdiagnostic variables) are active ingredients explaining the effects of an MBI on psychological symptoms in a clinical population of adults. These findings support two theoretical models presented in Chapter 1: Hölzel et al.'s (2011) Model on the Mechanisms of Mindfulness Meditation and Lindsay & Creswell's (2017) Monitor and Acceptance Theory (MAT).

Hölzel et al. (2011) included BA and ER as two of the four key mechanisms of mindfulness meditation. They further stressed the potential link between BA and ER processes, positing that an increased awareness of body sensations would be associated with an increased emotional awareness, a necessary first step in adaptive ER. Chapter 2 findings support these theoretical claims by showing that an MBI significantly improved attentional, attitudinal, and regulatory dimensions of adaptive BA, including an increased awareness of the connection between body sensations and emotional states. Furthermore, mediation models showed that the increased ability to regulate attention to and from body sensations was associated with an increased belief in one's ability to regulate emotions, and the two processes together explained the MBI's positive effects on symptomatology. Even though ER was not specifically assessed in Chapter 2, the related construct of ER self-efficacy was, providing indirect evidence for Hölzel et al.'s (2011) claims on ER. Chapter 2 findings also provide evidence for the MAT, which posits that attention monitoring of present-moment experience and an open and curious orientation towards this experience explain an MBI's effects on psychological well-being. Chapter 2 findings apply the MAT to present-moment bodily experiences and support the claim that attending to body sensations with an orientation of trusting, listening, and self-regulating, explained the MBI's reductions in symptomatology.

On top of providing evidence for mindfulness theoretical models, these findings also build on prior empirical research. They replicate findings showing a significant positive effect of an MBI on adaptive BA (Bornemann et al., 2014; De Jong et al., 2016; de Lima-Araujo et al., 2022; Fissler et al., 2016; Karing & Beelmann, 2021; van der Velden et al., 2023), as well as findings showing a mediating effect of BA in an MBI's reduction in symptoms (De Jong et al., 2016; Fissler et al., 2016). Chapter 2 findings are also in line with cross-sectional studies showing that ER and BA account for the effects of trait mindfulness and meditation experience on anxiety and depression (Burzler et al., 2019; Tran et al., 2014). Lastly, our findings are in line with qualitative and neuroimaging research reviewed in Chapter 2. Chapter 2 findings expand on existing literature by being the first (to our knowledge) pre-post intervention study to examine the joint mediating effect of adaptive BA and ER-related processes (i.e., ER self-efficacy) in an MBI, and by showing that adaptive BA does not act alone as it has associations with improvements in various other psychological processes.

In sum, Chapter 2 findings support our general hypothesis, provide evidence for theoretical models on the mechanisms of mindfulness, and support and extend prior empirical research on the topic. Unexpectedly, a different pattern of effects was found in Chapter 6 in an adolescent population.

The Role of Body Awareness and Emotion Regulation in MBIs in Adolescents

Chapter 6 findings suggest that in a population of adolescents, an MBI significantly improved ER but had no effect on adaptive BA or symptoms of emotional distress in comparison to an active control group. Potential explanations for the absence of an effect on adaptive BA and emotional distress are discussed in Chapter 6 (i.e., lack of statistical power, the MBI program used, infrequent home practice, unhelpful group dynamics, measurement issues, limited room for improvement in the general population, and MBI instructor). Here the issues of power and frequency of home practice are highlighted, the topic of developmental specificities is expanded upon , and certain aspects of the study design are considered.

I would like to reiterate that an important reason why an effect on adaptive BA was not detected, is a lack of statistical power. The *a priori* power analysis was designed to detect a small to medium effect size based on prior studies on BA in adults, but the effect size may be smaller in a general population of adolescents as suggested by meta-analyses in youth from the general population (Carsley et al., 2018). Therefore, the conclusions that can be made regarding the role of BA in an MBI for adolescents based on Chapter 6 are limited. This was, to our knowledge, the first study to examine the role of adaptive BA in an MBI for adolescents. Though Chapter 6 findings do not support the dissertation's general hypothesis, it is too soon to rule out the hypothesized effects. Future research is needed with a large enough sample size to continue building on this line of research (see Future Directions below).

I would also like to highlight the low frequency of home practice as a potential explanation for the null effects on MBA in Chapter 6 in comparison to the significant effects on MBA in Chapter 2, Participants in Chapter 2 practiced more frequently than participants in Chapter 6. As mentioned in Chapter 6, only 15.8% of adolescents did the prescribed amount of informal mindfulness home practice (i.e., daily) and only 5.4% did the prescribed amount of formal mindfulness home practice (i.e., six times per week). Most participants in Chapter 6 practiced zero to three times per week. In contrast, 62% of participants in Chapter 2 did informal mindfulness practices daily and 54% did formal mindfulness practices six to seven days a week. All participants in Chapter 2 reported practicing *at least* four times per week. Since prior research has shown that mindfulness home practice is associated with the benefits gained from an MBI (Kuyken et al., 2013; Quach et al., 2017), the difference in home practice frequency in these two studies may partially explain the differences in results concerning BA.A potential explanation for the null effects on MBA in Chapter 6 that was not discussed at length in the chapter itself, are developmental specificities during adolescence. Interoceptive abilities and the neural machinery that power them are still developing during adolescence (D. Li et al., 2017; J. Murphy et al., 2017), which may make it more challenging for teens to learn the MBA skills taught in MBIs. Furthermore, adolescence is a time in which many physical changes

occur as the body quickly transforms from a child's body to an adult's body and a process of sexual maturation takes place, all of which needs to be integrated into a coherent self-image (Je & Lacinov, 2008). Given the many new body sensations that arise and the difficulty of contextualizing and making sense of them (J. Murphy et al., 2017), the act of being openly aware of body sensations in a direct, experiential fashion as is taught in MBIs, may be a particularly challenging experience of exposure for teens in comparison to adults, potentially leading to a reaction of avoidance, an obstacle for mindfulness practice. This tendency to avoid potentially unpleasant and overwhelming internal experiences may be exacerbated by teens' hedonic approach to body sensations, which was observed in Chapter 3. The habit of avoiding unpleasant sensations and basking in pleasant sensations runs counter to the mindful attitude taught in MBIs, which involves an open, welcoming awareness of all body sensations regardless of their valence (Segal et al., 2018), and may render mindfulness practice more difficult. However, there is very little research on this topic and the field could benefit from qualitative and quantitative studies on how adolescents experience becoming aware of their internal body sensations during an MBI.

Another developmental specificity that may render mindfulness practice more challenging for teens is the central role of body image concerns during this period of life (Todd et al., 2019). Body image relies on exteroceptive or visual information about the body and includes subjective evaluations of bodily appearance (Cash & Pruzinsky, 2002). Body image concerns are particularly salient during adolescence, meaning teens may have the habit of adopting an observer view of their bodies which would drive attentional resources away from internal body sensations (Emanuelsen et al., 2015). The tendency to be aware of and concerned about body image was observed in Chapter 3 when female participants spoke about a "hyper-awareness" of external aspects of the body, and when many participants, across gender, spoke of a general lack of awareness of internal body sensations unless sensations were intense, problematic, new, or highly unpleasant. This suggests that adolescents' attention regarding their bodies may be naturally more externally rather than internally oriented, potentially rendering mindfulness practice more difficult and of low perceived relevance. To briefly summarize the above points, the absence of an effect of an MBI on MBA in teens may be a result of a variety of factors discussed in Chapter 6 as well as the above-mentioned developmental specificities that may render mindfulness practice more difficult and less engaging for adolescents.

A final potential explanation for the null effects on MBA in Chapter 6 in comparison to the significant effects on MBA in Chapter 2, are the differences in study design. Even though participants in Chapter 2 were matched on age, gender, education, and medication use, they were not allocated randomly as they were in Chapter 6. When randomization is not used in a study it increases the probability of having false results due to bias, as discussed in the Limitations section of Chapter 2 (Hariton & Locascio, 2018). Moreover, since the control group in Chapter 2 was passive and the control group in Chapter 6 was active, there is a higher risk of overestimating the intervention's effects in

Chapter 2 in comparison to Chapter 6. Therefore, study design elements may partially explain the differences in results observed in these two chapters.

Chapter 6 findings do support Hölzel et al.'s (2011), Deplus et al.'s (2014), and Davidson et al.'s (2012) theoretical claims that MBIs significantly improve ER. More specifically, Deplus et al.'s (2014) developmental model of the mechanisms of MBIs (see Chapter 1) posits that MBIs exert their effects via cognitive, attitudinal, and behavioral changes. Attitudinal changes involve an open exploration of internal experiences, including emotions, leading to greater emotional awareness and replacement of automatic emotional behaviors with behaviors in line with a young person's values. Moreover, Davidson et al.'s (2012) model on the psychological constructs most impacted by contemplative practices (including MBIs; see Chapter 1) in schools, proposes that contemplative practices strengthen the neural systems responsible for ER at an age when the prefrontal cortex and subcortical structures are particularly plastic. Training-induced changes in these neural substrates directly influence the psychological functions of ER. Chapter 6 findings provide evidence for both developmental theoretical models, as after an MBI adolescents reported finding it easier to regulate emotions, control impulsive behaviors, access ER strategies during an emotional experience, and more easily engage in goal-directed behaviors when experiencing emotions behaviors in comparison to the active control condition.

Chapter 6 findings are robust given the study design, an RCT with an active control condition (ACC). The ACC was comparable to the MBI with regards to number, duration, and frequency of sessions, interaction with the facilitators, group contact, and number of treatment-related activities to be completed at home, thereby controlling for these nonspecific factors (i.e., intervention aspects that are not theoretically specified; Donovan et al., 2009). Moreover, both programs were presented to participants as beneficial, which could partially control for program outcome expectations. Furthermore, both programs involved self-observation and reflection on one's own well-being and values. Lastly, engagement in and satisfaction with both programs was higher than 70%. Given the fact that many nonspecific factors were controlled for, we can safely conclude that the significant positive effects on ER observed in Chapter 6 can be attributed to specific effects of the MBI.

These findings support the literature reviewed in Chapter 6 that has found a positive effect of an MBI on ER in a school setting (e.g., Alampay et al., 2020; Broderick & Metz, 2009; Lau et al., 2020). However, since the present RCT had a small sample size, and since other studies in a school setting have found no effect of an MBI on ER (e.g., Campbell et al., 2019), and the general evidence-base for MBIs in youth has been deemed of low quality, more research is needed to replicate these findings.

Overall, we can conclude that adaptive BA and ER-related processes are significant outcomes and mechanisms of an MBI in adults with mood and anxiety disorders. However, in adolescents in a school setting, only ER is a significant outcome of an MBI.

7.3 Implications

The above findings have clinical implications for adults with emotional disorders, implications for prevention efforts in adolescents from the general population, and measurement implications for intervention studies on BA. Implications are discussed from the perspective of a process-based, transdiagnostic approach to psychotherapy and mental well-being.

A Process-Based, Transdiagnostic Approach

The process-based, transdiagnostic approach to psychotherapy emphasizes the primacy of psychological processes in instigating and maintaining mental disorders (Kinderman, 2009; Kinderman & Tai, 2007; Philippot et al., 2019). A psychological process is "an aspect of cognition (e.g., attention, memory, reasoning, thinking) or of behavior (e.g., overt or subtle avoidance) that might contribute to the maintenance of a psychological disorder" (p. 14; Harvey et al., 2004). Some examples include: intolerance of uncertainty, rumination, meta-cognitive beliefs, helplessness, and self-efficacy (Philippot et al., 2019). Psychological processes are often present in a wide range of mental disorders meaning many of them are transdiagnostic. Moreover, they are viewed as existing on a continuum from intact to disturbed with most individuals falling somewhere in between (Kinderman & Tai, 2007). Preventive interventions seek to target these psychological processes before they are disturbed enough to lead to a full-blown diagnosable mental disorder (Deplus et al., 2014).

Recently, there has been a shift from a diagnostic, symptom-focused view on psychological ailments to a transdiagnostic view based on psychological processes. Earlier theoretical accounts posited that mental disorders were a direct result of biological and psychosocial factors (Engel, 1980). From this perspective, treatment should proceed by giving clients a psychiatric diagnosis and using evidence-based pharmacological and/or psychological therapy to treat the diagnosed mental disorder. This perspective was challenged by the mediating psychological processes model, which states that biological, social, and circumstantial factors lead to disturbances in key psychological processes and these disturbed psychological processes are the ones that lead to mental disorders (Kinderman, 2009; Kinderman & Tai, 2007). From this perspective, treatment should include an identification of which psychological processes are disturbed, the creation of a person-centered case formulation, and a treatment plan including evidence-based interventions that target the disturbed processes (Kinderman & Tai, 2007). Treating the underlying processes at play in an individual's suffering will lead to a reduction or elimination of distressing symptoms.

Clinical Implications for Adults with Emotional Disorders

The present dissertation investigated two psychological processes (i.e., BA and ER) that when disturbed can lead to mental health difficulties. The general introduction

presented empirical research on how BA and ER disturbances are associated with mental health difficulties and a range of psychiatric diagnoses. The general introduction also discussed how BA and ER skills can protect individuals from mental health difficulties and promote mental well-being. The research reviewed in the general introduction suggests that both BA and ER are important processes for clinicians to look out for when concretizing a client's difficulties and when drafting a case formulation.

At various points, the dissertation also discussed the multidimensionality of both constructs. BA involves the capacity to engage and disengage attention from body sensations, cognitive proliferation about body sensations, listening to or avoiding body sensations, attending to sensations with an attitude of trust or mistrust, using body sensations to self-regulate, and being aware of the connection between body sensations and emotions (W. E. Mehling et al., 2012). ER involves skills such as emotional awareness, clarity on which emotions are experienced, the ability to access ER strategies when experiencing emotions, the ability to control impulses when upset, the ability to engage in goal-directed behavior when feeling negative emotions, and an attitude of acceptance toward emotional experiences (Gratz & Roemer, 2004). Clinicians are encouraged to consider the multidimensionality of these psychological processes when assessing a client. The self-report assessments discussed in this dissertation (i.e., the Multidimensional Assessment of Interoceptive Awareness [Mehling et al., 2012] to assess BA in adults, the Mindful Body Awareness Questionnaire to assess BA in AYAs [Pérez-Peña et al., 2023], and the Difficulties in Emotion Regulation Scale Short Form to assess ER in adults and adolescents [Kaufman et al., 2016; Pérez-Peña et al., 2023]) can be used as guides when concretizing a client's difficulties in BA or ER, either by directly administering the questionnaire or by using the questionnaire as a guide during a clinical interview.

The present dissertation's research findings have clinical implications for the treatment of disturbances in BA and related psychological processes. Chapter 2 findings suggest that clinicians can use mindfulness-based approaches to treat deficits in BA in adults with mood and anxiety disorders. Findings suggest that treating BA disturbances by using mindfulness-based approaches may be an efficient strategy, as increases in adaptive BA may lead to improvements in unconstructive rumination, ER self-efficacy, experiential avoidance, self-discrepancy gaps, and the distress caused by self-discrepancy gaps. Based on our findings, an accepting and open awareness of body sensations, as taught in MBIs, helps disengage attention from repetitive, negative thoughts while simultaneously helping engage attention in one's direct experience providing the space to collect information on one's state and to self-regulate. The repeated experiences of self-regulating with adaptive BA may increase an individual's ER skills and their belief in their ability to regulate emotions. Moreover, the repeated experience of engaging in one's direct bodily experience rather than in negative, discrepant thinking may weaken the self-discrepancy gap and the suffering caused by it. However, the temporal and causal relations between these psychological processes still need to be researched. In sum, an important clinical implication is that MBIs can be potentially used to treat BA

disturbances and related psychological processes in adults with emotional disorders, leading to an overall improvement in symptoms.

In conclusion, the present dissertation's results stress the importance of assessing disturbances in BA and ER processes during clinical assessment of adults with emotional disorders, encourage clinicians to consider the multidimensionality of these processes with the support of validated self-report assessments, and supports the use of mindfulness-based approaches in the treatment of disturbances in BA and related processes in adults with emotional disorders.

Practical Implications for Adolescents in a School Setting

As described above and as alluded to in the general introduction, psychological processes such as BA and ER can be deleterious when disturbed but protective and beneficial when functioning well. From a preventive perspective, we need not wait for psychological processes to be disturbed enough to instigate a mental disorder before intervening, particularly during childhood and adolescence when vulnerability is high (Ezpeleta et al., 2001). As described in Chapter 6, school based MBIs are increasingly being implemented as universal preventive approaches with mixed evidence for their efficacy (Dunning et al., 2022; Fulambarkar et al., 2023; Tudor et al., 2022). Below I discuss practical implications of the present dissertation's results regarding the use of MBIs as preventive interventions in school settings.

Findings in Chapter 6 suggest that an MBI in a school setting was effective at reducing difficulties regulating emotions, improving access to ER strategies, and protecting against increases in impulse control difficulties in adolescents between the ages of 13 and 16. The MBI was also marginally effective at improving difficulties engaging in goal-directed behaviors during emotional experiences. Overall, the MBI was well-received with an average level of satisfaction of 76%, with 74% of participants reporting the MBI should be an optional course in school, and with positive qualitative feedback from students. These findings are promising for preventive efforts as ER plays a key role in protecting against the development of mental health conditions and in promoting well-being, as discussed in Chapters 1 and 5.

Though our results were positive, more high-quality RCT studies are needed to replicate these findings as the observed effects were moderate, the majority of participants did not practice frequently at home, and effects were not assessed in a long-term follow-up assessment. Furthermore, the latest meta-analyses warn that MBI implementation in youth has gone ahead of the evidence (Dunning et al., 2022). One recent meta-analysis on the impact of MBIs on children and adolescents' cognitive skills, behavior, and mental health, summarized the current state of the evidence as follows: "While mindfulness-based programs show promising results for some outcomes, in general, the evidence is of low quality and inconclusive" (Dunning et al., 2022, p. 135). Another recent meta-analysis containing nine RCTs assessing the impact of MBIs implemented in a school setting,

found significant improvements in stress but not depression and anxiety as was previously found in clinical samples of young people (Fulambarkar et al., 2023). The authors warn against "extrapolating the results from clinical samples to adolescents in the general population" (Fulambarkar et al., 2023, p. 307). Therefore, more research is needed with special attention on moderators and mediators (Montero-Marin et al., 2022) before MBIs can be recommended for implementation in a general population of adolescents in a school setting (see Future Directions).

What does this mean practically? Should MBIs be implemented with adolescents in a school setting? Based on the findings of the present dissertation, the current evidence base, and on my own observations as a researcher and mindfulness trainer, the answer is: They can be implemented if the conditions are right but should not be implemented if the conditions are not right. Research on "what works, for whom, and how" (Montero-Marin et al., 2022) can offer guidance on the "right conditions". Furthermore, implementation must be closely linked to research, as this is a burgeoning field of study that will continue to produce new insights. Some of the "right conditions" based on both empirical evidence and personal observations include: (1) age, (2) MBI instructor, (3) MBI program, (4) participation on a voluntary basis, (5) a healthy group climate that fosters positive group processes, and (6) opportunities for practice between sessions.

Regarding age, research has shown that MBIs in the school setting are more effective in later adolescence (ages 15-18; Carsley et al., 2018) than early adolescence (ages 11-13; Montero-Marin et al., 2022). Older adolescents have sufficiently developed self-reflection capacities and a heightened brain plasticity to benefit from such a training (Dunning et al., 2019).

With regards to the MBI instructor, it is important that the instructor is adequately trained and has prior experience working with adolescents. Either external facilitators or trained schoolteachers can lead the trainings, but the benefits and drawbacks must be weighed before choosing which option is best in a given context. Prior research has shown that when school teachers lead the trainings, there are significant effects on mental health outcomes that are sustained over time (Carsley et al., 2018). Conversely, when external mindfulness trainers lead the programs, there are significant effects on mindfulness skills but not mental well-being outcomes, and these effects are not sustained at follow-up (Carsley et al., 2018). In an ideal scenario, schoolteachers who are properly trained to teach MBIs may be a great asset as they know the population and may ensure that treatment effects are sustained over time. Furthermore, if teachers as well as students are practicing, this may affect the classroom and school climate (Tudor et al., 2022). However, there may be a pre-existing dynamic already established between a schoolteacher and students, and it may be more difficult for teachers and students to step out of the existing framework to dive into the experiential and inquiry-based learning processes of MBIs. Furthermore, some teens may be less likely to participate openly with teachers whom they will continue to interact with after the training, which would not be the case with an external facilitator. For these reasons, future MBI implementation efforts in schools need

to carefully consider the choice of MBI instructor. Another aspect of the MBI instructor that has been neglected in the literature, is their potential as positive role models for teens. One of the important developmental changes during adolescence is identity development which is greatly supported by positive role models (Dahl et al., 2018). MBI instructors have the potential of being positive role models or mentors who embody certain values and inspire their students. For this kind of relationship to be established, it may be best for the trainer to have an affinity and prior experience with adolescents. To sum up, even though more research is needed on the influence of the MBI instructor on an MBI's effects in youth, current evidence does suggest it is an important factor in an MBI's success. Ideally, MBI instructors for youth in a school setting must be well-trained in delivering MBIs, have prior experience working with adolescents, be knowledgeable about the developmental specificities and needs of this age group, and have an affinity for working with this age group.

Regarding the MBI program, as discussed in Chapter 6, it is important that the program used is adapted to the school setting and to an adolescent population. The MBI program must clearly address adolescents' needs and concerns as well as account for the developmental specificities of this time of life, some of which were discussed above. It may be important to explicitly link mindfulness to relevant aspects of young people's lives, such as stress management, body satisfaction, positive social interactions, identity exploration, etc. In the RCT study described in Chapter 6, we observed that participants had difficulties making the link between mindfulness skills and the relevance in their daily lives. Therefore, it would be helpful if MBI programs and facilitators made this link clearer as this may increase program success and engagement. Moreover, developmental changes need to be considered when developing these programs. For instance, one characteristic developmental change during adolescence is a sensitivity to autonomy, respect, and prestige, which calls for interventions that respect and enhance this autonomy (Dahl et al., 2018). Another example is adolescents' increased tendency to seek novelty and excitement and explore (Dahl et al., 2018). MBIs could foster this by using a variety of mindfulness practices, and providing a variety of mindfulness practice resources that allow them to freely choose an explore. In fact, research has shown that yoga-based interventions and combinations of mindfulness activities have the largest effects in adolescents in a school setting (Carsley et al., 2018). In our RCT study, we provided a mindfulness app for participants to practice at home, but participants quickly grew bored of it and sought other sources of mindfulness practices such as You Tube. This may be connected to teens' need for novelty, autonomy, and exploration. Future research may consider a collaborative effort between research and clinical psychologists, mindfulness researchers and trainers, and adolescents in the creation of school based MBI programs tailored to adolescents.

The fourth aspect pertains to the conditions of participation. From a clinical psychological perspective, the role of a client's motivation in therapy success is crucial, which is why compulsory therapy often fails to achieve the desired outcomes. In fact, lack

of motivation is a well-known obstacle in psychotherapeutic interventions and psychotherapists are taught to address it before going any further with therapy (Andrea et al., 2014). The same principle could be at play when MBIs are implemented in a school setting at the classroom-level in a compulsory fashion, as has been done in prior studies (Bogaert et al., 2023; Kuyken et al., 2022). These studies have not found significant effects of the MBI on mental well-being outcomes, and one of the contributing factors for these null results may be participants' lack of motivation and interest, as this was not something they chose to partake in. Therefore, one of the "right conditions" for MBI implementation is voluntary participation, as this may lead to increased interest, engagement, increased probability of participating during the sessions and creating a positive learning environment, increased engagement in home practice, and increased chances of benefitting from the program. Participants in the RCT study in Chapter 6 voluntarily participated in the training (albeit some for the wrong reasons as some students could choose between the MBI or the regular class curriculum), which may have contributed to the significant effects observed.

The fifth "right condition" pertains to healthy group climate that fosters positive group processes. As discussed in Chapter 6, positive group processes are an essential component of an MBIs' beneficial effects as they promote healthy self-disclosure, an awareness of common humanity, and an engaging learning environment (Cormack et al., 2018). This aspect of positive group dynamics ties the above-mentioned elements together. A healthy and safe group climate depends on the facilitator's ability to steer the group dynamic in a positive direction (Cormack et al., 2018) and on motivated pupils who are curious about the program and wish to be present and learn. Implementation in classrooms may not be ideal as the motivational element may be absent and there are pre-existing group dynamics that may be unhealthy, leading the facilitator to have difficulties steering the group in the right direction. Hence, in my opinion, mindfulness training as an optional course is a better option that may foster healthier group dynamics.

Lastly, MBI implementation in schools would benefit from providing opportunities for practice between sessions. Findings in Chapter 6 and in other studies (e.g., Bogaert et al., 2023) found that students practiced very little between sessions and between the post- and follow-up assessment. Organizing practice sessions between sessions and maintenance sessions after the end of the training would boost frequency of home practice and the probability of participants benefitting from the program. One way in which peer-group practice sessions could be implemented is by dividing participants into dyads with the aim of practicing together between sessions, providing an opportunity for positive social learning (Dahl et al., 2018).

To conclude, the present dissertation's results support the implementation of MBIs as preventive approaches targeting ER skills in adolescents in a school setting if certain conditions pertaining age, MBI trainer, MBI program, voluntary participation, healthy group processes, and opportunities for practice are met. However, more high-quality research is needed to co-create properly adapted programs with the target group and to

continue to learn about the efficacy, moderators, and mediators of MBIs in a school setting. Implementation should follow the latest research developments.

Measurement Implications for Intervention Research on Body Awareness

Chapters 3 and 4 and Appendix A focused on the development of BA measures tailored to AYAs. Both self-report and behavioral measures were used in the RCT in Chapter 6 to balance out the strengths and limitations of each type of measure. The MBAQ exhibited good psychometric properties and may be a useful tool for future research on adaptive BA in youth and for concretization of BA skills during clinical interviews with AYAs. The validity of the BAIA behavioral measure in Appendix A, however, is unclear and more research is needed before it can be recommended for future use.

I deem it important to acknowledge the difficulty of measuring BA and interpreting BA results and encourage researchers to be aware of these challenges. Though BA self-report measures are useful tools in gathering information on people's beliefs about different dimensions of BA, they do not provide information on the accuracy of these beliefs. For instance, a recent study showed that people who report being more aware of their body sensations as measured by the MAIA (Mehling et al., 2012), were less able to track their interoceptive accuracy cardiac performance throughout the day (Rominger & Schwerdtfeger, 2024). Somewhat in line with these findings, in Appendix A, we found a negative association between MAIA attention regulation and participant's ability to perceive a vibrotactile stimulation on their wrist as measured by the BAIA. This may suggest that people who are skilled at BA may underestimate their performance when reporting on it, and people who are unskilled may overestimate their performance (Kruger & Dunning, 1999). Such a bias may also be at play in intervention studies such as those in Chapters 2 and 6, as by becoming more aware of the limitations of their BA capacities via an MBI, participants may judge their BA skills from a different standard and underreport at post-assessment in comparison to baseline assessment.

I also think it is important to acknowledge the benefits and drawbacks of different kinds of BA measures. For instance, self-report measures of BA are valuable because they give us access to otherwise inaccessible information on individuals' subjective experience from the most knowledgeable source, the individuals themselves (Paulhus, 2007). Furthermore, subjective measures of adaptive BA are positively associated with subjective well-being (Ferentzi et al., 2019), pointing to their relevance for an individual's perception of their mental health. Despite their strengths, self-report measures are particularly sensitive to biases linked to self-presentation, social desirability, among several others (see Razavi, 2001). Furthermore, in the field of interoception, BA self-report measures are highly heterogeneous and seem to measure different constructs rather than a unified construct (Desmedt et al., 2022). Once researchers are aware of these limitations, they can

take action to diminish them or account for them in their research. In the case of self-report biases, for instance, certain biases can be easily diminished by using anonymous surveys (diminishing social desirability bias) and including reverse coded items (diminishing acquiescence response styles; Razavi, 2001) to just give two examples among many. Concerning the heterogeneity of BA self-report measures, researchers are encouraged to be specific about the aspect of BA they are measuring, provide a clear definition, situate the construct in existing theoretical frameworks, and use validated measures.

Given self-report measures' sensitivity to certain biases, one could contend that using behavioral measures (sometimes referred to as objective measures) of BA, may be an interesting way to circumvent some of the limitations of self-report. However, existing behavioral measures of BA have many limitations of their own. A recent review on the topic outlines some of these limitations, such as contamination by exteroceptive processing, incomplete validity and reliability assessment, lack of ecological validity, among others (Desmedt, Luminet, et al., 2023). Another limitation is that objective measures of how accurately one can monitor one's body sensations are not related to mental health outcomes (Desmedt et al., 2022; Ferentzi et al., 2019), which questions the relevance of using such measures. Finally, it is important to note that the nature of BA, being a subjective and internal experience, means that a complete and entirely objective measurement may not be achievable. A combination of approaches may help us to gain a more comprehensive understanding of an individual's BA.

To conclude, given the complexity of measuring BA, the current empirical evidence, and the current availability of measures, I encourage psychology researchers doing intervention studies on BA to favor the use of a mixed-methods approach with clinically relevant BA measures that have been adequately validated in the population of interest. At this point in time and to my knowledge, the most well-validated and clinically relevant measures are self-report measures. Neurobiological measures such as fMRI may also be promising measures that circumvent some self-report biases and shed light on the neural bases of BA. Existing behavioral measures (e.g., interoceptive accuracy measures) need to be developed further before they can be recommended for use, and some researchers even question the possibility of ever having properly validated objective interoceptive accuracy measures (Desmedt, Luminet, et al., 2023). Self-report questionnaires can be coupled with qualitative interviews to better contextualize, understand, and interpret participants' scores, reducing the risk of an erroneous interpretation of findings. If the resources are available, combining self-report measures with fMRI is also an interesting and informative approach (e.g., van der Velden et al., 2023).

7.4 Future Directions

Future Directions for Mindfulness-Based Intervention Research in Adults

Future research can test the present dissertation's general hypothesis that adaptive BA and ER mediate the impact of an MBI on emotional distress using an improved study design. Chapter 2 findings in a population of adults with mood and anxiety disorders, could be replicated in an RCT study with an active control group and four measurement occasions (before, mid-way, right after, and a few months after the MBI). This study design will allow assessment of the long-term sustainability of the MBI's effects and of causality in the serial mediation model. Furthermore, instead of using ER self-efficacy measures, a multidimensional, validated measure of ER, such as the Difficulties in Emotion Regulation Scale long or short forms (Gratz & Roemer, 2004; Kaufman et al., 2016), should be used to assess ER skills. A longitudinal serial mediation model (Jose, 2016) can assess the specific hypothesis that an MBI improves adaptive BA first (mid-way measurement occasion) leading to improvements in ER skills (post-intervention measurement occasion), and these two serial mediators explain the reduction in emotional distress symptoms (follow-up measurement occasion).

Going a bit beyond the present dissertation's general hypothesis, Chapter 2 findings could also be built upon in future studies by assessing the complex interplay of mechanisms at play in an MBI. Adaptive BA, unconstructive rumination, experiential avoidance, the self-discrepancy gap, and ER self-efficacy are all psychological processes impacted by an MBI according to Chapter 2's results. Furthermore, these psychological processes play a mediating role alongside improvements in adaptive BA. However, many questions remain. Which processes of change occur first or do they occur simultaneously? Are there processes that are proximal outcomes of the MBI and other processes that are more distal outcomes? How do these mechanisms influence each other, and are there pathways of change that are stronger than others? How do these processes differentially affect diverse symptoms? Recently, researchers have suggested that a dynamic network approach might be a way to answer some of these questions (Hofmann et al., 2020). Processes of change in psychological interventions are complex, multi-directional, dynamic, and highly variable in different individuals. This complexity cannot be harnessed by the linear mediation models that are commonly used to assess mechanisms of change in psychological interventions. Therefore, future studies could explore the use of an individual dynamic network approach to assess the interplay of mechanisms in MBIs identified in Chapter 2.

Note however that idiographic network models are not yet ready for use in clinical interventions, as demonstrated by many different research groups who are unable to agree on a specific target or process for treatment (Bastiaansen et al., 2020). Furthermore, network models as currently implemented do not allow investigations into *how* a network

changes over time, but instead can only show which patterns are most prevalent within a specific period of time. As such, these network analyses do not allow us to answer all of these key questions regarding individual processes implicated in an MBI and have key limitations (Bringmann et al., 2022). Nonetheless, their possibility demonstrates that research into interventions and individual processes of change should be investigated with more nuance than allowed by linear mediation models.

Future Directions for Mindfulness-Based Intervention Research in Adolescents and Young Adults

Building on what was discussed in the section *Practical Implications for Adolescents in a School Setting*, future research in adolescents in a school setting could benefit from mixed-methods intervention research that includes a qualitative component diving into adolescents' experiences and perceptions of an MBI, their likes and dislikes, what is engaging, what is not engaging, what could be helpful in supporting home practice, which practices were helpful, which ones were not, whether they find the intervention relevant to their daily lives, how did they experience the group dynamic, how did they experience the facilitation method, how did they relate to the instructor, etc. Such research could represent the first steps in a co-creation process of more engaging MBI programs that are better adapted to the adolescent population and the school setting. This process could also be informed by relevant developmental literature highlighting characteristic changes during the adolescent period (e.g., an increased propensity to explore and seek novelty, a motivation for status and autonomy, a search for identity, an increased motivation for social learning, etc. Dahl et al., 2018).

Regarding assessment of the present dissertation's general hypothesis, future research could use an improved study design to re-assess our hypothesis in a population of adolescents in a school setting. Ideally, the six "right conditions" for MBI implementation discussed in the Implications section should be met. A mixed-methods RCT study can be used with the age-appropriate measures developed in this dissertation and the assessment of a longitudinal serial mediation model that considers the variable's temporal relations as described in the above section. The qualitative interviews component could help better understand the self-report findings, as well as provide in-depth information on how adolescents experience becoming aware of their body sensations in a mindful way. Are they capable of doing this? What is this experience like for them? What does it bring up for them, if anything? Furthermore, and very importantly, the study (and future studies in adolescents from the general population) needs to be powered to detect small effect sizes as recent meta-analyses have shown that effect sizes tend to be smaller in general adolescent samples in comparison to clinical samples and healthy adults (Carsley et al., 2018). Moreover, to assess the claim that MBIs can prevent the development of mental health conditions via the improvement of adaptive BA and ER skills, future studies can include longer follow-up assessments and outcome measures assessing the risk of developing specific mental health conditions as

well as outcome measures assessing resilience and well-being (see Kuyken et al., 2022 for an example of a study that uses these kinds of measures).

Future studies could also assess our general hypothesis in a clinical population of adolescents. A similar study design as the one described above could be used to assess whether adaptive BA and ER, as measured by the measures developed in the present dissertation, explain reductions in relevant symptomatology after an MBI. Assessing this hypothesis might be of particular interest in adolescents with disorders in which BA and ER processes are known to be disturbed, such as emotional disorders (e.g., anxiety, depression; Paulus & Stein, 2010) and eating disorders (T. A. Brown et al., 2020).

Given the current state of the evidence with regards to MBIs for adolescents, future research should assess moderators and mechanisms of an MBI's effects on youth mental health in both clinical and non-clinical populations, in the school setting and outside the school setting. This research could be guided by relevant developmental theoretical models (Davidson et al., 2012; Deplus et al., 2014; Tudor et al., 2022). For assessment of MBIs in school settings, Davidson et al.'s (2012) and Tudor et al.'s (2022) models can be used to guide choices regarding moderators and mediators that could be assessed. Since a large portion of research on MBIs in adolescents has had important methodological limitations (e.g., lack of a control group, underpowered studies, etc.), future studies should employ high-quality research designs to derive more robust conclusions and move this field of study forward.

Moreover, the present dissertation focused on an enlarged conception of "adolescence" that includes young adulthood. However, due to time constraints, we were not able to conduct an RCT study in young adults to assess our general hypothesis. Future studies could conduct a mixed-methods RCT study with a similar design as described above in young adults. This could shed light on developmental similarities and differences on the role of BA and ER in MBIs in young adults versus adolescents.

In sum, future research could use mixed methods studies to obtain in-depth information on participants' experiences and perceptions of an MBI with the aim of tailoring the program to the target population, re-test the present dissertation's general hypothesis with an improved study design in both AYA and adult samples, assess the complex interplay of mechanisms involved in an MBI using more appropriate statistical approaches, and assess moderators and mediators of MBIs in adolescents using high quality study designs.

Future Directions for Body Awareness and Emotion Regulation Measures in Adolescents and Young Adults

The present dissertation put forth three measures: the MBAQ self-report measure and the BAIA behavioral measure as measures of MBA, and the F-DERS-SF as a measure of difficulties regulating emotions. The MBAQ was developed and validated in a French-speaking non-clinical population of AYAs (see Chapter 4). Future research is needed to

validate the questionnaire in other languages and cultures, as well as in clinical populations of young people. The BAIA was developed and pre-validated in a pilot study described in Appendix A. However, the task itself needs to be modified and validated in a more rigorous and adequately powered study, described further in Appendix A. The F-DERS-SF was validated in a sample of French-speaking adolescents, but future research is needed to validate it in a population of young adults too. Furthermore, the validity of the Lack of Emotional Awareness subscale needs to be further assessed. Ways of doing so are discussed in Chapter 5.

7.5 Strengths & Limitations

The present dissertation's findings and conclusions need to be considered in light of certain limitations. The specific limitations of the research studies conducted were discussed in each chapter. Therefore, this section will focus on the overarching limitations of this work.

First, all studies were conducted in a WEIRD (Western, educated, industrialized, rich, and democratic) population (Rad et al., 2018). Therefore, our findings are not representative and cannot be generalized to people of other cultures or socio-economic statuses. Cultural considerations in the implementation of MBIs is a nascent line of research that we encourage researchers to pursue, particularly for AYAs who have not received much attention in this regard (Gonzalez, 2020).

Second, though we attempted to conduct the highest quality intervention studies possible within our context and constraints, the clinical trials conducted in the present dissertation did not meet all criteria for highest quality evidence (Harbour & Miller, 2001). For instance, the clinical trial in Chapter 2 did not include randomization, had a high attrition bias, program fidelity was not measured, the control group was passive, and there was no follow-up assessment. Regarding the RCT in Chapter 6, the sample size was very small (< 40), mindfulness trainers had less than three years' experience delivering mindfulness trainings, and though a 3-month follow-up was included, a longer-term follow-up (12 months or longer) was not. Furthermore, though many nonspecific factors were controlled for in the RCT study in Chapter 6 with the inclusion of an active control group, certain non-specific factors were not explicitly controlled for such as treatment expectancies and perceived social support as was done in Shallcross et al. (2015).

Third, though we tried to use the most age-appropriate validated measures for French-speaking adolescents, due to the scarcity of validated measures in this population, this was an impossible feat. Therefore, some studies included measures that had not yet been validated in French-speaking adolescents. For example, the DASS-21, used in Chapters 4-6, the MAIA in Chapter 4, and the BAIA, which was pre-validated but not fully validated, in Chapter 6. The use of these unvalidated measures may have compromised the validity of results obtained with them.

Fourth, though we strove to pre-register our work as much as possible, we did not pre-register three of the studies (i.e., Chapters 3,4, and 5) due to time constraints and in some cases due to study type (i.e., qualitative studies involving a highly exploratory and iterative approach). This may have limited the rigor with which the initial study plan was followed and may have led to making more ad-hoc decisions in the studies that were not pre-registered versus the studies that were (Krypotos et al., 2022). Though we do not think this was the case in the present work as all studies were conducted with high levels of planning, thoroughness, and rigor, we cannot definitively rule out that the studies without pre-registrations differed in their execution than the ones that were pre-registered.

Lastly, there was an inconsistency regarding age groups in the dissertation. Though our focus was on AYAs aged 14-24, due to time and practical constraints, this was not the focus of all studies. For instance, the F-DERS-SF was only validated in adolescents aged 14-18 (Chapter 5), and the RCT study assessing our general hypothesis was only done in a sample of adolescents in a school setting (Chapter 6). Furthermore, the dissertation could be criticized for conducting a proof-of-concept study in a sample of adults (Chapter 2), when they were not the targeted age group and results may not be translatable across developmental stages. However, since the Chapter 2 data had already been collected, included all the relevant variables, was directly connected to the topic, and generated the possibility for a rich discussion on developmental aspects, we deemed it relevant and important to include it.

Despite these limitations, the present work also has many strengths. First, the target group was AYAs, an age group that has received relatively little attention in the MBI, BA, and ER literature, (particularly when it comes to adolescents). Second, the present dissertation developed and/or validated BA and ER measures for French-speaking AYAs, contributing to increasing the availability of measures in this population and hence to the development of research in these areas. Third, the present work contributes to a better understanding of the psychological processes, feasibility, way of delivery, and content development of an MBI for adolescents in a school setting, contributing to informing long-term prevention efforts in this vulnerable population.

General Conclusion

The aim of the present dissertation was to assess whether a mindfulness-based intervention (MBI) improved two developmentally important resilience factors in youth, adaptive body awareness (BA) and emotion regulation (ER). The initial proof-of-concept study in adults with emotional disorders supported our hypothesis as we observed a significant improvement in BA and ER self-efficacy after the MBI and these two processes explained the positive effect of the MBI on emotional distress symptoms. However, the randomized-controlled trial conducted with adolescents in a school setting found no effect of an MBI on BA or emotional distress in comparison to an active control group. There was, however, a significant reduction in various dimensions of difficulties regulating emotions in the MBI group in comparison to the active control group. These findings provide partial support for theoretical accounts emphasizing the importance of BA and ER in MBIs.

The findings in adults with emotional disorders have promising clinical implications as they suggest MBIs can be used to treat deficits in BA and ER. Clinical implications for adolescents in a school setting are less conclusive, however, as the effects observed were small and there were many null effects. This pattern of results has also been found in prior school based MBI studies. Therefore, researchers are increasingly interested in the moderators and mediators of school based MBIs for adolescents. I propose that given the current evidence base, MBIs can only be implemented in schools under the right conditions, which include adequate age (mid-late adolescence), well-trained MBI instructors with prior experience working with adolescents, a developmentally appropriate and engaging MBI program, participation on a voluntary basis, a healthy group climate, and opportunities for practice between sessions.

Future directions for this field of study include launching a co-creation process with youth to create engaging MBIs that are relevant to the target group and motivate them to participate and practice. These tailored MBI programs can be then assessed for feasibility and efficacy in high-quality mixed methods studies that explore key psychological processes, as well as young people's subjective experience of the program. More research is also needed on the moderators and mediators of MBIs in adolescents.

The present dissertation also provided validated self-report measures of BA and ER for adolescents and young adults. These measures can be used for future research on BA, ER, and MBIs in youth. Researchers are encouraged to use multi-modal measures of these complex constructs to facilitate accurate interpretation of results. The measures developed and/or validated in this dissertation can also be used in clinical practice when concretizing

a young client's difficulties in BA or ER as well as for monitoring change in BA and ER skills throughout the therapeutic process.

Overall, this dissertation contributes to a better understanding of the psychological processes of MBIs in adults with emotional disorders and to a better understanding of the outcomes, feasibility, way of delivery, and content development of an MBI for adolescents in a school setting.

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Appendices

Appendix A BAIA

Appendix B Chapter 2 Appendices

- S1 provides effect sizes for the significant intervention effects found in Chapter 2.

Appendix C Chapter 3 Appendices

- S1 provides additional information on the demographic characteristics of participants per focus group. This may help the reader further contextualize the findings.
- S2 provides additional quotes organized per age group and per theme. Since only a few quotes were included in the results section, these additional quotes can provide more information that may help the reader refine their understanding of specific themes.

Appendix D Chapter 4 Appendices

- S1 lists the questionnaires from which items were retrieved for the initial item pool.
- S2 provides the number of items per dimension and sub-dimension throughout the item development process.
- S3 lists the items that were rated most difficult to understand in the pre-test, as well as why they were rated as difficult, and the modifications made as a result. S3 further includes a summary of the pre-test's qualitative results.
- S4 provides the detailed item analysis results. Items that performed poorly and were deleted are highlighted in yellow. Figures of the distributions of these items are also included.
- S5 provides the EFA factor loadings and mean scores per factor of the three-factor model's simple solution.

- S6 displays a table with Study 3's demographic characteristics among adolescents, young adults, and the entire sample.
- S7 displays the Cronbach's alphas of all questionnaires used in the present study.
- S8 provides detailed descriptions of the questionnaires used in Study 3.
- S9 provides a detailed description of the correlation analytic method used in Study 3.
- S10 provides the standardized CFA factor loadings of the hypothesized three-factor model with 22 items.
- S11 provides the French and English items of the chosen MBAQ three-factor model with 18 items alongside their standardized CFA factor loadings.
- S12 displays an illustration of the final MBAQ model.
- S13 provides the final MBAQ (in French and English), including scoring instructions.

Appendix E Chapter 5 Appendices

- S1 is the Difficulties in Emotion Regulation Scale – Short Form French version (F-DERS-SF) with instructions on how to score and cite the scale.
- S2 provides an overview of how items were selected and adapted from the Swiss and Canadian French versions of the DERS.
- S3 provides the psychometric properties of Model 2: Five-factor model excluding Awareness.
- S4 displays the psychometric properties of Model 3: Five-factor model combining Awareness and Clarity into one subscale.

Appendix F Chapter 6 Appendices

- S1 debriefing questions asked in the BAIA per time point.
- S2 provides an overview of the MBCT program for adolescents used in the present study.
- S3 provides an overview of the Health Psychoeducation program for adolescents used in the present study.

- S4 provides a summary of the observed significant effects.
- S5 shows the correlations between outcome variables at baseline.
- S6 provides a table of the multilevel models adjusted for baseline differences.
- S7 provides the results of regression to the mean corrections.

Appendix A: The Body Awareness Indirect Assessment (BAIA): A Novel Body Awareness Task for Youth

Background. Body awareness can be broadly defined as paying attention to body sensations originating from physiological states, emotions, movements, or touch. Existing self-report measures of body awareness are limited because they assess intra- versus inter-individual variability, and they can only assess phenomena accessible to conscious awareness. Existing behavioral measures of body awareness overcome these limitations, but their validity has been questioned. Moreover, to our knowledge, there are no existing body awareness behavioral measures developed for youth. Therefore, the present paper introduces a novel task for youth, the Body Awareness Indirect Assessment (BAIA). The BAIA indirectly measures attention to bodily signals and use of these signals in complex psychological processes (e.g., learning). The objective of the current study is to explore how the BAIA behaves in a general population of youth and to evaluate its validity.

Method. Young people between the ages of 14 and 24 (N = 42) were recruited and randomized to two groups. The first group did a control version of the BAIA first (i.e., condition that has no meaningful bodily signals) and the experimental version second (i.e., condition that has meaningful bodily signals giving participants the correct answer to the task). The second group did the experimental version first and the control version second. All participants completed body awareness and mindfulness questionnaires after the task.

Results and conclusions. Results revealed similar performance in the BAIA in both groups and conditions. Certain aspects of performance in the BAIA were significantly correlated with some aspects of self-reported body awareness and mindfulness. However, perceivers of the bodily signal reported lower levels of body awareness and mindfulness. Results provide mixed evidence for the validity of the BAIA. Modifications to the BAIA are discussed and future research directions are suggested.

Reference

Pérez-Peña, M., De Radiguès, M., & Philippot, P. (2023). *The Body Awareness Indirect Assessment (BAIA): A Novel Body Awareness Task for Youth*. Internal UCLouvain report: unpublished.

Introduction

Body awareness (BA; also known as interoception) is one's ability to sense, interpret, and integrate sensations coming from the body (Khalsa et al., 2018; J. Murphy et al., 2017). It is a multi-dimensional construct involving various levels of processing (Suksasilp & Garfinkel, 2022). Low levels of processing include, for instance, the central nervous system's processing of signals coming from the body. Higher levels of processing include monitoring, attending to, and interpreting body sensations (see Suksasilp & Garfinkel [2022] for a detailed description of each level of processing).

The present study focuses on higher-order processing dimensions of BA, namely, interoceptive attention (i.e., one's tendency to pay attention to body sensations), interoceptive self-report and beliefs (i.e., one's beliefs about body sensations), and attribution of interoceptive sensations (i.e., one's interpretation of body sensations and why they arise; Suksasilp & Garfinkel, 2022). The specific construct of interest is body awareness (BA) defined as: paying attention to body sensations and integrating this information into complex psychological processes, such as decision-making and self-regulation (Pérez-Peña et al., 2023).

Existing measures of BA and its different dimensions include self-report and objective behavioral measures (J. Murphy, Catmur, et al., 2019). With regards to self-report measures, many questionnaires have been developed to assess aspects of BA that are accessible to conscious awareness. According to Desmedt et al. (2022), the most cited questionnaires are: the Body Perception Questionnaire (Porges, 1993), the Multidimensional Assessment of Interoceptive Awareness (MAIA; Mehling et al., 2012), the Body Awareness Questionnaire (Shields et al., 1989), the Private subscale of the Body Consciousness Questionnaire (Miller et al., 1981), and the Self-Awareness Questionnaire (Longarzo et al., 2015). All these questionnaires were developed for an adult population. To our knowledge, there are only three questionnaires validated in a population of youth: the MAIA youth (A. Jones et al., 2020a), the Bodily Awareness sub-scale of the Emotion Awareness Questionnaire revised (Rieffe et al., 2008), and the Mindful Body Awareness Questionnaire (Pérez-Peña et al., 2023).

Although these questionnaires provide useful insights into people's subjective experience of BA, they have certain limitations. First, they are subject to response distortions inherent to all self-report measures (e.g., acquiescence response style, extreme and moderacy response styles, negative affectivity bias, and social desirability bias; Razavi, 2001). Second, they capture intra- versus interindividual variability in BA, meaning people report deviations from their own baseline as they are unaware of other people's levels of BA (W. E. Mehling et al., 2012). Third, it is challenging for participants to report on awareness of their body if they lack this awareness (W. E. Mehling et al., 2012). Some of these self-report biases can be controlled for. For example, acquiescence response style can be diminished by including negatively worded items (Razavi, 2001). Moreover, social desirability can be diminished by measuring participants' susceptibility to social

desirability and statistically controlling for it, by using online surveys where participants' responses are not influenced by an interviewer's presence, and by ensuring anonymity (Grimm, 2010; Razavi, 2001). Other limitations of self-report (e.g., reporting on something one may not be very aware of), may be more easily overcome by using objective measures of BA.

Most existing objective measures of BA measure interoceptive accuracy or one's ability to correctly monitor physiological events (Suksasilp & Garfinkel, 2022). Recently, behavioral task measures have also been developed to assess interoceptive beliefs (e.g., the heart rate discrimination task of Legrand et al., 2022), and there is a call for the use of behavior-based measures for the assessment of interoceptive attention in the form of experience sampling methodology with wearable sensor technology (Suksasilp & Garfinkel, 2022). Since the literature has mostly focused on objective measures of interoceptive accuracy, we will briefly review the most frequently used interoceptive accuracy measures.

Interoceptive accuracy measures have mostly focused on three bodily axes: cardiac, respiratory, and gastrointestinal (Desmedt, Luminet, et al., 2023). The cardiac domain is the most frequently researched one. The most frequently used task is the Heartbeat Counting Task which involves asking participants to count their heartbeats without feeling their pulse (Schandry, 1981). A cardiac interoceptive accuracy index is then obtained by subtracting perceived heartbeats from actual heartbeats measured by a heart monitor. Though easy to administer, this task has many limitations, namely that participants use non-interoceptive processes such as heartbeat estimation to report their heartbeats leading to unreliable results (Desmedt et al., 2018; Zamariola et al., 2018). In the respiratory domain, resistance-detection paradigms are often used and involve, for instance, asking participants to breathe through a mouthpiece connected to a tube and indicate whether there is a resistive load added during the respiration (e.g., Daubenmier et al., 2013). These respiratory tasks also have some limitations; mainly that they require long testing times and are subject to confounding variables such as the negative affect resulting from the resistive loads (Desmedt, Luminet, et al., 2023). Lastly, a commonly used task in the gastrointestinal domain is the two-step Water Load Test (WLT-II) requiring participants to drink water until perceived satiation and until maximum fullness (Van Dyck et al., 2016). An individual gastric interoception index is calculated by dividing the water volume required to reach satiation by the total water volume required to reach satiation and fullness multiplied by 100. Though less invasive than other measures used to assess gastric interoception (e.g., mechanical distension; Andresen, 2009), the WLT-II has questionable validity as there are many confounding variables that are unaccounted for such as stomach capacity, beliefs, and guessing strategies (Desmedt, Luminet, et al., 2023). There are many more interoceptive accuracy tasks that were not cited here; see Desmedt et al. (2023) for a systematic review of interoceptive accuracy tasks in each of these domains.

Despite the wide range of existing objective measures of interoceptive accuracy, all of them suffer from important limitations, and none of them combine high validity, reliability and ease of assessment (i.e., with regards to time, equipment, cost, and non-invasiveness; Desmedt et al., 2023). Furthermore, to our knowledge, no objective measures have been developed specifically for a population of adolescents. The most frequently used tasks in BA research in youth are heartbeat tracking tasks (Emanuelsen et al., 2015; Mata et al., 2015; Nicholson et al., 2019; Palser, Fotopoulou, et al., 2018; Schütteler et al., 2023) despite their clear limitations. Other, much fewer studies, use measures of respiratory interoception such as resistance-detection paradigms (G. K. Fritz et al., 1999).

Given the limitations of existing objective measures, the lack of BA tasks developed specifically for youth, and the need to assess a complex construct like BA with multiple modes of measurement (i.e., subjective and objective), the present study aimed to develop a new interoception task for youth. The purpose of the task was to indirectly measure two aspects of the BA definition stated above: attention to body sensations and integration of bodily information into complex psychological processes such as decision-making. We wanted to develop a task that is appealing to youth, so they stay engaged, that is not contaminated by response biases inherent to questionnaires (see above), that is not aversive or invasive, that is practical (i.e., takes less than an hour to administer, is easy to administer, and requires simple, non-costly equipment), that is not likely to be performed with guessing, and where the strength of the signal and individual differences in signal perception can be controlled.

Therefore, the present study has three aims: (1) to introduce the Body Awareness Indirect Assessment task (BAIA), (2) to explore how the BAIA behaves in a general population of youth, and (3) to evaluate its validity. The BAIA requires participants to sit in front of a computer and detect whether there is a change in visual stimuli presented on the screen. Participants have bracelets connected to the laptop on their wrists. In the experimental condition, the bracelets generate a subtle vibration that provides the correct response to the task. In the control condition, the bracelets generate random subtle vibrations that do not indicate the correct response to the task. Participants are not informed about the vibrations. The subtle vibrations represent a bodily signal. The choice of this stimulus is supported by BA definitions that incorporate touch into their conceptualization (Craig, 2002, 2003, 2008). Performance on the task is evaluated based on detection of the signal, reliance on the signal to perform the task, reaction time on correct trials, and a sensitivity index. We hypothesized that performance would be better in trials where the signal was present, that BAIA outcome measures would have medium to strong positive correlations with related BA measures, and that BAIA outcome measures would have no correlations with an unrelated measure. A detailed description of the BAIA and the detailed hypotheses can be found below in the Methods section and in the present study's pre-registration on OSF (*https://osf.io/845kb*).

Methods

Participants

A total of 42 participants were recruited. Inclusion criteria included being between 14 and 24 years old, not having any mind-body practice within the past 6 months (e.g., meditation, yoga, Tai Qi Quan, etc.), and not having been a serious student of mind-body practices earlier in life (J. Daubenmier et al., 2013). Two participants were excluded because they did not meet the inclusion criteria, leading to a final sample of 40 participants who were on average 21 years old (SD = 1.92). The sample's demographic characteristics can be found in Table A1.

Initially, the research team aimed to recruit 50 participants as a power analysis revealed that this sample size would suffice to conduct the main analyses. The power analysis conducted with G*Power (Faul et al., 2009) showed that with a sample size of 50 participants for a mixed ANOVA, an error probability of 0.05, with two groups, two measurements, a correlation among repeated measures of 0.5, a nonsphericity correction of one, and a statistical power at the recommended .80 level, a small to medium effect size could be detected (f = 0.20). Since this is a satisfactory effect size for our study, we deemed the sample size of 50 adequate. This power analysis was done based on the analyses for the primary outcome measures, D prime (sensitivity index) and BAIA reaction time. A simpler model was used to compute the sample size, as power calculations for multi-level models (which were used to assess relationships with reaction time) are complex. Unfortunately, due to time constraints, the desired sample size was not achieved, a topic that is further addressed in the limitations section of the Discussion section.

Recruitment was done via three channels: (1) the subject pool provided by the Faculty of Psychology's bachelor's course on research methods, (2) social media platforms such as Facebook and Instagram where recruitment ads were posted in various youth groups, and (3) the posting of recruitment ads in different departments of the authors' university and nearby cities. For the first channel, all interested students had the opportunity to participate. Recruitment and validation of participation was done via a university website where teachers communicate announcements to students. These participants received one course credit for participation. For the second and third channels, recruitment ads included information about the study, the names of the researchers involved in the study, and a link and QR code leading to a Qualtrics page where interested participants could provide their contact information and respond to a few questions assessing inclusion criteria. The ad and the Qualtrics page clearly indicated that participants under 18 years of age had to provide a signed parental consent form to participate in the study. Participants recruited via these channels were compensated with participation in a raffle where one participant won 50 euros, two participants won 20 euros, and one participant won 10 euros.

Parental consent forms were obtained from participants who were younger than 18. All participants were asked to sign an informed consent form at the beginning of the study. The study was approved by the Ethical Committee of the Psychological Sciences Research Institute of the first author's university (Projet 2022-16; approved on February 23rd, 2022).

Measures

The Body Awareness Indirect Assessment

The Body Awareness Indirect Assessment (BAIA) is an adaptation of a visual change detection task (VCDT; i.e., a measure of visual working memory) adapted for an adolescent population (Isbell et al., 2015). The BAIA is hypothesized to measure automatic attention to body sensations and integration of detected body sensations into complex psychological processes (e.g., learning). This applies to body sensations that are accessible to conscious awareness or that are under the threshold of conscious awareness. The BAIA is performed individually and is programmed on E-Prime software.

The BAIA uses the same kind of stimuli and arrays as those used by Isbell and colleagues (2015), colored squares superimposed with stick figures that are introduced to participants as youngsters wearing different colored shirts. Each colored square is randomly selected from a set of nine colors (red, pink, purple, blue, green, yellow, orange, brown and black) and a given color does not appear more than once in an array. The only difference between the target arrays in the BAIA and those in the VCDT is that the BAIA's arrays include sets of 6 stimuli. The stimuli are randomly positioned at each trial to appear on a gray background. Throughout the trials, there is a fixation cross at the center of the screen.

The main way in which the VCDT task was adapted to become the BAIA is that it includes tactile stimulation on participants' wrists. The tactile stimuli are meant to represent a subtle bodily signal. Tactile stimuli are delivered by haptic controllers (i.e., stimulators) programmed with E-Prime and connected to the laptop via a cable. The stimulators are positioned on the participants' wrists using a fabric structure attached to the wrist with Velcro straps. The stimulators are integrated into these structures. The vibratory frequency is calibrated at 175 Hz, with an amplitude of 0.176 volts over a duration of 200ms. There is only one pulse per trial.

At the beginning of the task, participants are told that the task is used to measure visual working memory. There is no reference to BA to avoid priming participants to pay attention to their body sensations. The experimenter then places the stimulators on both wrists and tells the participant that these are electrodermal sensors. Participants then sit in front of a laptop, view the task instructions explaining that in each trial, a group of six teenagers wearing different colored shirts will appear on the screen, disappear briefly, and then return to the screen in the exact location they were in before. Their task is to indicate

whether any of the group members have changed the color of their shirts. Participants then begin the task by clicking on a key on the keyboard. First, participants are presented with a gray background with a fixation cross in the center for 2000ms. Second, an array of target stimuli appears for 150ms. This is followed by a black screen with a fixation cross for 900ms known as the retention interval. Finally, a second array with stimuli is presented for 2000ms. The participant is then asked to indicate whether he/she thinks the two sets of stimuli (the first and the second) are the same or different by using the keyboard keys labeled as "I" and "D" defined as "Same" and "Different" respectively. Participants receive a vibrotactile stimulation on one of their hands during the retention interval that tells them whether the next array will be identical or different from the first array (e.g., vibration on the right wrist means the next array will be identical and vibration on the left wrist means the next array will be different). Participants are asked to answer as quickly and accurately as possible. Once they have indicated their response, feedback appears: a positive smiley face for a correct answer or a negative smiley face for an incorrect answer, or a non-response.

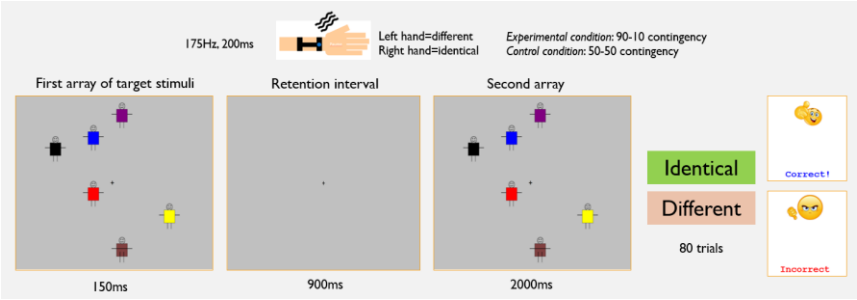
In the present study, the task had two conditions that all participants completed: (1) the control condition in which 50% of the vibrations indicated the correct response (e.g. a vibration on the right wrist indicating the second array is the same as the first; a vibration on the left wrist indicating the second array is different from the first), and 50% of the vibrations were reversed indicating the incorrect response (e.g., a vibration on the right wrist indicating the second array is different from the first; a vibration on the left wrist indicating the second array is the same as the first) and (2) the experimental condition in which 90% of the vibrations indicated the correct response (e.g., a vibration on the right wrist indicating the second array is the same as the first; a vibration on the left wrist indicating the second array is different from the first) and 10% of the vibrations indicated the incorrect response (e.g., a vibration on the right wrist indicating the second array is different from the first; a vibration on the left wrist indicating the second array is the same as the first). Each condition was composed of 80 trials. The trials appeared in a random order. After completion of both conditions, the researcher did a debriefing with each participant, further described in the Procedure section below. Figure A1 shows a diagram summarizing the above explanation of the BAIA.

Performance on the BAIA was assessed with four indices. The first was explicit body perception (EBP), or participants' ability to detect the vibrotactile stimulation on their wrist. This information was obtained during the debriefing when participants were asked whether they noticed the vibration or not leading to a self-reported categorical variable coded as 0 if the response was "no" and 1 if the response was "yes". The second index was explicit body reliance (EBR) referring to participants' awareness of the fact that the vibration provides useful information to complete the task and use of this information to complete the task. This information was also obtained during the debriefing when participants were asked whether they used the vibration to perform the task or not, leading to a second self-reported categorical variable coded as 0 if the response was "no"

and 1 if the response was "yes". The third index was the reaction time of correct responses indicating how rapidly participants responded on correct trials. Finally, the fourth index was the BAIA sensitivity index, a D prime index calculated from participants' responses in the BAIA indicating how well they performed on the task. Higher BA was operationalized as being able to detect the vibrotactile stimulation (EBP = 1), being able to be aware of the utility of the vibration and use it to perform the task (EBR = 1), lower reaction time, and a higher D prime.

Figure A1

A diagram illustrating the BAIA.



Mindful Body Awareness Questionnaire

The Mindful Body Awareness Questionnaire (MBAQ) is an adaptive BA questionnaire developed for adolescents and young adults. It contains 18 items investigating three dimensions, namely *Equanimity* (i.e., relationship of non-judgment, non-reactivity, and openness towards unpleasant body sensations), *Listening* (i.e., approaching body sensations as useful sources of information to identify one's needs, emotions, and to self-regulate), and *Non-avoidance* (i.e., facing [not ignoring or suppressing] body sensations). Answers are rated on a five-point Likert scale from 0 (Never) to 4 (Always). Sub-scale scores are obtained by calculating the mean of the relevant items. The MBAQ has good psychometric properties and displays measurement invariance across age (adolescence and young adulthood) and gender (Pérez-Peña et al., 2023). Internal consistency in the present study's sample was 0.88 for the Equanimity sub-scale, 0.83 for the Listening sub-scale, and 0.82 for the Non-Avoidance sub-scale.

Multidimensional Assessment of Interoceptive Awareness

The Multidimensional Assessment of Interoceptive Awareness (MAIA) is a 32-item questionnaire that measures interoceptive awareness from a multidimensional perspective (W. E. Mehling et al., 2012). It includes eight sub-scales defined as follows by Mehling et al. 2012, p. 10: "(1) Noticing: awareness of uncomfortable, comfortable, and neutral body sensations, (2) Not-Distracting: tendency to ignore or distract oneself from sensations of pain or discomfort, (3) Not-Worrying: emotional distress or 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: experience one's body as safe and trustworthy." Answers are rated on a six-point Likert scale from 0 (Never) to 5 (Always). The Not-Distracting and Not-Worrying sub-scales were omitted in the present study because of low internal consistency in prior studies (e.g., $\alpha = 0.55$ for Not-Distracting and $\alpha = 0.61$ for Not-Worrying; Pérez-Peña et al., 2022). The MAIA was initially created for and validated in an adult population (Mehling et al., 2012). It was later slightly adapted and validated in youth between the ages of 7 and 17 (A. Jones et al., 2020a). Since the MAIA for youth does not yet have a French translation and validation, the French translation of the MAIA for adults was used in the present study (Michael et al., 2016). The use of the MAIA for adults in an adolescent population has proven acceptable in prior studies (Todd et al., 2019). Cronbach's alphas ranged from .55 to .90 in the present study's sample. See Supplementary Materials S1 for the Cronbach's alphas per dimension.

Five-Facet Mindfulness Questionnaire

The Five-Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2008; French adult validation: Heeren & Philippot, 2011) is a 39-item questionnaire measuring mindfulness on a 5-point Likert scale from 1 (Never or very rarely true) to 5 (Very often or always true). It includes five factors, namely Observing (i.e., noticing internal and external experiences), Describing (i.e., naming internal experiences with words), Acting with awareness (i.e., paying attention to the present moment as opposed to being on automatic pilot), Nonjudgement of inner experience (i.e., non-judgmental attitude towards internal experiences), and Nonreactivity to inner experience (i.e., allowing internal experiences to come and go, without being caught up or influenced by them; Baer et al., 2008). There are adapted and validated versions of the FFMQ for adolescents in English (Cortazar et al., 2020), but not in French. Existing mindfulness measures for adolescents validated in French (i.e., the CAMM; Roux et al., 2019) were not fitting for the present study because we sought to explore the concept of mindfulness in a multidimensional rather than unidimensional way. Despite this, Cronbach's alphas in the present study's sample were acceptable ranging from .65 to .89. See Supplementary Materials S1 for the Cronbach's alphas per dimension.

Vibration sensitivity task

The vibration sensitivity task (VST) is a 3-minute E-prime task developed by the research team with the goal of assessing the vibration amplitude each participant is capable of perceiving. As in the BAIA, in the VST, participants must sit in front of a computer screen with a haptic controller delivering vibrotactile stimulations on each wrist. The task is a yes-no detection task where participants are randomly presented with

vibrations of different amplitudes via the haptic controller, and they must indicate whether they can perceive the vibrations by clicking on a specific key on the keyboard. Half of the trials have vibrations and half of the trials do not. The data from this task was used to calculate a vibration sensitivity index to be included as a control variable in the analyses.

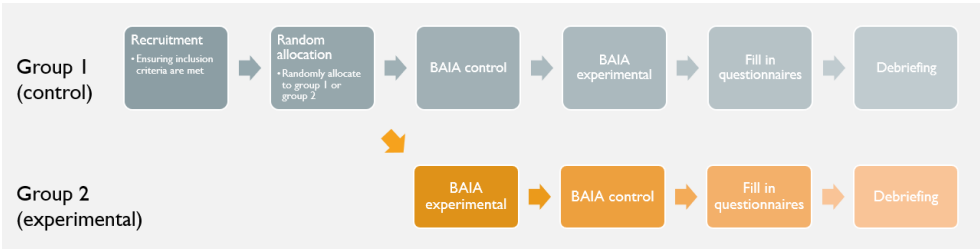
Procedure

After participants were recruited, simple randomization in Excel was used to assign participants to two groups with a different order of conditions. Group 1 did the control condition first and the experimental condition second, and Group 2 did the experimental condition first and the control condition second (see Description above for description of the conditions). This allowed for within- and between-subject comparisons.

The experimental procedure was as follows. Participants arrived in the lab and were asked to sign an informed consent form if they had not yet done so. Then, a brief explanation was given on the purpose and procedure of the experiment. The experimenter said the purpose of the study was to assess the impact of mindfulness on visual working memory as research shows mindfulness may be beneficial for visual working memory. The experimenter then put the haptic controller on the participants' wrists and gave the participant noise-canceling headphones to remove distractions and to make it impossible for the participant to hear the vibration rather than feel it. The participant then completed the BAIA which included six practice trials, 80 trials of the first condition (10 min), a pause, and 80 trials of the second condition (10 min). This was followed by completion of the three questionnaires listed in the Measures section. Lastly, the experimenter did a debriefing in which participants were asked whether they detected and relied on the vibrotactile stimulation, the true objective of the study was revealed, and the participants' questions were answered. At the end of the debriefing, participants were asked to complete the VST. Participants were asked to keep the true objective of the experiment a secret and were thanked for their participation. The debriefing questions can be found in Supplementary Materials S2. See Figure A2 for an overview of the study procedure.

Figure A2

A diagram of the study procedure.



Hypotheses

The research team formulated the following hypotheses:

1. Participants in the experimental condition of the experimental group (i.e., where the vibration is giving useful information) will perform better on all BAIA outcome measures (i.e., EBP, EBR, BAIA reaction time, and BAIA d' index) than participants in the control condition of the control group (i.e., where the vibration does not give any useful information).

2. With the same reasoning, we hypothesize that within-person, participants will perform better on BAIA reaction time and BAIA d' index in the experimental condition than in the control condition.

3. The ability to detect the vibration in the BAIA (EBP) will be indicative of participants' ability to notice and attend to bodily signals, and hence will have medium to strong positive correlations (>.30) with the following sub-scales of body awareness and mindfulness questionnaires that measure the ability to notice and attend to sensations: MAIA Noticing, MAIA Attention Regulation, FFMQ Observing, and FFMQ Mindfulness.

4. The ability to be aware of the fact that the vibration indicates the correct response and use this to do the task (EBR) will have medium to strong positive correlations (>.30) with the following sub-scales of body awareness and mindfulness questionnaires which measure the ability to listen to body sensations in an appropriate way and use them as sources of useful information: MBAQ Listening, MAIA Body Listening, and FFMQ mindfulness.

5. Performance on the BAIA, as assessed by reaction time, will have a significant negative relationship with all sub-scales of the chosen body awareness questionnaires (MAIA and MBAQ). This assumes that better performance is indicated by lower reaction times, as we hypothesize that lower reaction times mean the participant is relying on his/her bodily signals (i.e., the vibration) to perform the task. This may be at a conscious or unconscious level. We further hypothesize that FFMQ Mindfulness will have a medium negative relationship with reaction time, as this quality may boost participant's performance on the task.

6. Performance on the BAIA, as assessed by d', will have medium to strong positive correlations (>.30) with all sub-scales of the MAIA and MBAQ and medium positive correlations (approximately .30-.49) with FFMQ Mindfulness.

7. As a measure of discriminant validity, no association is expected between any of the BAIA outcome measures and the Describing sub-scale of the FFMQ which measures one's ability to find the accurate words to express one's feelings.

Statistical Analyses

Prior to starting the analyses, the main BAIA outcome variables were coded or calculated. The EBP and EBR variables were coded from the debriefing interviews. The D prime sensitivity indices (d' indices) were calculated for the BAIA and the VST following the instructions described in Keating (2005). Calculation of the d' indices involved first calculating the hit, miss, false alarm, and correct rejection rates per participant per condition. Then, the z scores of the hit and false alarm rates were calculated. Finally, subtraction of the z scores yielded the d' index: $d' = z(H) - z(F)$. Lastly, reaction time data was directly obtained from the E prime output file and questionnaire scores were obtained from the Qualtrics output file.

Once the datasets were ready, preliminary analyses were conducted. They included: checking the data for accuracy, excluding participants who did not meet the inclusion criteria, conducting a missing data analysis, calculating descriptive statistics and scores, checking statistical assumptions for the main analyses, and exploring the data with relevant graphs.

Next, the hypotheses listed above were tested using the pre-registered analysis plan. The effect of condition (control versus experimental) on each of the BAIA outcome measures was assessed. Separate models were run for within and between-subject analyses. This deviates from the pre-registration plan where within and between-subject analyses were planned to be done in the same model. This was not done because the datasets needed for between and within subject analyses differed as the within-subject analyses require a dataset with both within-subject conditions and the between-subject analyses require a dataset with only the first condition of each group. Logistic regressions were used to assess the impact of condition on EBP and EBR whilst controlling for vibration sensitivity. Separate multiple regression models were computed to assess the effect of the first between-group condition and the effect of both within-subject conditions on the BAIA d' index while controlling for vibration sensitivity. Finally, separate multilevel models were computed to assess the effect of the first between-group condition and the effect of both within-subject conditions on BAIA reaction time (of correct responses) while controlling for vibration sensitivity. Reaction time was log-transformed due to violations in homoscedasticity.

Then, associations between BAIA outcome variables and self-reported BA and mindfulness were assessed. Point biserial correlations were computed to assess the relationship between EBP and EBR and the relevant dimensions of self-reported BA and mindfulness listed in the Introduction section. Pearson's correlations were computed to assess the associations between the BAIA d' index and BA and mindfulness self-report measures. Non-parametric correlation analyses were used in the case of variable pairs that did not meet the correlation assumptions. For BAIA reaction time, multilevel models were computed to assess its association with BA and mindfulness questionnaires as reaction time data is nested within participants. Originally, these analyses were to be

performed per group (Group 1 versus Group 2) for the first condition of each group (i.e., control condition of Group 1 and experimental condition of Group 2). However, to increase power and because of reasons further explained in the results section, analyses were performed across groups for the first condition of each group.

Lastly, exploratory analyses were performed. The sample was divided into three groups: participants who were aware of the vibrotactile stimulation and the rule (aware group), participants who were aware of the vibrotactile stimulation and not the rule (partially aware group), and participants who were not aware of the signal nor the rule (unaware group). Group differences in BAIA d' index and reaction time of participants who did the experimental condition first, were assessed using ANOVA and multilevel models respectively. Within-person differences in performance were also assessed per group using paired sample t-tests (or the non-parametric equivalent if appropriate) for d' and multilevel models for reaction time. Group differences in self-reported BA, self-reported mindfulness, and vibration sensitivity were assessed using MANOVA. Finally, correlations between BAIA outcome variables and the other dimensions of the MBAQ, MAIA, and FFMQ that were not included in the hypotheses were assessed. Where strong correlations were identified, t-tests were performed to assess whether there was a significant difference in perceivers of the signal versus non-perceivers.

Results

Preliminary analyses

There was no missing data in the BAIA outcome measures. There was one missing data point in vibration sensitivity because an error occurred while this participant was doing the VST. There was 19% missing data in the demographic and questionnaire data. Five participants did not complete the demographic survey or any of the questionnaires because they had asked to complete the survey at home due to time constraints, but they finally forgot to complete the questionnaire. Another five participants had incomplete survey entries for the same reason. Pairwise deletion was chosen to deal with the missing data because it is the recommended technique for cross-sectional data and because we wanted to avoid losing power (Bennett, 2001).

Most of the data met the statistical assumptions for correlation (i.e., linearity, normality, no outliers, and equal variances per category for point biserial correlations), regression (i.e., linearity, normality, homoscedasticity, and no outliers), and multilevel analyses (i.e., linearity, normality of residuals, and homoscedasticity). For correlations, when a particular pair of variables did not meet the assumptions of normality or equality of variances per category (specifically for point biserial correlations), Spearman's correlations were used. When a particular pair of variables did not meet the assumption of no outliers, outliers were removed, and the correlation was performed without outliers. Correlations without outliers are reported below. For multiple regression analyses, all assumptions were met except for the assumption of no outliers. Outliers were identified

and analyses were performed with and without outliers. Since results were the same, regression results with outliers are reported below. Lastly, for multilevel models all assumptions were met except for homoscedasticity. Therefore, reaction times were log transformed which solved the issue.

Participant demographic characteristics and descriptive statistics can be found per group and for the entire sample in Table A1. There were no differences in demographic characteristics and in most variables of interest (except reaction time) between groups.

Table A1

Demographic characteristics and descriptive statistics per group and for the entire sample

	Group 1 (*n* = 23)			Group 2 (*n* = 17)			Entire sample (*n* = 40)		
Variable	N	M / %	SD	N	M/%	SD	N	M / %	SD
Age	19	21	1.97	16	21.56	1.86	35	21.26	1.92
Gender (% female)	19	65	NA	16	59	NA	35	63	NA
Education (% in university)	19	52	NA	16	65	NA	35	58	NA
Nationality (% Belgian)	19	65	NA	16	53	NA	35	60	NA
French as mother tongue (%)	19	83	NA	16	94	NA	35	88	NA
EBP (%)	23	74	NA	17	77	NA	40	75	NA
EBR (%)	23	26	NA	17	18	NA	40	23	NA
BAIA d' index	23	1.70	0.48	17	1.75	0.65	40	1.72	0.55
BAIA RT (ms)	23	756.39*	254.70	17	807.29*	260.63	40	777.87	258.39
VST d' index	22	2.26	0.18	17	2.29	0.25	39	2.27	0.21
MBAQ Equanimity	18	1.80	0.81	16	2.03	0.79	34	1.91	0.80
MBAQ Listening	18	2.14	0.75	16	1.96	0.82	34	2.05	0.78
MBAQ Non-avoidance	18	2.58	0.98	16	2.28	0.86	34	2.44	0.92
MAIA Noticing	17	3.54	0.66	13	3.23	0.94	30	3.41	0.80
MAIA Attention reg.	17	2.75	0.87	13	2.89	1.37	30	2.81	1.09
MAIA Emotional Aw.	17	3.62	0.845	13	3.15	1.10	30	3.42	0.98
MAIA Self-regulation	17	1.94	1.28	13	2.77	1.24	30	2.30	1.31
MAIA Body Listening	17	2.47	1.23	13	2.05	1.15	30	2.29	1.19
MAIA Trusting	17	3.14	1.35	13	3.72	1.53	30	3.39	1.44
FFMQ Observation	18	29.11	4.73	16	26.25	5.04	34	27.76	5.02

FFMQ Description	18	21.94	7.92	16	22.19	7.43	34	22.06	7.58
FFMQ Acting with aw.	18	21.83	5.32	16	26.62	6.64	34	24.09	6.37
FFMQ Nonreactivity	18	18.44	5.67	16	19.81	5.18	34	19.09	5.41
FFMQ Nonjudging	18	21.78	7.03	16	25.50	6.50	34	23.53	6.94
FFMQ Mindfulness	18	113.11	18.33	16	120.38	20.73	34	116.53	19.54

Note. Group 1 = group who did experimental condition first and control condition second. Group 2 = group who did control condition first and experimental condition second; M / % = mean or percentage; SD = standard deviation; EBP = Explicit body perception (i.e., perceiving the vibration); EBR = Explicit body reliance (i.e., relying on the vibration); RT = reaction time; VST = Vibration Sensitivity Task; MBAQ = Mindful Body Awareness Questionnaire; MAIA = Multidimensional Assessment of Interoceptive Awareness; FFMQ = Five-Facet Mindfulness Questionnaire; N = sample size; Attention reg. = Attention regulation; Aw. = Awareness; BAIA d' indices and reaction times are calculated for the first condition of each group; * = independent samples t-tests indicate this value is significantly higher in Group 1 than in Group 2 at $p < .05$; all other variables are equivalent between groups at $p < .05$.

Confirmatory Analyses Results

Is performance on the BAIA better in the experimental condition versus the control condition between and within-subjects?

Within-subjects, a multiple regression with BAIA d' index as the dependent variable and condition (experimental versus control) and vibration sensitivity as predictors, resulted in a non-significant model, $R^2 = .015, F(2, 75) = 0.56, p = .57$, where neither condition ($\beta = 0.05, p = .84$) nor vibration sensitivity were significant predictors ($\beta = 0.12, p = .30$). Regarding reaction time, a random-intercept multilevel model with the log of reaction time as dependent variable and condition and vibration sensitivity as predictors, revealed no effect of condition ($\beta = 0.00, p = 0.91$) nor vibration sensitivity on reaction time ($\beta = 0.13, p = .33$). These results indicate that performance on the BAIA is equivalent in the experimental and control conditions within-subjects.

Between subjects for the first condition of each group, a multiple regression with BAIA d' index as the dependent variable and condition (experimental versus control) and vibration sensitivity as predictors, resulted in a non-significant model, $R^2 = .002, F(2, 36) = 0.036, p = .96$, where neither condition ($\beta = -0.09, p = .80$) nor vibration sensitivity were significant predictors ($\beta = -0.02, p = .93$). The same was true for reaction time where a random-intercept multilevel model with the log of reaction time as dependent variable and condition and vibration sensitivity as predictors, revealed no effect of condition ($\beta = -0.07, p = 0.24$) nor vibration sensitivity on reaction time ($\beta = 0.15, p = .29$). Regarding EBP, a logistic regression revealed no effect of condition (experimental versus control; $\beta = 0.05, p = .94$) or vibration sensitivity ($\beta = 0.37, p = 0.83$) on the likelihood of perceiving the signal or not. Similarly, with respect to EBR, a logistic regression revealed no effect of condition (experimental versus control; $\beta = 0.66, p = .47$) or vibration sensitivity ($\beta = -3.75, p = 0.09$) on the likelihood of perceiving the signal. These results indicate no

difference in BAIA performance in the experimental or control condition between subjects.

Since participants' performance was equal in both conditions within and between subjects, this suggests that the vibrotactile stimulation does not improve performance on the task and we cannot interpret reaction times and d' indices as indicators of BA. Participants are more likely using visual working memory to perform the task and the correlations below must be interpreted with these results in mind.

Are BAIA outcomes associated with BA and mindfulness questionnaires?

Results can be found in Table A2. Since the above results indicated no differences in performance between and within-subjects, correlations were performed across groups rather than within groups to increase statistical power. Results show that, contrary to our hypotheses, EBP is negatively correlated with MAIA Attention Regulation and FFMQ Mindfulness. It has very weak correlations with the other two hypothesized variables, MAIA Noticing and FFMQ Observing. Regarding EBR, as hypothesized, there is a significant positive correlation between EBR and listening to body sensations as measured by the MBAQ. However, no association was found between EBR and the other two hypothesized variables, MAIA Body Listening and FFMQ Mindfulness. Concerning BAIA d' index, our hypothesis of a medium to strong positive correlation with BA and mindfulness was supported for the dimensions of MBAQ Listening, MAIA Attention Regulation, MAIA Self-Regulation, MAIA Body Listening, and FFMQ Observing. Other dimensions of BA and mindfulness had weak correlations with BAIA d' index. Lastly, we hypothesized a negative association between reaction time on the BAIA and BA and mindfulness. Results partially supported this hypothesis for the dimensions of MBAQ Equanimity and MAIA attention regulation, but not for the other BA and mindfulness dimensions.

Is there a lack of association between the BAIA outcome measures and an unrelated variable, describing?

We hypothesized that the FFMQ Describing dimension or the act of naming internal experiences with words, would be independent from and hence not related to the four BAIA outcome measures. Results support this hypothesis for EBR, BAIA d' index, and BAIA RT, but not for EBP which shows a significant negative correlation with FFMQ Describing (see Table A2).

Table A2

Confirmatory and exploratory correlations between BAIA outcome measures and BA and mindfulness questionnaires

	EBP	EBR	BAIA d' index	BAIA RT
EBP	-	-	-.03	.09
EBR	-	-	-.18	-.08
MBAQ Equanimity	-.19	-.08	.10	-.09*
MBAQ Listening	-.08	.41*	0.47[1]**	-.08
MBAQ Non-avoidance	.17[1]	.18[1]	-0.00[1]	.03
MAIA Noticing	-.19	.10	.22	-.07
MAIA Attention Reg.	-.59**	.18[1]	.45*	-.10**
MAIA Emotional Awa.	-.10	.18	.24	.10
MAIA Self-Reg.	-.71***	0.00	.37*	.04
MAIA Body Listening	-.16	-.00	.34	-.03
MAIA Trusting	-.16[1]	-.26[1]	.19[1]	-.04
FFMQ Observe	.03	-.20	.43*	-.01
FFMQ Describe	-.41*	-.09	.11[1]	-.003
FFMQ Act with Awa.	-.24	.03	.16	-.01
FFMQ Nonreactivity	-.24	-.35	.27	-.01
FFMQ Nonjudge	.01	.14	-.08	.003
FFMQ Mindfulness	-.40*[1]	-.06	.27	-.002

Note. EBP = Explicit Body Perception; EBR = Explicit Body Reliance; RT = reaction time; MBAQ = Mindful Body Awareness Questionnaire; MAIA = Multidimensional Assessment of Interoceptive Awareness; Reg. = regulation; Awa. = Awareness FFMQ = Five Facet Mindfulness Questionnaire; *$p < .05$, ** $p < .01$, *** $p < .001$. EBP and EBR correlations are point biserial correlations. BAIA d' index correlations are Pearson's correlations unless otherwise specified. BAIA RT correlations are beta coefficients from multilevel models assessing the association between each pair of variables while considering the nestedness of the data. [1] = Spearman correlation.

Exploratory Analyses Results

Are there differences in performance between those who were aware, those who were partially aware, and those who were unaware?

If the vibration provided valuable information and participants used it to perform the BAIA, a better performance in the experimental condition (higher d' indices and lower reaction times) would be expected in aware and partially aware participants in

comparison to unaware participants. However, an ANOVA revealed no differences in BAIA d' index between the three groups, $F(2,20) = 0.41$, $p = .67$. Similarly, a random intercept multilevel model revealed no difference in reaction times between the three groups ($\beta_1 = .09$, $p = .35$; $\beta_2 = .03$, $p = .82$).

Within-subject differences in performance were also assessed within groups. Once again, if the vibration provided useful information and participants used it to complete the BAIA, we would expect aware participants and perhaps partially aware participants to have better performance in the experimental condition than in the control condition. Results showed that BAIA d' index was equivalent in both conditions in aware ($n = 9$, $Z = 23$, $p = 1$), partially aware ($t(20) = 0.38$, $p = .71$), and unaware participants ($t(9) = 0.03$, $p = .98$). Likewise, random intercept multilevel models revealed no effect of condition on reaction time in aware ($\beta = -0.01$, $p = .58$), partially aware ($\beta = 0.004$, $p = .66$), and unaware participants ($\beta = 0.02$, $p = .20$).

These results indicate no differences in within or between-subject performance between those who were aware, partially aware, or unaware.

Are there differences in BA, mindfulness, and vibration sensitivity between the three groups?

Group differences in self-reported BA, self-reported mindfulness, and vibration sensitivity were assessed. No differences were found in BA as measured by the MBAQ ($n = 34$, $F(6, 58) = 0.40$, $p = .88$), BA as measured by the MAIA ($n = 30$, $F(12, 44) = 0.97$, $p = .50$), mindfulness ($n = 34$, $F(12, 44) = 0.97$, $p = .49$), or vibration sensitivity ($n = 38$, $F(2,35) = 1.41$, $p = .26$).

Exploratory correlations

Correlations between the BAIA outcome variables and all dimensions of the MBAQ, MAIA, and FFMQ not included in the hypotheses were computed in an exploratory fashion. Results can be found in Table 2. Most correlations are weak. However, one correlation that stands out is the strong negative correlation between MAIA Self-Regulation and EBP. To further explore this result, an independent samples t-test was performed comparing self-regulation scores in participants who perceived the vibration and those who did not. Participants who did not perceive the vibration reported significantly higher self-regulation than participants who perceived the vibration, $t(28) = 2.94$, $p = .007$.

Discussion

The purpose of the present study was to introduce and assess the validity of a new behavioral measure of BA tailored to a population of youth, the BAIA. To assess the validity of the measure, we first tested whether the presence of a meaningful bodily signal would improve performance on the task. We then assessed construct validity by

computing correlations between performance on the BAIA and two BA self-report measures. Next, discriminant validity was assessed by computing correlations between performance on the BAIA and an unrelated measure (i.e., one's ability to describe internal experiences with words). Finally, exploratory analyses were conducted to acquire a more complete understanding of the results. Overall, the study provides mixed evidence for the validity of the BAIA as a measure of BA.

First, contrary to our hypotheses, the presence of a meaningful bodily signal did not improve performance on the task. In fact, performance was equivalent when the meaningful bodily signal was present in the experimental condition, and when a random bodily signal was present in the control condition. These results suggest that the meaningful vibrotactile stimulation does not boost nor hinder performance on the task. Exploratory results showed that this is the case for all groups of participants: those who are unaware of the signal and its meaningfulness, those who are aware of the signal but not its meaningfulness, and even those who are aware of the signal and its meaningfulness. Hence, the first conclusion that can be made is that the reaction time and d' indices cannot be interpreted as indicators of BA. Instead, participants are most likely relying on their visual working memory capacity to perform the BAIA, and reaction time and d' indices might be best interpreted as indicators of visual working memory capacity.

Results regarding the other two outcome measures, EBP and EBR, however, are less clear-cut. EBP and EBR cannot be interpreted as indicators of visual working memory as they are solely centered around self-reported detection of and reliance on the vibrotactile stimulation. Though results showed that rates of EBP and EBR were equal in Groups 1 and 2, this does not tell us whether EBP and EBR were higher in the experimental or control conditions because of the study design. The study design involved asking participants to report EBP and EBR only once, after they did both the experimental and control conditions to prevent priming attention to the vibration in between conditions. This prevents us from making meaningful conclusions regarding EBP and EBR across conditions. A follow-up between-subject study involving only one condition (experimental or control) per participant would be needed to make such conclusions.

Regarding correlations with related BA measures, mixed results were obtained. Contrary to our hypotheses, participants who reported having detected the vibrotactile stimulation, also reported lower levels of attention to body sensations, self-regulation using body sensations, and mindfulness. These results are in line with prior studies that found a significant negative association between self-reported BA and performance on tasks of action and non-action-oriented body representations (Raimo et al., 2021). A potential explanation for the negative association found in the present study is that participants who have low BA may not be aware of the limitations of their BA and may therefore have difficulties reporting it accurately in a questionnaire. This explanation is supported by the well-documented Dunning-Kruger effect, a cognitive bias in which people who are unskilled in a given domain tend to overestimate their abilities in that

domain (Kruger & Dunning, 1999). The Dunning-Krueger effect is an important cognitive bias to consider in the interpretation of BA questionnaire results as people who are unaware of their bodies may be overestimating their abilities and people who are aware of their bodies may be underestimating their abilities. Hence, a lower questionnaire score supported by good performance on an adequate objective measure may be more indicative of higher BA than a high questionnaire score accompanied by poor performance on an objective measure.

Concerning EBR, in line with our hypotheses, participants who relied on the bodily signal to perform the BAIA reported higher levels of listening to the body as measured by the MBAQ. This supports the construct validity of the MBAQ Listening sub-scale and the EBR component of the BAIA which both measure relying on bodily signals to inform one's actions. On the contrary and unexpectedly, there was no association between EBR and MAIA Body Listening and mindfulness. This puts into question the validity of the MAIA Body Listening sub-scale that claims to measure listening to the body to get insights on one's state and choice of actions. Regarding the null association with mindfulness, this may be because reliance on bodily signals to inform one's actions may go beyond the concept of mindfulness. Influential mindfulness theoretical frameworks put forth two components of mindfulness: attention regulation to present moment experience and an orientation of curiosity, acceptance, and openness toward this experience (Bishop et al., 2004; Lindsay & Creswell, 2017). The aspect of relying on the content of present-moment experience to make a decision or take a specific action is not usually included in the conceptualization of mindfulness.

The significant positive associations between the BAIA d' index and MBAQ Listening, MAIA Attention Regulation, and MAIA Self-Regulation, as well as the significant negative association between BAIA reaction time and MBAQ Equanimity and MAIA Attention Regulation, suggest a link between visual working memory and BA. To our knowledge, there are no studies assessing the link between visual working memory and BA so future research is needed to replicate this finding. The significant positive association between BAIA d' index and FFMQ Observe suggest a link between visual working memory and mindfulness. This is in line with prior research showing significant improvements in working memory capacity after a mindfulness training in adolescents (Argüero-Fonseca et al., 2022), young adults (Mrazek et al., 2013), and adults (Van Vugt & Jha, 2011). Working memory may be enhanced by mindfulness practice via various pathways. One possibility is that mindfulness limits irrelevant information thereby allowing the maintenance of more task-relevant information in working memory (Ostafin et al., 2015). Another possibility is that training in mindfulness meditation may expand working memory capacity (Ostafin et al., 2015).

Lastly, discriminant validity was supported for all BAIA outcome measures except for EBP which was significantly negatively associated with FFMQ Describe. The negative association between EBP and one's ability to describe internal experiences with words is unexpected but suggests that people who are more attentive to their bodily signals

perceive themselves to be less apt at conveying their experiences with words. One possibility could be that those who are more aware of their internal experiences, are more likely to recognize the limitations of spoken language to fully convey what they feel, leading them to rate themselves as less competent at describing their internal experiences.

Overall, this pattern of results provides mixed evidence for the validity of the BAIA. On the one hand, the BAIA d' index and reaction time cannot be used to measure BA because they are contaminated by visual working memory capacity. On the other hand, EBP and EBR may still be used as potential indices of conscious attention to body sensations and conscious reliance on these sensations for complex psychological processes, respectively. Although convergent validity of the EBP was not supported by correlations with self-report measures, this may not be because the index itself is not valid but because of an inappropriate assessment of its validity. BA questionnaires may not be the best choice of measure to assess the validity of a more objective measure such as EBP as research has repeatedly shown the lack of association between subjective and objective BA measures. Future studies could assess the convergent validity of EBP using another promising task as recommended in Desmedt et al. (2023). Regarding EBR, its convergent validity was supported by correlations with the MBAQ Listening sub-scale. However, validity assessment could be strengthened by computing correlations between EBR and another relevant task. Lastly, a more meaningful assessment of EBP's and EBR's discriminant validity would be to compute correlations with an exteroceptive version of the task as recommended in Desmedt et al. (2023). An exteroceptive version of the BAIA could be done by replacing the vibrotactile stimulation with specific sounds that provide the answers on the task.

The BAIA in its current form has certain strengths that make it interesting to the field. An important strength is that during the debriefing, most young people reported finding the task accessible and engaging, suggesting that the task is appealing to youth. Furthermore, the BAIA is easy to administer, uses non-costly equipment, and is time-efficient with each condition lasting only ten minutes. Another important benefit is that the experimenter has full control over the vibrotactile stimulation and can measure and statistically control for individual differences in stimulus sensitivity. Moreover, the BAIA is not contaminated by guessing strategies as participants have no prior beliefs about the vibrotactile stimulation and are not even aware it will be there, making it almost impossible for them to guess its presence or utility. If d' index and reaction time measures are not used and only EBP and EBR outcome measures are kept, the BAIA is also free from contamination from exteroceptive processing, as participants can only perceive the vibrotactile stimulation by feeling it and not by any other channel such as smell, sight, taste, or sound. The experimenter can ensure the vibration is not heard by using noise-canceling headphones as done in the present study. Lastly, if only EBP and EBR outcome measures are used, the BAIA cannot be performed using other processes such as visual working memory. Therefore, the BAIA with its two outcome measures EBP and EBR,

follows many of the recommendations for interoceptive accuracy measures listed in Desmedt et al. (2023).

Despite its strengths, the BAIA has many weaknesses that need to be improved before recommending it for future use. First, d' index and reaction time outcome measures cannot be used as they reflect visual working memory performance. This means only two BAIA outcome measures can be used, EBP and EBR, and they are both yes-no binary variables reported during the debriefing. Both EBP and EBR may be contaminated by certain self-report biases, such as social desirability bias and participants' beliefs. Participants may report having felt (or not) the vibrotactile stimulation based on their beliefs about the task and what they believe is considered good performance on the task. For instance, since the task is presented as a visual working memory task, when asked if they felt a vibration, they may say no despite having felt it, because they believe it is irrelevant to the task at hand. Similarly, when asked if they relied on the vibration to perform the task, they may say no even though they did rely on it, because they believe they should have been using their visual working memory and not the vibration. Some of these limitations are already targeted in the debriefing by asking the question twice, first generally and then specifically, giving the participant multiple opportunities to report on this. However, the debriefing process could be further strengthened by having the experimenter emphasize at the beginning that there are no correct or incorrect responses to the questions, and encouraging the participant to be honest in their answers as it is important for the research. Another way to confirm the reliability of participants' EBP responses is to use the VST to check whether the participant can perceive the BAIA's amplitude of vibrotactile stimulation.

Another limitation of the BAIA is the lack of precision of the EBR outcome measure. The EBR measures two things: participant's awareness of the fact that the vibrotactile stimulation provides the correct response and participant's use of this information to perform the BAIA. Most participants who reported being aware of the vibration also reported using it (at least partially) to perform the task. However, some participants were aware of the vibration and did not use it to perform the task for two main reasons: (1) the vibration did not provide the correct response 100% of the time, so they did not trust it and (2) relying on the vibration was not part of the instructions. Therefore, for greater measurement precision, we suggest dividing the EBR into two indices: one that assesses whether participants were aware of the informative quality of the vibration (explicit body awareness; EBA), and one that assesses whether participants used the vibration to perform the task (EBR). To do this, an extra question would need to be added to the debriefing. It is important to acknowledge, however, that EBA, which involves learning the contingency between the bodily signal and the response in the visual working memory task, is not a measurement of BA and should not be reported as such. EBP, which involves detecting the signal, and EBR, which involves relying on the signal to perform the task, can be considered indices of BA.

A final limitation of the BAIA as it was administered in the present study is that it may be too long and repetitive for youth. During the debriefing, when participants were asked what they thought about the BAIA, many of them said it felt long and required a lot of sustained concentration which was tiring. Since each participant did two conditions, the task was in total 20 minutes long. However, since d' index and reaction time outcome measures should not be used, there is no need to have participants do both conditions as actual performance on the visual working memory task need not be measured. Participants can hence do the experimental condition only and the main outcome measures of interest would be the EBP and EBR. This would limit the task to only 10 minutes with a five-minute debriefing.

The present study's findings need to be interpreted considering the following limitations. First, the desired sample size of 50 was not achieved due to time constraints. This may affect the reliability of the findings. Future studies are needed with larger samples so reliable sub-group analyses can be performed. Second, the present study did an incomplete assessment of validity and reliability as concurrent validity, predictive validity, and internal consistency were not assessed. Future studies with an improved version of the BAIA can perform complete reliability and validity assessments. Third, the sample of the present study was 65% female, limiting its representativeness. Fourth, individual learning rates in the BAIA were not computed. Individual differences in learning rates may have impacted how quickly participants learned the contingency between the vibrotactile stimulation and the correct response on the task. Therefore, if learning this contingency boosted performance (as measured by d' or reaction time), individual differences in learning rates may have led to a "boost" at different moments for different individuals, which was not captured by the group-level analyses performed. Nonetheless, even if individual learning rates had been computed, it does not change the fact that performance on the task is contaminated by visual working memory capacities and learning may be happening at the level of visual working memory or at the level of learning the link between the vibrotactile stimulation and the correct response on the task. It is very difficult to untangle the two aspects when assessing learning rates, d' or reaction time outcomes in the BAIA. Furthermore, given that Group 2 participants either did not detect the vibrotactile stimulation at all ($n = 6$), did not make the link between the vibration and its informative quality ($n = 11$), did not rely on the vibration even when they were aware of its informative quality ($n = 3$), or relied on both visual working memory and the vibration to perform the task ($n = 3$), learning rate calculations would mostly be indicative of visual working memory learning rather than BA learning.

In conclusion, the present study provides mixed evidence for the BAIA's validity and reliability as a measure of attention to body sensations and integration of these sensations into complex psychological processes. The BAIA has many strengths, but also many weaknesses that need to be addressed. Two of the BAIA's outcome measures, EBP and EBR, and an additional index, EBA, could be promising measures of BA. However, future

research is needed to conduct a complete validity and reliability assessment of an improved version of the BAIA before the task is recommended for further use.

Supplementary Materials

S1 displays the Cronbach's alphas of all questionnaires used in the present study.

S2 displays the questions the experimenter asked after the BAIA was completed, during the debriefing.

S1: Cronbach's alphas of all questionnaires and sub-scales used in the present study.

Scale and dimensions	Cronbach's alpha (n = 40)
MBAQ Equanimity	.88
MBAQ Listening	.83
MBAQ Non-avoidance	.82
MAIA Noticing	.55
MAIA Attention Reg.	.87
MAIA Emotional Aw.	.73
MAIA Self-Reg.	.86
MAIA Listening	.82
MAIA Trusting	.90
FFMQ Observe	.76
FFMQ Describe	.65
FFMQ Act with Awa.	.89
FFMQ Nonreactivity	.83
FFMQ Nonjudge	.88
FFMQ Total	.89

Note. MBAQ = Mindful Body Awareness Questionnaire; MAIA = Multidimensional Assessment of Interoceptive Awareness; Attention Reg. = Attention Regulation; Emotional Aw = Emotional Awareness; Self-Reg. = Self-regulation; FFMQ = Five Facet Mindfulness Questionnaire; Act with Awa. = Act with Awareness

S2: Questions asked during debriefing after BAIA

1. What did you think of the experiment?
2. What kind of information/knowledge will it produce?
3. Was the procedure of the study clear?
4. How did the study go for you?
5. Did you notice or feel anything?
6. In your opinion, what was the purpose of the study?
7. Reveal the real objective of the study => to indirectly measure body awareness.
8. Do you have any questions?
9. Did you notice the vibration?
    a. If so, did you use it to perform the task?
    b. Perform a short vibration amplitude sensitivity test to record the amplitude that participants can perceive.
10. Are there any aspects of the study that should be modified (instructions, order of performance, etc.)?
11. If there are still participants, ask them to keep the study objective secret until the end.
12. Thank participants for their participation.

Appendix B: Chapter 2 Appendices

S1: Effect sizes for significant intervention effects

There is a lack of clear guidance and consensus regarding the calculation and reporting of effect sizes in multilevel models (Lorah, 2018). A few suggestions exist for random-intercept models with two levels, such as the ones used in Chapter 2: (1) calculating the intraclass correlation coefficient when the research question concerns the random effects, (2) calculating standardized regression coefficients for the fixed effects of interest, or (3) calculating the proportion of variance explained (R^2) for the entire model (Lorah, 2018). Since in Chapter 2 we were interested in the specific fixed effect of the intervention variable on post-treatment outcome variables, option two was chosen.

Below is a table listing the standardized regression coefficients for the intervention variable while controlling for baseline values. The coefficients of interest are those in the third column, β(*SE*) – Intervention. Only effects that were significant in the Chapter 2 models are included. The standardized regression coefficient for the binary intervention variable (dummy coded as 0 for the control group and 1 for the MBCT group), can be interpreted as the size of the treatment effect. For instance, a coefficient of 1.21 represents that the MBCT group scored 1.21 standard deviations higher than the control group in MAIA Attention Regulation. Overall, the magnitude of the treatment effects is largest for MAIA Attention Regulation, MAIA Self-Regulation, and MAIA Body Listening.

Table S1: standardized regression coefficients for significant effects

Post-treatment outcome measures	Intercept	β(*SE*) - Intervention	β(*SE*) – Baseline levels
FBSQ total	-0.40 (0.33)	0.51 (0.37) *p* = .21	0.62 (0.07)*** *p* < .001
FBSQ Perception	-0.36 (0.33)	0.46 (0.37) *p* =.26	0.54 (0.07)*** *p* < .001
FBSQ Differentiation	-0.25 (0.10)	0.42 (0.13)* *p* = .02	0.65 (0.07)*** *p* < .001
FBSQ Regulation	-0.44 (0.34)	0.55 (0.38) *p* = .20	0.54 (0.07)*** *p* < .001
MAIA Noticing	-0.41 (0.11)	0.70 (0.14)** *p* = .003	0.51 (0.07)*** *p* < .001
MAIA Not-Worrying	-0.32 (0.11)	0.50 (0.13)* *p* = .01	0.56 (0.07)*** *p* < .001
MAIA Attention Regulation	-0.72 (0.10)	1.21 (0.12)*** *p* < .001	0.43 (0.06)*** *p* < .001
MAIA Emotional Awareness	-0.45 (0.10)	0.78 (0.13)** *p* = .001	0.55 (0.06)*** *p* < .001
MAIA Self-Regulation	-0.85 (0.09)	1.42 (0.12)*** *p* < .001	0.37 (0.06)*** *p* < .001
MAIA Body Listening	-0.61 (0.11)	1.03 (0.14)*** *p* < .001	0.46 (0.07)*** *p* < .001
MAIA Trusting	-0.36 (0.16)	0.63 (0.19)*	0.58 (0.07)***

		$p = .02$	$p < .001$
Mini-CERTS Unconstructive R	0.39 (0.11)	-0.65 (0.14)**	0.62 (0.07)***
		$p = .004$	$p < .001$
MEAQ total	0.43 (0.11)	-0.72 (0.14)**	0.60 (0.07)***
		$p = .002$	$p < .001$
MEAQ Behavioral avoidance	0.45 (0.10)	-0.76 (0.13)**	0.57 (0.06)***
		$p = .001$	$p < .001$
MEAQ Procrastination	0.12 (0.10)	-0.21 (0.13)*	0.71 (0.06)***
		$p = .16$	$p < .001$
MEAQ Dist. /Suppression	0.38 (0.11)	-0.61 (0.14)**	0.46 (0.07)***
		$p = .006$	$p < .001$
SCL-90-R total	0.43 (0.10)	-0.71 (0.13)**	0.66 (0.07)***
		$p = .002$	$p < .001$
SE-Q total	-0.32 (0.11)	0.53 (0.15)*	0.65 (0.07)***
		$p = .01$	$p < .001$
SE-Q Emotion regulation SE	-0.54 (0.12)	0.87 (0.16)**	0.41 (0.08)***
		$p = .002$	$p < .001$
SD-S Actual-ideal gap	0.32 (0.13)	-0.50 (0.17)**	0.44 (0.08)***
		$p = .02$	$p < .001$
SD-S Actual-ideal gap distress	0.03 (0.13)	-0.05 (0.17)	0.46 (0.09)***
		$p = .79$	$p < .001$
SD-S Actual-ought gap distress	-0.08 (0.15)	0.12 (0.19)	0.35 (0.09)***
		$p = .54$	$p < .001$
AMT's specific positive memories (with outliers)	-0.38 (0.13)	0.75 (0.19)*	0.33 (0.10)**
		$p = .02$	$p = .001$

Note. *$p < .05$, **$p < .01$, ***$p < .001$; R = Rumination; SE = Self-efficacy; mention of BS positive = mention of body sensations during positive memory recall

Appendix C: Chapter 3 Appendices

Table S1. Participant Characteristics

FG with female young adults	(*N* = 7)
Age (*M, SD*)	22.29 (1.98)
Female gender	7
Year of studies (university)	
Bachelor	2
Master	5
Type of studies	
Psychology	3
Communication	2
Audiovisual	1
Speech therapy	1
Nationality	
Belgian	6
French	1
French as mother tongue	7
FG with male young adults	(*N* = 4)
Age (*M, SD*)	20.25 (1.71)
Gender	
Male	3
Other	1
Year of studies (university)	
Bachelor	4
Type of studies	
Psychology	1
Marketing	1
Social work	1
Biomedical sciences	1
Belgian nationality	4
French as mother tongue	4
FG with male adolescents	(*N* = 5)
Age (*M, SD*)	15.6 (0.55)
Male gender	5
Year of studies (secondary school)	
11th grade	2
9th grade	2
Unknown	1
Orientation of studies	
General	3
Technical	1
Unknown	1
Belgian nationality	5
French as mother tongue	5
FG with female adolescents	(*N* = 4)
Age (*M, SD*)	15.75 (0.5)
Female gender	4
Year of studies (secondary school)	

9th grade	1
10th grade	1
11th grade	2
Type of studies	
General	4
Belgian nationality	4
French as mother tongue	4

S2: Supplementary focus group quotes organized by group and themes

Adolescent results

Attention

Attention grabbers

So I when I really observe the sensation is when it's really too strong and it really takes over me so I try to stop myself and understand what is happening… (FG4)

Yes, if not, for me it's especially tiredness, it's a bit like Participant 25 but I pay attention to tiredness even if it's sometimes a bit in my daily life because sometimes it prevents me from doing things in my daily life… (FG4)

Temporality of attention

I would say both [paying attention during and after perception of sensations] because I sometimes have some discomfort in my belly but I don't really pay attention and then maybe afterwards, a few minutes after really having a stomach ache and then and then I tell myself in that moment yes, it's true, ten minutes ago I also already had that but I was just not paying attention because I was busy doing something else… (FG3)

Awareness of body sensations

Types of sensations

When I feel angry I sometimes feel, I feel something in my arms, I feel like breaking everything, I feel something itchy in my arms. (FG3)

When I'm hungry, I have gurgling pains and all that. I feel a sense of urgency to eat. (FG4)

Lack of awareness

I don't really pay attention to what I feel in my body, except when I'm hungry and when I'm tired. (FG3)

Reactions to body sensations

Hedonic

Participant: And uh when I feel a positive sensation, well I try to... to make it last.

Facilitator: And what do you do to make it last?

Participant: Well, I continue to do what gives me that feeling, I don't know... for example I'm laughing with a friend and I'll try to continue to have a good time with her and when she leaves or whatever I'll try to remember the moments we had and generally it makes me smile… (FG4)

Listening

But now that we're in lockdown, well when I get up I don't force myself to eat, I wait a little until I'm really hungry and tell myself what am I going to eat? (FG4)

Instrumental

When we do sports and well the body sends signals like we are suffering and so we must not listen to it otherwise we give up, we don't evolve and there you go. (FG3)

Beliefs about BA

Adaptivity

Yes, it's useful because I think that the body sends us signals and that it's a bit like an alarm signal to say ah uh your body tells you that you're hungry uh that you're sleepy and so you have to know how to listen to it. (FG3)

Consequences of not listening

We must not not pay attention to it [body sensations] because it can become harmful, for example, if we don't pay attention to the fact that we are tired, the next morning we have less energy and all that. (FG3)

Good balance

I think we have to pay attention, but we shouldn't let it eat us up either, we shouldn't think about it day and night, saying to ourselves ah why did it hurt that day? Why did I feel sad? Why did I have a lump?... (FG4)

Link between states and sensations

Well, sometimes I... I don't know... yes I have I have sensations but we'll say unexplained that come or whatever…uh for example I slept well or things like that but uh I have a feeling of heaviness like when I'm tired or things like that but uh so I don't really consider that it's fatigue but uh I don't know sometimes it happens to me but it's still very rare in general it's related. (FG4)

Young adult results

Attention

Types of attention

I realize that I don't pay any attention to my sensations at all, not at all, but when they come and I feel them, well, of course they come, I don't pay special attention to them but I feel them. (FG2)

Body sensations

Types

There are sensations that are a little less normal but that are not linked to anything emotional, that require a little more analysis and to see in the long term what, what I can do, is it maybe linked to the contraceptive pill, is it linked to a state that I am not aware of, is it linked to something else. (FG1)

Impermanent

When it's uh uh a feeling due to uh a rather important irritation or uh or a deep sadness for example uh then there uh uh I can only count on time so that it attenuates and returns to a normal state. (FG2)

Processes

Interpretation

… for me it's not what you feel that is the problem, it's how you interpret it... (FG1)

Attitudes

Sometimes if something happens in our body, we will want to analyze it at all costs and so on and we will want to know exactly what it is and this can turn into an obsession or we can misinterpret it or something like that and I think that it can be harmful because it makes us ruminate, there are always the same ideas coming back because it's like oh I feel that, but why can't I find the cause? And I feel that way and so in the end it makes me ruminate and it annoys me more than anything else in fact and so it's a bit harmful because it goes round and round in a loop, uh it doesn't change anything, yes. (FG1)

…almost every hour in my opinion there is at least one time when I say to myself uh where am I? Uh what is it? You come back to your body or I come back to the present moment through my senses or I try to cut off the mind. For example, so even more so in this period, when I pet my cats I try to really feel what's going on, same when uh I go to see my horses uh every time I go to see them I come back to my feet, I feel my feet, I feel

when I'm walking near them, I feel my breathing, I listen to the sounds around uh so I pay attention to the sensations in my body too. So, when I do this process of coming back into my body I do with what's there or I connect to the parts of the body that are easier to reach so I feel what's going on under my fingers or in my feet. (FG1)

Reactions to body sensations

Reactions to physical sensations

…there are sensations that I consider more physiological such as I am thirsty, I am hungry, uh I am tired, well at that moment uh it depends on the moment but most of the time I try to just uh meet this need linked to the sensation, for example if I'm really thirsty I'll go and get a glass of water, if I'm hungry I'll maybe try to open the fridge to see if there's something I could eat so it's nothing special. (FG2)

Reactions to emotion-related sensations

If I notice a sensation that was linked to a strong emotion of sadness or something like that, well I realize that it's negative so at that moment I say to myself uh that anyway it's ruining what I'm doing at the moment and so one of the only ways to deal with it if I can't do anything else, if I can't go directly to the source, then I say to myself, too bad, I give up what I'm doing for the moment, I cry a little bit because I have the right to feel what I feel and then I let myself go a little bit because I say to myself, at the end of the day, we have the right to feel these feelings and that's it. (FG1)

Reactions to undefined sensations

The sensation uh uh hm (laughs) how to explain that... for example uh let's take the case of a transgender person FTM [female-to-male] for example, uh the sensation of his chest uh compressed by a binder or or something like that uh if he can't uh obstruct this sensation uh it's a constant reminder uh to his birth sex, which can uh well then uh uh engender uh dark thoughts and a uh yes a bad mood and uh etcetera. (FG2)

Mind-body connection

Sensations, states, and mind

I know that I had a lot of sensations before where I didn't know how to associate them with my emotions, I didn't know what it meant. I felt things and I didn't really know what it meant and uh I didn't know how to react to it and... now that I've associated certain sensations to feelings, it's much clearer how I function, I know myself much better and uh analyzing these sensations well it allowed me to understand myself much better and to get to know myself too. (FG1)

(Mal)adaptivity

Adaptive

Personally, being aware of my body has helped me a lot to get out of destructive spirals, you know, especially in adolescence, 14-15 years old, in terms of eating habits, it is sometimes problematic, so personally I had a phase that was more problematic in that respect and uh we'll say that I lost a lot of weight intentionally but it was in fact negative in the end and it is after being aware again of my body that told me ah finally stop here or don't force this thing or at that level you are fine, that I was able to reconcile myself with my body but also mentally that allowed me to have a better balance, so it allowed me to have a healthier life both physically and mentally and by paying attention to these body signals, that finally the weight at which I felt good was not necessarily the weight that was the lowest, but the moment when I felt the best in my body was a little bit in another place, or by doing perhaps this type of exercises rather than others, by eating such things rather than others. And so, it really allows you to pay attention to what your body is saying and it allows you to be more balanced on all levels. (FG1)

Appendix D: Chapter 4 Appendices

S1: Questionnaires from which items were retrieved for the initial item pool.

The initial item pool was created on the basis of two sources: (1) items that were drafted by the research team based on the language used by adolescents and young adults in the focus groups, and (2) items retrieved (and some adapted) from the following BA and mindfulness questionnaires:

- The Inner Body Awareness subscale of the Body Intelligence Scale (R. Anderson, 2006)
- The Multidimensional Assessment of Interoceptive Awareness for youth (A. Jones et al., 2020b)
- The Body Awareness Questionnaire (Shields et al., 1989)
- The Body Responsiveness Questionnaire (J. J. Daubenmier, 2005)
- The Child and Adolescent Mindfulness Measure (Greco et al., 2011; Roux et al., 2019)
- The Mindful Attention Awareness Scale for Adolescents (Brown et al., 2011; Jermann et al. 2009).

S2: the number of items per dimension and sub-dimension throughout the item development process.

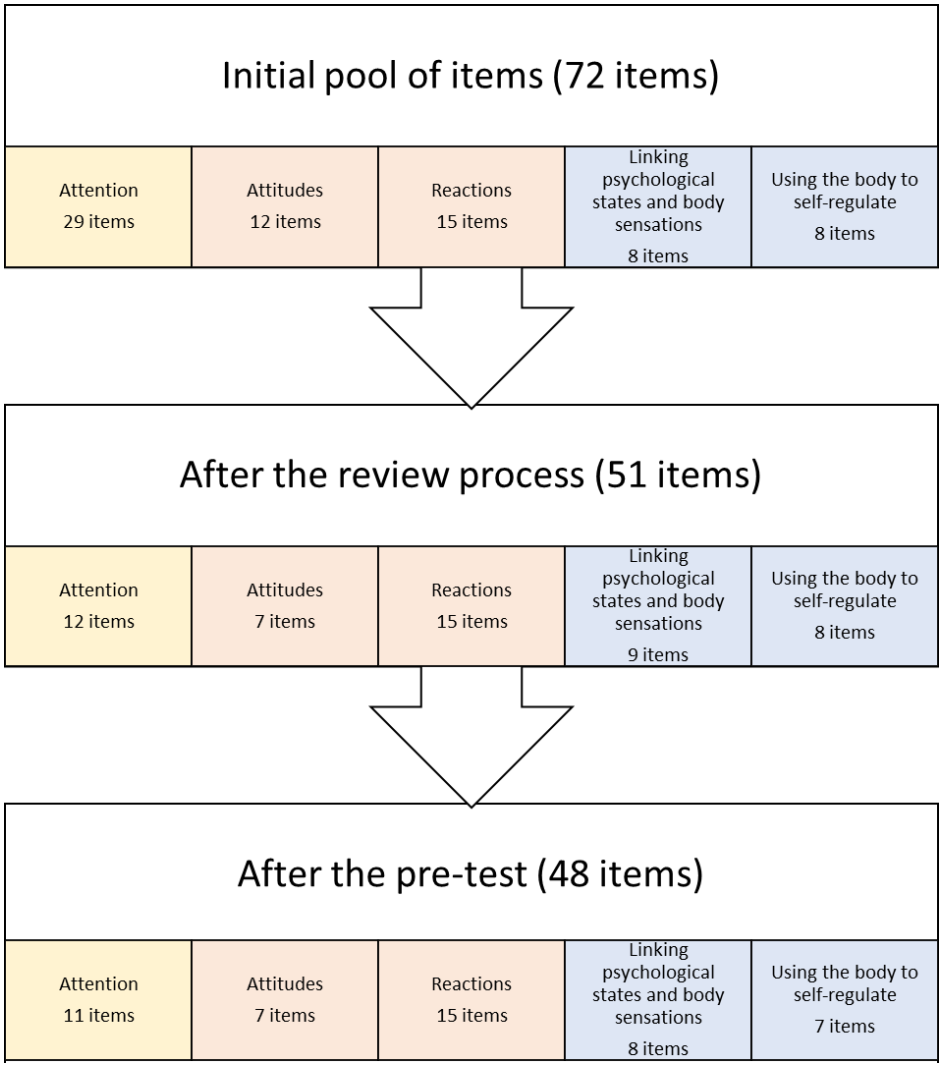


Figure S2. Items per dimension throughout the item development process.

Note: Boxes are color-coded per overarching dimension. Yellow = attention dimension. Orange = attitudes and reactions dimension. Blue = regulatory aspects dimension.

S3: Pre-test most difficult items and qualitative results

Table S3. Pre-test most difficult items

Original item	Non-comprehension index (1-4)	Why it was difficult	Modification/Omission
24. I listen for clues in my body about my emotions. (retrieved from MAIA youth) *J'écoute la résonance de mes émotions dans mon corps.*	2.37	Too abstract. Participants had difficulties understanding the word "résonance" in French and how emotions can "resonate" in the body.	Omitted.
25. When I feel an intense body sensation, paying attention to my body helps me realize what I need in that moment. *Lorsque je ressens une sensation corporelle intense, faire attention à mon corps m'aide à définir ce dont j'ai besoin à ce moment-là.*	1.93	Too abstract.	The item was made more concrete by adding an example: When I feel an intense emotion, paying attention to my body helps me know what I need in that moment (for example, if I'm angry, paying attention to my body sensations helps me realize I need to let off steam to release energy). *Lorsque je ressens une émotion intense, faire attention à mon corps m'aide à savoir ce dont j'ai besoin à ce moment-là (par exemple, si je me sens en colère, prêter attention à mes sensations corporelles m'aide à réaliser que j'ai besoin de me défouler pour libérer l'énergie.)*
43. I suppress sensations in my body that I don't find useful. *Je refoule les sensations dans mon corps que je ne trouve pas utiles.*	1.57	The word "suppress" was not understood by most participants.	The difficult word was changed to "ignore": I ignore body sensations that I don't find useful. *Je ne tiens pas compte des sensations corporelles que je ne trouve pas utiles.*
4. When I feel a sensation in my body I am curious	1.5	Participants reported not knowing how to explore a sensation in their body.	The item was modified by making the wording simpler:

about exploring it and feeling it fully. *Quand je ressens une sensation dans mon corps, je suis curieux.se de l'explorer et de la ressentir pleinement.*			When I feel a body sensation, I am curious about paying attention to it and feeling it fully. *Quand je ressens une sensation corporelle, je suis curieux.se d'y faire attention et de la ressentir pleinement.*
7. When I walk from one place to another, I do not notice how my body feels. (adapted from CAMM). *Quand je marche d'un endroit à l'autre, je ne remarque pas ce qui se passe dans mon corps.*	1.5	Participants found the phrase "walking from one place to another", too abstract and requested concrete examples.	The item was made more concrete by adding an example: When I walk from one place to another (for example, from my house to somewhere else), I do not notice how my body feels. *Quand je marche d'un endroit à l'autre (par exemple de chez moi à un autre endroit), je ne remarque pas ce qui se passe dans mon corps.*
11. When I feel bad, but I don't know why, I look at my body sensations to understand. *Quand je me sens mal et que je ne sais pas pourquoi, j'examine mes sensations corporelles pour comprendre.*	1.47	Participants did not understand the word "examine" in French in this context.	The confusing word was changed to paying attention: When I feel bad, but I don't know why, I pay attention to my body sensations to understand. *Quand je me sens mal et que je ne sais pas pourquoi, je fais attention à mes sensations corporelles pour comprendre.*
1. I quickly and clearly notice all sensations in my body. *Je remarque vite et clairement toute sensation dans mon corps.*	1.4 and often mentioned in the qualitative interviews as being difficult.	Participants found the words "quickly and clearly" confusing in this context.	Omitted.
20. When I notice an unpleasant body sensation, I try to first feel it fully and then dissipate it by breathing deeply.	1.37 and often mentioned in the qualitative interviews as being difficult.	Participants found it confusing.	Omitted.

Lorsque je remarque une sensation corporelle désagréable, j'essaye d'abord de la ressentir à fond et puis de la dissiper en respirant profondément.			

Qualitative results can be summarized into four main themes: (1) from ambiguity to concretization, (2) repetitions and similarities, (3) first steps in body awareness, and (4) structure of the questionnaire.

Regarding the first theme, participants had the greatest difficulty understanding items that were ambiguous, abstract, or that included terms that were unclear to them. Participants suggested including examples in the items so they could have a concrete idea of what was being referred to. Many participants did not understand the difference between terms like body sensation and emotion and would have found an explanation of these terms useful. We thus decided to add examples to items where pertinent, to replace complex words such as "suppression" with simple descriptions, and to add a short, concrete explanation of the terms "body sensations" and "emotions" at the beginning of the questionnaire.

Regarding the second theme, several participants expressed that the items seemed very repetitive. At this stage in the questionnaire development process, repetitive items were kept because we wanted to assess how they behave in the test with exploratory factor analysis described in Study 2.

The third theme, first steps in body awareness, describes participants' general feedback that the concept of body awareness was new to them, and this was the first time they answered questions about this topic. For some, this made it difficult to imagine what the item meant for their daily lives. One participant suggested we include the response option "I don't know" as for several questions, they were not aware of their own functioning. Other participants found the questionnaire very accessible even though it was the first time they came across the term "body awareness". This theme's results emphasize the importance of including concrete examples where possible and of defining terms that are likely new to participants.

Finally, concerning the fourth theme, participants reported that the questionnaire was mostly comprehensible. However, several participants expressed that some items were too long, leading them to become distracted. Hence, items were shortened as much as possible to make them more direct and easier to understand.

S4: Item analysis results

Items that performed poorly and were removed are highlighted in light purple.

Table S4. Item analysis results

Item	Mean	SD	Difficulty
1. I notice the signs of tiredness in my body. (adapted from I-BAS) *Je remarque les signes de fatigue dans mon corps.*	2.88	0.78	0.72
2. I can feel my emotions (for example, fear, sadness, joy, anger) in my body. *Je ressens les émotions (par exemple, la peur, la tristesse, la joie, la colère) dans mon corps.*	3.01	0.85	0.75
3. I can stay calm and not worry when I have feelings of discomfort or pain. (Retrieved from MAIA-2 Not-Worrying) *Je peux rester calme et ne pas m'inquiéter lorsque je ressens un inconfort ou une douleur.*	2.11	1.01	0.53
4. When I feel a sensation in my body I am curious about paying attention to it and feeling it fully. *Quand je ressens une sensation corporelle, je suis curieux.se d'y faire attention et de la ressentir pleinement.*	1.95	0.98	0.49
5. I could be experiencing some emotion in my body and not be conscious of it immediately. (Adapted from MAAS-A) **Je peux vivre une émotion dans mon corps et ne pas m'en rendre compte tout de suite.*	2.14	1	0.54
6. When I feel uncomfortable or feel pain, I do something else. (Retrieved from MAIA-Youth Not-Distracting) **Quand je ressens de l'inconfort ou de la douleur je fais autre chose.*	1.85	0.94	0.46
7. When I walk from one place to another (like from my house to somewhere else), I notice how my body feels. (Adapted from CAMM) *Quand je marche d'un endroit à l'autre (par exemple de chez moi à un autre endroit), je remarque ce qui se passe dans mon corps.*	1.6	1.08	0.40
8. When I feel strong, unpleasant emotion-related sensations in my body (like a knot in my throat when I'm scared), I try to calm down. *Lorsque je ressens des sensations corporelles fortes et désagréables liées à des émotions (comme un nœud dans ma gorge quand j'ai peur), j'essaie de me calmer.*	2.78	0.88	0.70
9. When I am thinking too much, I can calm my mind by focusing on my bodily sensations. (Adapted from MAIA-youth Self-Regulation) *Lorsque je pense trop, j'arrive à calmer mon esprit en me concentrant sur mes sensations corporelles.*	1.16	0.96	0.29
10. I can tell when my breathing changes, like if it slows down or speeds up. (Retrieved from MAIA-Youth Noticing) *Je remarque quand ma respiration change, comme quand elle ralentit ou accélère.*	2.55	1.05	0.64
11. When I feel bad, but I don't know why, I pay attention to my body sensations to understand. *Quand je me sens mal et que je ne sais pas pourquoi, je fais attention à mes sensations corporelles pour comprendre.*	1.77	1.13	0.44
12. When I feel a pleasant bodily sensation, I tell myself that I must enjoy it. **Quand j'éprouve une sensation corporelle agréable, je me dis que je dois en profiter.*	1.31	1.09	0.33
13. I know I appreciate someone thanks to the body sensations I feel.	2.26	1.12	0.57

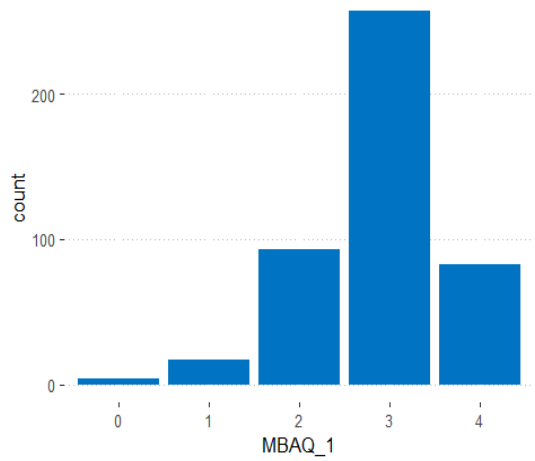
Je peux savoir si j'apprécie une personne grâce aux sensations corporelles que je ressens.			
14. Certain unpleasant body sensations scare me. *Certaines sensations corporelles désagréables me font peur.*	1.75	1.16	0.44
15. When I feel emotion-related body sensations, I accept them and let them follow their course. *Lorsque je ressens des sensations corporelles qui sont liées à une émotion, je les accepte et je les laisse passer.*	2.26	0.88	0.56
16. I can feel how my bodily sensations change when I experience an emotion (like joy, sadness, anger, or peace). (Adapted from MAIA-Youth Emotional Awareness) *Je peux sentir comment mes sensations corporelles changent quand je vis une émotion (comme la joie, la tristesse, la colère ou la paix).*	2.59	0.98	0.65
17. I focus on my body several times per day to pay attention to my body sensations. *Je me concentre sur mon corps plusieurs fois par jour pour faire attention à mes sensations corporelles.*	1.19	1.09	0.30
18. When I feel sensations in my body, I ask myself why I am feeling this way. **Lorsque je ressens des sensations dans mon corps, je me demande pourquoi je me sens ainsi.*	1.7	1.03	0.43
19. I enjoy feeling the sensations in my body. *J'aime ressentir les sensations de mon corps.*	2.11	0.98	0.53
20. I tend to notice feelings of physical tension or discomfort only when they become very intense. (Adapted from MAAS-A) **J'ai tendance à remarquer les sensations de tension physique ou d'inconfort seulement lorsqu'elles deviennent très intenses.*	1.73	1.08	0.43
21. I can feel that my breathing becomes free and easy when I am comfortable. (Retrieved from MAIA-Youth Emotional Awareness) *Je peux sentir que ma respiration devient fluide et facile quand je me sens à l'aise.*	2.3	1.17	0.57
22. When I have a pleasant sensation in my body, I try to make it last. **Quand j'ai une sensation agréable dans mon corps, j'essaie de la faire durer.*	1.43	1.09	0.36
23. When I feel an intense emotion, paying attention to my body helps me realize what I need in that moment. *Lorsque je ressens une émotion intense, faire attention à mon corps m'aide à savoir ce dont j'ai besoin à ce moment-là.*	1.81	1.06	0.45
24. If I concentrate, I can pay attention to each part of my body from head to feet. *En me concentrant, je peux faire attention à chaque partie de mon corps, des pieds à la tête.*	2.14	1.28	0.53
25. I am attentive to my body sensations when I feel an emotion. *Je suis attentif.ve à mes sensations corporelles quand j'éprouve des émotions.*	1.9	1	0.47
26. I listen to the signs of tiredness in my body. *Je tiens compte des signes de fatigue dans mon corps.*	2.34	1.02	0.59
27. When I am too emotional, I focus on how I feel in my body to calm down. (Adapted from MAIA-Youth Self-Regulation) *Quand je suis trop émotif.ve, je me concentre sur ce que je ressens dans mon corps pour me calmer.*	1.57	1.01	0.39
28. I don't really pay attention to what I feel in my body.	2.18	1.17	0.54

** Je ne fais pas vraiment attention à ce que je ressens dans mon corps.*			
29. When I feel overwhelmed or carried away by an emotion, I concentrate on my body sensations to calm down. *Quand je me sens dépassé.e ou emporté.e par une émotion, je me concentre sur mes sensations corporelles pour me calmer.*	1.49	0.97	0.37
30. I ignore unpleasant sensations in my body until they become very strong. (Adapted from MAIA-Youth Not-Distracting) **J'ignore les sensations désagréables dans mon corps jusqu'à ce qu'elles deviennent très fortes.*	1.95	1.1	0.49
31. I get very worried if I feel pain or if I feel uncomfortable in my body. (Adapted from MAIA-Youth Not-Worrying) **Je suis vraiment inquièt.e quand je ressens de la douleur ou de l'inconfort dans mon corps.*	1.94	1.09	0.48
32. Unpleasant sensations in my body grab my attention very quickly. **Les sensations désagréables dans mon corps attirent vite mon attention.*	1.56	1.06	0.39
33. I can focus on my breath to help me calm down and relax. (Adapted from MAIA-Youth Self-Regulation) *Je peux me concentrer sur ma respiration pour m'aider à me calmer et à me détendre.*	2.16	1.1	0.54
34. I am confident that my bodily sensations will let me know what is good for me. (Retrieved from BRQ-I) *Je suis convaincu.e que mes sensations corporelles m'aident à savoir ce qui est bon pour moi.*	2.19	1.07	0.55
35. When something is wrong in my life I can feel it in my body. (Retrieved from MAIA-Youth Emotional Awareness) *Lorsque quelque chose ne va pas dans ma vie, je peux le ressentir dans mon corps.*	2.59	1.06	0.65
36. When I have unpleasant feelings in my body I cannot stop thinking about them. **Quand j'ai des sensations désagréables dans mon corps, je ne peux pas m'arrêter d'y penser.*	1.71	1.15	0.43
37. When I am talking to someone, I am able to pay attention to my posture (for example, the sensations of being seated, laying down, or standing). (Adapted from MAIA-Youth Attention Regulation) *Lorsque je parle a quelqu'un, je peux etre conscient.e de ma posture (par exemple, les sensations d'être assis.e, couché.e ou debout).*	2.34	1.13	0.58
38. I ignore sensations in the body that I don't like. (Adapted from CAMM) ** J'ignore les sensations corporelles que je n'aime pas.*	2.53	0.99	0.63
39. I can have an intense experience (for example an important event) without feeling it in my body. **Je peux vivre quelque chose de fort (par exemple un événement important) sans rien ressentir dans mon corps.*	2.67	1.2	0.67
40. I suppress sensations in my body that I don't find useful. **Je ne tiens pas compte des sensations corporelles que je ne trouve pas utiles.*	2	1.1	0.50
41. I listen to my body to help me choose what I need. (Retrieved from MAIA-Youth Body Listening) *J'écoute mon corps pour m'aider à choisir ce dont j'ai besoin.*	1.93	0.96	0.48

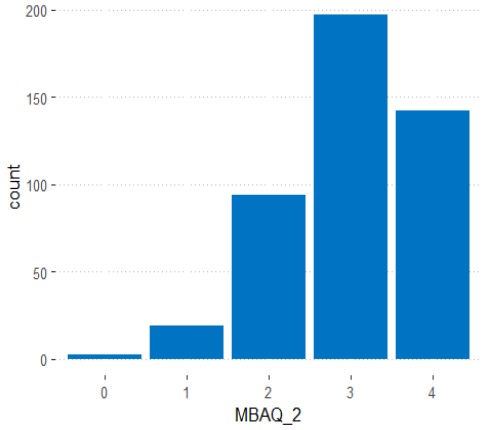
42. When I feel pain in my body, I become upset. (Retrieved from MAIA-Youth Not-Worrying) ** Lorsque je ressens une douleur dans mon corps, je me sens inquiet.e.*	1.8	1.05	0.45
43. Certain body sensations I feel don't seem normal to me. ** Certaines de mes sensations corporelles ne me semblent pas normales.*	2.05	1.05	0.51
44. After a peaceful moment, I can feel my body is different. (Retrieved from MAIA-Youth Emotional Awareness) *Après un moment d'apaisement, je peux sentir que mon corps est différent.*	2.5	1.03	0.62
45. When I feel strong emotions in my body, I ignore them because I don't know how to face them. **Quand je ressens des émotions fortes dans mon corps, je les ignore parce que je ne sais pas comment y faire face.*	2.45	1.02	0.61
46. The sensations in my body help me understand what I feel. *Les sensations de mon corps m'aident à comprendre ce que je ressens.*	2.12	0.99	0.53
47. When I notice an unpleasant feeling in my body, I don't worry about it. (Adapted from MAIA-Youth Not-Worrying) *Quand je remarque une sensation désagréable dans mon corps, je ne m'inquiète pas.*	1.62	1.06	0.40
48. When I feel an unpleasant sensation in my body, I try to find a solution that will make it disappear. **Lorsque je ressens une sensation désagréable dans mon corps, j'essaie de trouver une solution qui la fera disparaître.*	1.62	0.9	0.41

*Items with an asterisk are reverse scored.

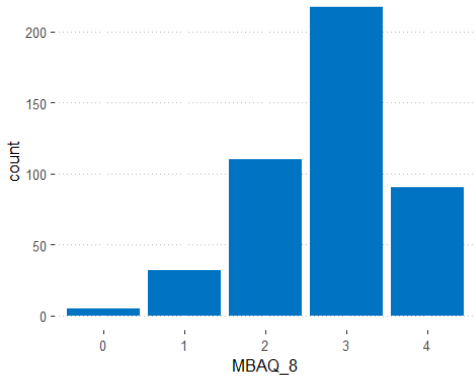
Item 1 variability



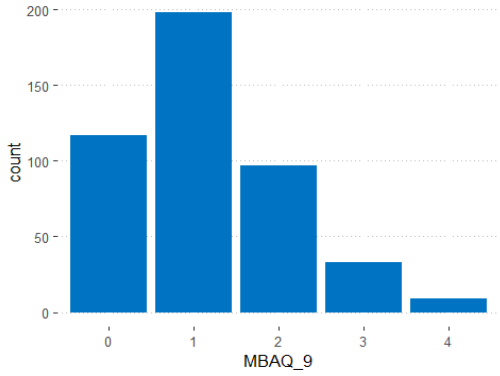
Item 2 variability



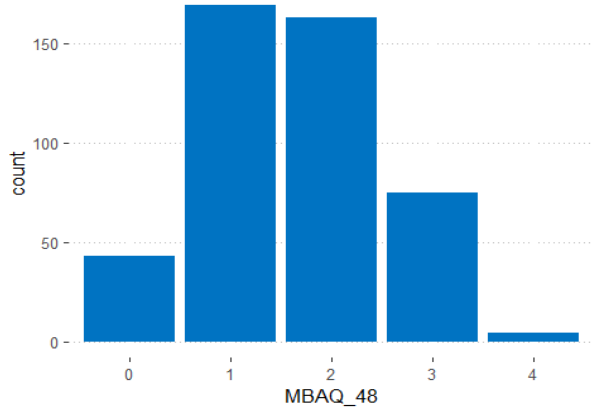
Item 8 variability



Item 9 variability



Item 48 variability



S5: EFA 3-factor solution loadings and mean scores per factor

The mean scores for each factor were:

- Factor 1 M = 2.00 (SD = 0.62)
- Factor 2 M = 1.81 (SD = 0.77)
- Factor 3 M = 2.17 (SD = 0.73)

Table S5. EFA 3-factor solution loadings

Item	Factor 1 (Listening)	Factor 2 (Equanimity)	Factor 3 (Non-avoidance)
11	**0.53**	-0.12	0.05
16	**0.40**	-0.05	0.14
17	**0.51**	0.01	0.14
19	**0.45**	0.09	0.15
23	**0.67**	-0.13	-0.08
24	**0.41**	0.03	0.08
25	**0.55**	-0.06	0.14
27	**0.62**	0.12	-0.07
29	**0.64**	0.07	-0.05
34	**0.61**	0.02	-0.03
35	**0.43**	-0.21	-0.04
41	**0.68**	0.01	0.05

44	**0.43**	-0.04	-0.04
46	**0.73**	0.02	0.03
3	0.04	**0.59**	-0.05
14	-0.10	**0.63**	0.25
31	-0.04	**0.82**	0.05
32	-0.15	**0.55**	-0.26
36	-0.03	**0.72**	0.04
42	0.02	**0.85**	-0.02
43	0.00	**0.49**	0.21
47	0.07	**0.76**	-0.19
20	-0.02	0.04	**0.50**
30	0.08	-0.09	**0.66**
38	0.00	-0.24	**0.52**
45	0.14	0.13	**0.60**

Note. Factor loadings have been sorted and bolded for ease of reading. See S2 for the specific items.

S6: Study 3 demographic characteristics among adolescents, young adults, and entire sample

Table S6. Study 3 demographic characteristics per group

	Adolescents (*n* = 267)	Young adults (*n* = 485)	Entire sample (*n* = 752)
Age (*M, SD*)	16.1 (0.97)	20.6 (2.03)	19.0 (2.74)
Female gender (%)			
Female	60.3	68.2	65.4
Male	37.1	24.1	28.7
Non-binary	2.62	4.33	3.72
Nationality (%)			
Belgian	55.4	49.9	51.9
French	32.2	38.4	36.2
Other	12.4	8.87	10.1
Education (%)			
Secondary	89.5	26.2	48.7
University	8.24	69.1	47.5
Other	2.25	1.86	1.99
French proficiency (%)			
French as mother tongue	89.9	89.9	89.9
Advanced level	7.87	5.57	6.38
Intermediate level	2.25	1.44	1.73

Have prior experience with mind-body practices (%)	38.6	48.9	45.2

Note. N = sample size; M = mean; SD = standard deviation

S7: Cronbach's alphas of all questionnaires used in the present study

Table S7. Cronbach's alphas of Study 3 questionnaires

Scale and dimensions	Adolescents (*n* = 267)	Young adults (*n* = 485)	Entire sample (*n* = 752)
MBAQ Equanimity	.82	.83	.82
MBAQ Listening	.82	.84	.84
MBAQ Non-avoidance	.74	.77	.76
MAIA Noticing	.73	.68	.68
MAIA Not-Distracting	.41	.60	.56
MAIA Not-Worrying	.81	.83	.82
MAIA Attention Reg.	.82	.85	.85
MAIA Emotional Aw.	.64	.81	.79
MAIA Self-Reg.	.80	.80	.80
MAIA Listening	.79	.81	.81
MAIA Trusting	.81	.85	.84
FFMQ Observe	NA	.76	.76
FFMQ Describe	NA	.92	.92
FFMQ Act with Awa.	NA	.85	.85
FFMQ Nonreactivity	NA	.80	.80
FFMQ Nonjudge	NA	.88	.88
FFMQ Total	NA	.90	.90
CERQ Self blame	.77	.80	.80
CERQ Acceptance	.78	.71	.74
CERQ Rumination	.74	.76	.76
CERQ Refocusing	.79	.85	.84
CERQ Planning	.83	.84	.83
CERQ Reappraisal	.76	.84	.82
CERQ Perspective	.77	.80	.80
CERQ Catastrophizing	.79	.69	.72
CERQ Blame others	.77	.83	.81
CERQ Positive	.90	.90	.90
CERQ Negative	.82	.79	.79

PCS Rumination	.71	.74	.74
PCS Magnification	.69	.78	.76
PCS Helplessness	.78	.81	.81
PCS Total	.86	.89	.88
DASS Total	.91	.92	.92
DASS Depression	.88	.88	.88
DASS Anxiety	.83	.79	.80
DASS Stress	.76	.83	.82
DS36-OD	NA	.81	.81
CAMM	.77	NA	.77
EPQ-J-Lie	.51	NA	.51

Note. MBAQ = Mindful Body Awareness Questionnaire; MAIA = Multidimensional Assessment of Interoceptive Awareness; Attention Reg. = Attention Regulation; Emotional Aw = Emotional Awareness; Self-Reg. = Self-regulation; FFMQ = Five Facet Mindfulness Questionnaire; Act with Awa. = Act with Awareness; CERQ = Cognitive Emotion Regulation Questionnaire; PCS = Pain Catastrophizing Scale; DASS = Depression, Anxiety, and Stress Scale; DS36-OD = Social Desirability Scale Other-Deception scale; EPQ-J-Lie = Eysenck Personality Questionnaire-Junior Lie scale

S8: Detailed descriptions of the questionnaires used in Study 3

Multidimensional Assessment of Interoceptive Awareness (MAIA; Mehling et al., 2012; adolescent validation: Jones et al., 2020; French adult validation: Michael et al., 2016). The MAIA is a 32-item questionnaire that measures interoceptive awareness from a multidimensional perspective. It includes eight subscales: Noticing, Not-Distracting, Not-Worrying, Attention Regulation, Emotional Awareness, Self-Regulation, Body-Listening and Trusting. Answers are rated on a six-point Likert scale from 0 (Never) to 5 (Always). The MAIA was initially created for and validated in an adult population (Mehling et al., 2012). It was later slightly adapted and validated in youth between the ages of 7 and 17 (A. Jones et al., 2020b). Since the MAIA for youth does not yet have a French translation and validation, the French translation of the MAIA for adults was used in the present study (Michael et al., 2016). The use of the MAIA for adults in an adolescent population has proven acceptable in prior studies (Todd et al., 2019). Cronbach's alphas ranged from .56 to .85 in the entire sample.

Pain Catastrophizing Scale. (PCS: Sullivan et al., 1995; French adult validation: French et al., 2005; French adolescent validation: Tremblay et al., 2008). The PCS is a 13-item scale assessing three pain-related reactions: rumination (i.e., inability to suppress pain-related thoughts or direct attention elsewhere), magnification (i.e., amplifying the discomfort of painful events and anticipating negative consequences) and helplessness (i.e., inability to manage painful experiences). Items are rated on a five-point Likert scale from 0 (Never) to 4 (Always). Cronbach's alphas ranged from .74 to .88 in the entire sample.

Depression, Anxiety, and Stress Scale-21 (DASS-21: Lovibond & Lovibond, 1995; French adult translation: Donald, 2012). The DASS-21 measures emotional states of depression, anxiety, and stress. It includes 21 items and consists of three subscales: (1) depression (i.e., symptoms of dysphoria, hopelessness, lack of interest, etc.); (2) anxiety (i.e., autonomic arousal, anxious affect, situational anxiety); and (3) stress (i.e., irritability, difficulties relaxing, nervous arousal). Items are assessed on a scale ranging from 0 (did not apply to me at all) to 3 (applied to me very much, or most of the time). Scores are obtained by summing the relevant items per dimension and all items for the total score. The DASS-21 has well-documented psychometric properties in adolescent samples (Szabó, 2010) and across cultures (Mellor et al., 2015). The long version of the scale, DASS-42, has been validated in a French-speaking young adult sample (Ciobanu et al., 2018). Overall, the psychometric properties were good. The present study used the French version of the DASS-21 developed by Donald Martin's team from the University of Ottawa. Though this French version of the DASS-21 has yet to be validated, it has been successfully used in prior studies (e.g.,Arcand et al., 2023) and internal consistency in the present study's sample was very good ranging from .80 to .92 in the entire sample.

Cognitive Emotion Regulation Questionnaire. (CERQ: Garnefski & Kraaij, 2007; French adult validation: Jermann et al., 2009; French adolescent validation: d'Acremont & Van der Linden, 2007). The CERQ is a 36-item questionnaire assessing nine distinct strategies to cope with emotionally stressful or threatening situations. Five of these strategies are regarded as adaptive (i.e., acceptance, positive refocusing, refocusing on planning, positive reappraisal, and putting into perspective), and four are regarded as maladaptive (i.e., self-blame, rumination, catastrophizing, and blaming others). Scores are calculated for each subscale, as well as for the total scores of the adaptive and maladaptive coping strategies. Items are rated on a five-point Likert scale from 1 (Almost never) to 5 (Almost always). Cronbach's alphas ranged from .72 to .90 in the entire sample.

Mindfulness. The Five-Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2008; French adult validation: Heeren & Philippot, 2011) was used for young adults, and the Child and Adolescent Mindfulness Measure (CAMM: Greco et al., 2011; French adolescent validation: Roux et al., 2019) was used for adolescents. The FFMQ is a 39-item questionnaire measuring mindfulness on a five-point Likert scale ranging from 1 (Never or very rarely true) to 5 (Very often or always true). It includes five factors, namely Observing (i.e., noticing internal and external experiences), Describing (i.e., naming internal experiences with words), Acting with awareness (i.e., paying attention to the present moment as opposed to being on automatic pilot), Nonjudgement of inner experience (i.e., non-judgmental attitude towards internal experiences), and Nonreactivity to inner experience (i.e., allowing internal experiences to come and go, without being caught up or influenced by them; Baer et al., 2008). Cronbach's alphas in the present study's young adult sample ranged from .76 to .92.

The CAMM is a 10-item questionnaire that assesses mindfulness as a unidimensional construct in children and adolescents. The definition of mindfulness used in the CAMM

is "present-moment awareness and nonjudgmental, nonavoidant responses to thoughts and feelings" (Greco et al., 2011 p. 610). Items are rated on a five-point Likert scale ranging from 0 (Never true) to 4 (Always true). The Cronbach's alpha in the present study's adolescent sample was .77.

Social Desirability. For the social desirability construct, young adults completed the Other-Deception scale of the Social Desirability-36 (DS36-OD: Tournois et al., 2000), and adolescents completed the Lie scale of the Eysenck Personality Questionnaire-Junior (EPQ-J: Eysenck & Eysenck, 1975; French validation: Rothen et al., 2008). The DS36 is a 36-item questionnaire originally developed in French that assesses social desirability across two dimensions, namely self-deception and other-deception. Only the other-deception (OD) component (i.e., consciously deceiving others) was used in the present study as a measure of social desirability. The OD subscale contains 18 items rated on a seven-point Likert scale ranging from 1 (Completely false) to 7 (Completely true). The Cronbach's alpha in the present study's young adult sample was .81.

The EPQ-J measures four aspects of personality: neuroticism, extraversion, psychoticism, and one's tendency to deceive (i.e., the Lie scale). The present study used the Lie scale as a measure of social desirability. The Lie scale contains 18 items measured on a dichotomous scale of "yes" or "no". The Cronbach's alpha in the present study's adolescent sample was 0.51.

S9: a detailed description of the correlation analytic method used in Study 3

To evaluate criterion validity, correlations were computed between the MBAQ and measures of interoceptive sensibility, mindfulness, emotion regulation, pain catastrophizing, and emotional distress. Independence from social desirability was assessed by computing correlations between the MBAQ and social desirability. Correlations were computed using R's flexible correlation code (Apšvalka, 2022) based on Pernet et al. (2013) who states that different correlation methods should be used depending on the assumptions met (or not met) by the data. Pearson's correlation should be used for normally distributed data without outliers, Spearman skipped correlation should be used for data with bi-variate outliers, and percentage-bend correlations should be used for data with bi-variate outliers and a non-normal distribution. Since we performed correlations between many pairs of variables that exhibited different statistical characteristics, the above-mentioned correlation methods were used appropriately. The results tables indicate which method was used for which correlation pair.

S10: Standardized CFA factor loadings of the hypothesized three-factor model with 22 items

Table S10. Standardized CFA factor loadings of 22-item model

Item	F1 (Equan.)	F2 (Listen.)	F3 (Non-av.)
I can stay calm and not worry when I have feelings of discomfort or pain. (2) *Je peux rester calme et ne pas m'inquiéter lorsque je ressens un inconfort ou une douleur.*	0.58		
*When I have unpleasant feelings in my body, I cannot stop thinking about them. (4) **Quand j'ai des sensations désagréables dans mon corps, je ne peux pas m'arrêter d'y penser.*	0.57		
*I get very worried if I feel pain or if I feel uncomfortable in my body. (7) **Je suis vraiment inquièt.e quand je ressens de la douleur ou de l'inconfort dans mon corps.*	0.80		
When I notice an unpleasant feeling in my body, I don't worry about it. (12) *Quand je remarque une sensation désagréable dans mon corps, je ne m'inquiète pas.*	0.69		
*Certain body sensations I feel don't seem normal to me. (14) **Certaines de mes sensations corporelles ne me semblent pas normales.*	0.29		
*When I feel pain in my body, I become upset. (16) **Lorsque je ressens une douleur dans mon corps, je me sens inquiet.e.*	0.85		
***Certain unpleasant body sensations scare me.** (19) **Certaines sensations corporelles désagréables me font peur.*	0.60		
*Unpleasant sensations in my body grab my attention very quickly. (21) **Les sensations désagréables dans mon corps attirent vite mon attention.*	0.52		
The sensations in my body help me understand what I feel. (1) *Les sensations de mon corps m'aident à comprendre ce que je ressens.*		0.58	
When I feel overwhelmed or carried away by an emotion, I concentrate on my body sensations to calm down. (5) *Quand je me sens dépassé.e ou emporté.e par une émotion, je me concentre sur mes sensations corporelles pour me calmer.*		0.46	
I am confident that my bodily sensations will let me know what is good for me. (9) *Je suis convaincu.e que mes sensations corporelles m'aident à savoir ce qui est bon pour moi.*		0.58	
When I feel bad, but I don't know why, I pay attention to my body sensations to understand. (11)		0.68	

Quand je me sens mal et que je ne sais pas pourquoi, je fais attention à mes sensations corporelles pour comprendre.		
I focus on my body several times per day to pay attention to my body sensations. (13) *Je me concentre sur mon corps plusieurs fois par jour pour faire attention à mes sensations corporelles.*	0.60	
I listen to my body to help me choose what I need. (15) *J'écoute mon corps pour m'aider à choisir ce dont j'ai besoin.*	0.69	
When I feel an intense emotion, paying attention to my body helps me realize what I need in that moment. (17) *Lorsque je ressens une émotion intense, faire attention à mon corps m'aide à savoir ce dont j'ai besoin à ce moment-là.*	0.72	
I am attentive to my body sensations when I feel an emotion. (20) *Je suis attentif.ve à mes sensations corporelles quand j'éprouve des émotions.*	0.70	
*I ignore unpleasant sensations in my body until they become very strong. (3) **J'ignore les sensations désagréables dans mon corps jusqu'à ce qu'elles deviennent très fortes.*		0.65
*I ignore sensations in the body that I don't like. (6) **J'ignore les sensations corporelles que je n'aime pas.*		0.61
*When I feel strong emotions in my body, I ignore them because I don't know how to face them. (8) **Quand je ressens des émotions fortes dans mon corps, je les ignore parce que je ne sais pas comment y faire face.*		0.58
*I ignore body sensations that I don't find useful. (10) **J'essaie de ne pas ressentir les sensations corporelles que je trouve inutiles.*		0.47
*I tend to notice feelings of physical tension or discomfort only when they become very intense. (18) **J'ai tendance à remarquer les sensations de tension physique ou d'inconfort seulement lorsqu'elles deviennent très intenses.*		0.49
I prefer not to pay attention to what I feel in my body. (22) **Je préfère ne pas faire attention aux sensations dans mon corps.*		0.73

F = Factor. Equan. = Equanimity; Listen. = Listening; Non-av. = Non-avoidance. *Items with an asterisk are reverse scored. Item numbers are in parentheses.

S11: French and English items of the chosen MBAQ three-factor model with 18 items alongside their standardized CFA factor loadings.

Table S11. Standardized CFA factor loadings of 18-item MBAQ (French & English)

Item	F1 (Equan.)	F2 (Listen.)	F3 (Non-av.)
I can stay calm and not worry when I have feelings of discomfort or pain. (2) *Je peux rester calme et ne pas m'inquiéter lorsque je ressens un inconfort ou une douleur.*	0.58		
*When I have unpleasant feelings in my body, I cannot stop thinking about them. (4) **Quand j'ai des sensations désagréables dans mon corps, je ne peux pas m'arrêter d'y penser.*	0.58		
*I get very worried if I feel pain or if I feel uncomfortable in my body. (7) **Je suis vraiment inquièt.e quand je ressens de la douleur ou de l'inconfort dans mon corps.*	0.80		
When I notice an unpleasant feeling in my body, I don't worry about it. (12) *Quand je remarque une sensation désagréable dans mon corps, je ne m'inquiète pas.*	0.70		
*When I feel pain in my body, I become upset. (16) **Lorsque je ressens une douleur dans mon corps, je me sens inquiet.e.*	0.84		
***Certain unpleasant body sensations scare me.** (19) **Certaines sensations corporelles désagréables me font peur.*	0.58		
*Unpleasant sensations in my body grab my attention very quickly. (21) **Les sensations désagréables dans mon corps attirent vite mon attention.*	0.53		
The sensations in my body help me understand what I feel. (1) *Les sensations de mon corps m'aident à comprendre ce que je ressens.*		0.59	
I am confident that my bodily sensations will let me know what is good for me. (9) *Je suis convaincu.e que mes sensations corporelles m'aident à savoir ce qui est bon pour moi.*		0.58	
When I feel bad, but I don't know why, I pay attention to my body sensations to understand. (11) *Quand je me sens mal et que je ne sais pas pourquoi, je fais attention à mes sensations corporelles pour comprendre.*		0.67	
I focus on my body several times per day to pay attention to my body sensations. (13) *Je me concentre sur mon corps plusieurs fois par jour pour faire attention à mes sensations corporelles.*		0.59	

I listen to my body to help me choose what I need. (15) *J'écoute mon corps pour m'aider à choisir ce dont j'ai besoin.*	0.70	
When I feel an intense emotion, paying attention to my body helps me realize what I need in that moment. (17) *Lorsque je ressens une émotion intense, faire attention à mon corps m'aide à savoir ce dont j'ai besoin à ce moment-là.*	0.71	
I am attentive to my body sensations when I feel an emotion. (20) *Je suis attentif.ve à mes sensations corporelles quand j'éprouve des émotions.*	0.71	
*I ignore unpleasant sensations in my body until they become very strong. (3) **J'ignore les sensations désagréables dans mon corps jusqu'à ce qu'elles deviennent très fortes.*		0.59
*I ignore sensations in the body that I don't like. (6) **J'ignore les sensations corporelles que je n'aime pas.*		0.58
*When I feel strong emotions in my body, I ignore them because I don't know how to face them. (8) **Quand je ressens des émotions fortes dans mon corps, je les ignore parce que je ne sais pas comment y faire face.*		0.55
I prefer not to pay attention to what I feel in my body. (22) **Je préfère ne pas faire attention aux sensations dans mon corps.*		0.79

F = Factor. Equan. = Equanimity; Listen. = Listening; Non-av. = Non-avoidance. *Items with an asterisk are reverse scored. Item numbers are in parentheses. Only items in French have been validated.

S12: an illustration of the final MBAQ model.

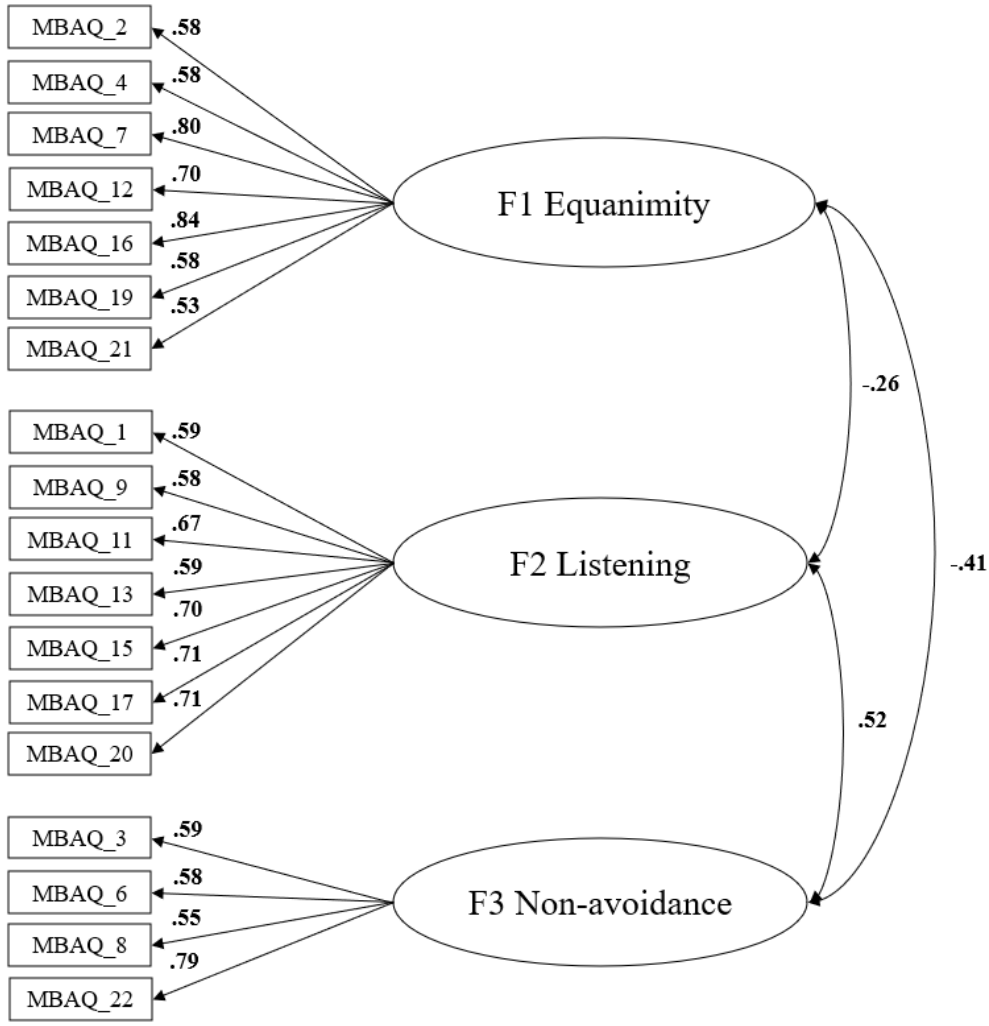


Figure S12. Illustration of the final MBAQ model

Note: Standardized factor loadings and subscale correlations of the chosen MBAQ model. All loadings are significant at $p < .001$.

S13: The final MBAQ (in French and English).

Note: only the French MBAQ has been validated.

Questionnaire d'Ouverture aux Sensations Corporelles (QOSCo)

The Mindful Body Awareness Questionnaire (MBAQ)

Les phrases ci-dessous concernent l'attention que nous accordons à nos sensations corporelles et la relation que nous entretenons avec elles. Lisez chaque phrase. Choisissez un nombre entre 0 (jamais) et 4 (toujours) pour nous dire à quel point chaque phrase est vraie pour vous.

Avant de commencer le questionnaire, veuillez noter la distinction entre le terme sensation corporelle et le terme émotion.

- Une sensation corporelle est une sensation que vous ressentez dans votre corps, ou lorsque votre corps est dans une certaine position (assis, debout), ou en mouvement. Voici quelques exemples de sensations corporelles : la douleur, la faim, la soif, les sensations de contraction ou de détente des muscles, la sensation de boule dans l'estomac, des sensations de chaleur dans le corps, des sensations du cœur qui bat fort ou vite.
- Les émotions sont des états comme la peur, la tristesse, la colère, le bonheur, etc.

0	1	2	3	4
Jamais ou très rarement vrai	Rarement vrai	Parfois vrai	Souvent vrai	Très souvent ou toujours vrai

_____1. Les sensations de mon corps m'aident à comprendre ce que je ressens.

_____2. Je peux rester calme et ne pas m'inquiéter lorsque je ressens un inconfort ou une douleur.

_____3. Quand j'ai des sensations désagréables dans mon corps, je ne peux pas m'arrêter d'y penser.

_____4. J'ignore les sensations désagréables dans mon corps jusqu'à ce qu'elles deviennent très fortes.

_____5. Je suis vraiment inquièt.e quand je ressens de la douleur ou de l'inconfort dans mon corps.

_____6. J'ignore les sensations corporelles que je n'aime pas.

_____7. Je suis convaincu.e que mes sensations corporelles m'aident à savoir ce qui est bon pour moi.

_____8. Quand je ressens des émotions fortes dans mon corps, je les ignore parce que je ne sais pas comment y faire face.

_____9. Quand je me sens mal et que je ne sais pas pourquoi, je fais attention à mes sensations corporelles pour comprendre.

_____10. Quand je remarque une sensation désagréable dans mon corps, je ne m'inquiète pas.

_____11. Je me concentre sur mon corps plusieurs fois par jour pour faire attention à mes sensations corporelles.

_____12. J'écoute mon corps pour m'aider à choisir ce dont j'ai besoin.

_____13. Lorsque je ressens une douleur dans mon corps, je me sens inquiet.e.

_____14. Lorsque je ressens une émotion intense, faire attention à mon corps m'aide à savoir ce dont j'ai besoin à ce moment-là.

_____15. Certaines sensations corporelles désagréables me font peur.

_____16. Je suis attentif.ve à mes sensations corporelles quand j'éprouve des émotions.

_____17. Les sensations désagréables dans mon corps attirent vite mon attention.

_____18. Je préfère ne pas faire attention aux sensations dans mon corps.

Dimensions:

1. **Equanimité** : relation de non-jugement, de non-réactivité et d'ouverture à l'égard des sensations corporelles désagréables. Items : 2, 3R, 5R, 10, 13R, 15R, 17R
2. **Écoute** : aborder les sensations corporelles comme des sources d'information utiles pour identifier ses besoins, ses émotions et pour s'autoréguler. Items : 1, 7, 9, 11, 12, 14, 16
3. **Non-évitement :** affronter (ne pas ignorer ou supprimer) les sensations corporelles. Items : 4R, 6R, 8R, 18R

Scores par dimension : moyenne des items par dimension.

The Mindful Body Awareness Questionnaire (MBAQ)

The following list of sentences asks about the attention we pay to bodily sensations and the relationship we have with them. Read each sentence. Choose a number between 0 (never) and 4 (always) to tell us how often each sentence is true for you.

Before beginning the questionnaire, please note the distinction between the term bodily sensation and emotion.

- A bodily sensation is a sensation you feel in your body or when your body is in a certain position (seated, standing), or when your body is moving. Some examples of bodily sensations include: pain, hunger, thirst, sensations of the muscles contracting or relaxing, the sensation of a knot in the stomach, sensations of heat in the body, or of the heart beating quickly.
- Emotions are states like fear, sadness, anger, happiness, and so on.

0	1	2	3	4
Never or very rarely true	Rarely true	Sometimes true	Often true	Very often or always true

_____1. The sensations in my body help me understand what I feel.

_____2. I can stay calm and not worry when I have feelings of discomfort or pain.

_____3. When I have unpleasant feelings in my body, I cannot stop thinking about them.

_____4. I ignore unpleasant sensations in my body until they become very strong.

_____5. I get very worried if I feel pain or if I feel uncomfortable in my body.

_____6. I ignore sensations in the body that I don't like.

_____7. I get very worried if I feel pain or if I feel uncomfortable in my body.

_____8. When I feel strong emotions in my body, I ignore them because I don't know how to face them.

_____9. I am confident that my bodily sensations will let me know what is good for me.

_____10. When I notice an unpleasant feeling in my body, I don't worry about it.

_____11. I focus on my body several times per day to pay attention to my body sensations.

_____12. I listen to my body to help me choose what I need.

_____13. When I feel pain in my body, I become upset.

_____14. When I feel an intense emotion, paying attention to my body helps me realize what I need in that moment.

_____15. Certain unpleasant body sensations scare me.

_____16. I am attentive to my body sensations when I feel an emotion.

_____17. Unpleasant sensations in my body grab my attention very quickly.

_____18. I prefer not to pay attention to the sensations in my body.

Dimensions:

1. **Equanimity**: relationship of non-judgment, non-reactivity, and openness towards unpleasant body sensations. Items : 2, 3R, 5R, 10, 13R, 15R, 17R
2. **Listening**: approaching body sensations as useful sources of information to identify one's needs, emotions, and to self-regulate. Items : 1, 7, 9, 11, 12, 14, 16

3. **Non-avoidance**: facing (not ignoring or suppressing) body sensations. Items : 4R, 6R, 8R, 18R

Scores per dimension: average of items per dimension.

Appendix E: Chapter 5 Appendices

S1: Difficulties in Emotion Regulation Scale – Short Form French version (F-DERS-SF)

F-DERS-SF : Échelle des difficultés de régulation des émotions - Version française abrégée

Répondez à toutes les questions en cochant à chaque fois une seule case par énoncé selon si celui-ci vous correspond.

	Presque jamais (0–10%)	Quelques fois (11–35%)	La moitié du temps (36–65%)	La plupart du temps (66–90%)	Presque toujours (91–100%)
1. Je prête attention à ce que je ressens	1	2	3	4	5
2. Je n'ai aucune idée de ce que je ressens	1	2	3	4	5
3. J'ai des difficultés à donner un sens à ce que je ressens	1	2	3	4	5
4. J'accorde de l'importance à ce que je ressens	1	2	3	4	5
5. Je ne suis pas certain(e) de ce que je ressens	1	2	3	4	5
6. Quand je suis contrarié(e), je reconnais avoir des émotions	1	2	3	4	5
7. Quand je suis contrarié(e), je suis gêné(e) de ressentir une telle émotion	1	2	3	4	5
8. Quand je suis contrarié(e), j'ai de la difficulté à avancer dans mon travail	1	2	3	4	5
9. Quand je suis contrarié(e), je deviens incontrôlable	1	2	3	4	5
10. Quand je suis contrarié(e), je crois que je vais finir par me sentir très déprimé(e)	1	2	3	4	5
11. Quand je suis contrarié(e), j'ai des difficultés à me concentrer sur d'autres choses	1	2	3	4	5
12. Quand je suis contrarié(e), je me sens coupable de ressentir une telle émotion	1	2	3	4	5
13. Quand je suis contrarié(e), j'ai des difficultés à me concentrer	1	2	3	4	5
14. Quand je suis contrarié(e), j'ai des difficultés à contrôler mon comportement	1	2	3	4	5

15. Quand je suis contrarié(e), je crois qu'il n'y a rien que je puisse faire pour me sentir mieux	1	2	3	4	5
16. Quand je suis contrarié(e), je me sens irrité(e) contre moi-même de ressentir une telle émotion	1	2	3	4	5
17. Quand je suis contrarié(e), je perds le contrôle de mon comportement	1	2	3	4	5
18. Quand je suis contrarié(e), il me faut beaucoup de temps avant de me sentir mieux	1	2	3	4	5

COTATION

Les échelles peuvent être évaluées en utilisant des sommes ou des moyennes des items. Si l'objectif est la comparaison avec le questionnaire DERS original, envisagez d'utiliser les moyennes de chaque sous-échelle afin que les scores soient dans la métrique de l'échelle de réponse. Veuillez noter que les trois items de l'échelle Conscience doivent être codés de manière inversée.

En raison des faibles propriétés psychométriques de la sous-échelle Conscience, il est conseillé d'interpréter les scores de cette sous-échelle avec prudence.

Toutes les sous-échelles sont notées de manière à ce que des valeurs plus élevées reflètent une plus grande difficulté à réguler les émotions.

Sous-échelles :

L'accès limité à des stratégies de régulation des émotions (Stratégies)

10. Quand je suis contrarié(e), je crois que je vais finir par me sentir très déprimé(e).

15. Quand je suis contrarié(e), je crois qu'il n'y a rien que je puisse faire pour me sentir mieux.

18. Quand je suis contrarié(e), il me faut beaucoup de temps avant de me sentir mieux.

Le manque d'acceptation émotionnelle (Manque d'acceptation)

7. Quand je suis contrarié(e), je suis gêné(e) de ressentir une telle émotion.

12. Quand je suis contrarié(e), je me sens coupable de ressentir une telle émotion.

16. Quand je suis contrarié(e), je me sens irrité(e) contre moi-même de ressentir une telle émotion.

Les difficultés à contrôler des comportements impulsifs (Impulsivité)

9. Quand je suis contrarié(e), je deviens incontrôlable.

14. Quand je suis contrarié(e), j'ai des difficultés à contrôler mon comportement.

17. Quand je suis contrarié(e), je perds le contrôle de mon comportement.

Les difficultés à s'engager dans des comportements orientés vers un but en présence d'émotions négatives (Buts)

8. Quand je suis contrarié(e), j'ai de la difficulté à avancer dans mon travail.

11. Quand je suis contrarié(e), j'ai des difficultés à me concentrer sur d'autres choses.

3. Quand je suis contrarié(e), j'ai des difficultés à me concentrer.

Le manque de conscience émotionnelle (Conscience)

1. Je prête attention à ce que je ressens. [codage inversé]

4. J'accorde de l'importance à ce que je ressens. [codage inversé]

6. Quand je suis contrarié(e), je reconnais avoir des émotions. [codage inversé]

Le manque de clarté émotionnelle (Clarté)

2. Je n'ai aucune idée de ce que je ressens.

3. J'ai des difficultés à donner un sens à ce que je ressens.

5. Je ne suis pas certain(e) de ce que je ressens.

Citation: Pérez-Peña, M. & Philippot, P. (2023). A French version of the Difficulties in Emotion Regulation Scale Short Form (F-DERS-SF): Validation in an adolescent sample. [Manuscript submitted for publication]. Department of Psychology and Educational Sciences, UCLouvain.

This measure was adapted from the original DERS-SF: Kaufman, E. A., Xia, M., Fosco, G., Yaptangco, M., Skidmore, C. R., & Crowell, S. E. (2016). The Difficulties in Emotion Regulation Scale Short Form (DERS-SF): Validation and replication in adolescent and adult samples. *Journal of Psychopathology and Behavioral Assessment, 38*, 443-45

S2: Selection and adaptation of F-DERS-SF items

Items on the F-DERS-SF were extracted from the French Canadian 36-item DERS (Côté et al., 2013) and the Swiss French 36-item DERS (Dan-Glauser & Scherer, 2013). The most clearly articulated items that best reflected the meaning of the original English items were selected. The phrasing of certain items was slightly modified to increase comprehensibility for an adolescent audience and to better reflect the original items' meaning. Items highlighted in light purple are items that were unchanged.

F-DERS-SF for adolescents Present research	**English items from DERS-SF** (Kaufman et al., 2016)	**French items from DERS version 1** (Côté et al., 2013) Canada	**French items from DERS version 2** (Dan-Glauser & Scherer, 2013) Switzerland
10. Quand je suis contrarié(e), je crois que je vais finir par me sentir très déprimé(e). (*Strategies*)	When I'm upset, I believe that I will end up feeling very depressed.	Lorsqu'une situation me bouleverse, je crois que je finirai par tomber en dépression.	Quand je suis contrarié(e), je crois que je vais bientôt me sentir très déprimé(e).
15. Quand je suis contrarié(e), je crois qu'il n'y a rien que je puisse faire pour me sentir mieux. (*Strategies*)	When I'm upset, I believe there is nothing I can do to make myself feel better. (Strategies)	Lorsqu'une situation me bouleverse, je crois que je ne peux rien faire pour améliorer mon état.	Quand je suis contrarié(e), je crois qu'il n'y a rien que je puisse faire pour me sentir mieux.
18. Quand je suis contrarié(e), il me faut beaucoup de temps avant de me sentir mieux. (*Strategies*)	When I'm upset, it takes me a long time to feel better. (Strategies)	Lorsqu'une situation me bouleverse, cela me prend beaucoup de temps avant de me sentir mieux.	Quand je suis contrarié(e), cela prend du temps avant que je ne me sente mieux.
7. Quand je suis contrarié(e), je suis gêné(e) de ressentir une telle émotion. (*Non-acceptance*)	When I'm upset, I become embarrassed for feeling that way.	Lorsqu'une situation me bouleverse, je suis mal à l'aise de me sentir comme ça.	Quand je suis contrarié(e), je suis embarrassé(e) de ressentir une telle émotion.
12. Quand je suis contrarié(e), je me sens coupable de ressentir une telle émotion. (*Non-acceptance*)	When I'm upset, I feel guilty for feeling that way.	Lorsqu'une situation me bouleverse, je me sens coupable de me sentir comme ça.	Quand je suis contrarié(e), je me sens coupable de ressentir une telle émotion.
16. Quand je suis contrarié(e), je me sens irrité(e) contre moi-même de ressentir une telle émotion. (*Non-acceptance*)	When I'm upset, I become irritated at myself for feeling that way.	Lorsqu'une situation me bouleverse, cela m'agace de me sentir comme ça.	Quand je suis contrarié(e), je m'en veux de ressentir une telle émotion.
9. Quand je suis contrarié(e), je deviens incontrôlable. (*Impulse*)	When I'm upset, I become out of control.	Lorsqu'une situation me bouleverse, je perds le contrôle.	Quand je suis contrarié(e), je deviens incontrôlable.
14. Quand je suis contrarié(e), j'ai des difficultés à contrôler mon comportement. (*Impulse*)	When I'm upset, I have difficulty controlling my behavior.	Lorsqu'une situation me bouleverse, j'ai de la difficulté à maîtriser mes comportements.	Quand je suis contrarié(e), j'ai des difficultés à contrôler mon comportement.
17. Quand je suis contrarié(e), je perds le contrôle de mon comportement. (*Impulse*)	When I'm upset, I lose control over my behavior.	Lorsqu'une situation me bouleverse, je ne maîtrise plus mes comportements.	Quand je suis contrarié(e), je perds le contrôle de mes comportements.
8. Quand je suis contrarié(e), j'ai de la difficulté à avancer dans mon travail. (*Goals*)	When I'm upset, I have difficulty getting work done.	Lorsqu'une situation me bouleverse, j'ai de la difficulté à faire mon travail.	Quand je suis contrarié(e), j'ai de la difficulté à terminer un travail.
11. Quand je suis contrarié(e), j'ai des difficultés à me concentrer sur d'autres choses. (*Goals*)	When I'm upset, I have difficulty focusing on other things. (Goals)	Lorsqu'une situation me bouleverse, j'ai de la difficulté à me concentrer sur autre chose.	Quand je suis contrarié(e), j'ai des difficultés à me concentrer sur d'autres choses.

13. Quand je suis contrarié(e), j'ai des difficultés à me concentrer. (*Goals*)	When I'm upset, I have difficulty concentrating. (Goals)	Lorsqu'une situation me bouleverse, j'ai de la difficulté à me concentrer.	Quand je suis contrarié(e), j'ai des difficultés à me concentrer.
1. Je prête attention à ce que je ressens. (*Awareness*)	I pay attention to how I feel.	Je prête attention à ce que je ressens.	Je fais attention à ce que je ressens
4. J'accorde de l'importance à ce que je ressens. (r) (*Awareness*)	I care about what I am feeling.	J'attache de l'importance à mes émotions.	Je prends garde à ce que je ressens
6. Quand je suis contrarié(e), je reconnais avoir des émotions. (r) (*Awareness*)	When I'm upset, I acknowledge my emotions.	Lorsqu'une situation me bouleverse, je reconnais que j'ai des émotions.	Quand je suis contrarié(e), je prends en compte cette émotion.
2. Je n'ai aucune idée de ce que je ressens. (*Clarity*)	I have no idea how I am feeling.	Je n'ai aucune idée de ce que je ressens.	Je n'ai aucune idée concernant comment je me sens.
3. J'ai des difficultés à donner un sens à ce que je ressens. (*Clarity*)	I have difficulty making sense out of my feelings.	J'ai de la difficulté à comprendre mes émotions.	J'ai des difficultés à donner un sens à mes sentiments.
5. Je ne suis pas certain(e) de ce que je ressens. (*Clarity*)	I am confused about how I feel.	Je ne sais pas trop ce que je ressens.	Je suis déconcerté(e) par ce que je ressens.

S3: Psychometric properties of Model 2: Five-factor model excluding Awareness

Table S3.1 Confirmatory factor loadings for Model 2 in an adolescent sample (*N* = 139)

Item	Factor Loadings
Strategies (α = .79)	
10. When I'm upset, I believe that I will end up feeling very depressed.	.70
15. When I'm upset, I believe there is nothing I can do to make myself feel better.	.82
18. When I'm upset, it takes me a long time to feel better.	.71
Nonacceptance (α = .81)	
7. When I'm upset, I become embarrassed for feeling that way.	.79
12. When I'm upset, I feel guilty for feeling that way.	.85
16. When I'm upset, I become irritated at myself for feeling that way.	.69
Impulse (α = .91)	
9. When I'm upset, I become out of control.	.85
14. When I'm upset, I have difficulty controlling my behavior.	.88
17. When I'm upset, I lose control over my behavior.	.91

Goals (α = .86)	
8. When I'm upset, I have difficulty getting work done.	.75
11. When I'm upset, I have difficulty focusing on other things.	.88
13. When I'm upset, I have difficulty concentrating.	.83
Clarity (α = .78)	
2. I have no idea how I am feeling.	.66
3. I have difficulty making sense out of my feelings.	.83
5. I am confused about how I feel.	.71

Within-measure subscale correlations for Model 2 of the F-DERS-SF in an adolescent sample

Same within-measure subscale correlations as Model 1 excluding the Awareness sub-scale. See Table 3 in the main text.

Convergent validity correlations for Model 2 of the F-DERS-SF in an adolescent sample

Same correlations as Model 1 excluding the Awareness sub-scale. See Table 4 in the main text.

Test-retest reliability

Same subscale test-retest reliability indices as Model 1. See the Psychometric Properties sub-section of the Results section in the main text disregarding the results for the Awareness subscale.

S4: Psychometric properties of Model 3: Five-factor model combining Awareness and Clarity into one subscale

Table S4.1 Confirmatory factor loadings for Model 3 in an adolescent sample (N = 139)

Item	Factor Loadings
Strategies (α = .79)	
10. When I'm upset, I believe that I will end up feeling very depressed.	.70
15. When I'm upset, I believe there is nothing I can do to make myself feel better.	.82
18. When I'm upset, it takes me a long time to feel better.	.71
Nonacceptance (α = .81)	
7. When I'm upset, I become embarrassed for feeling that way.	.79

12. When I'm upset, I feel guilty for feeling that way.	.85
16. When I'm upset, I become irritated at myself for feeling that way.	.69
Impulse (α = .91)	
9. When I'm upset, I become out of control.	.85
14. When I'm upset, I have difficulty controlling my behavior.	.88
17. When I'm upset, I lose control over my behavior.	.91
Goals (α = .86)	
8. When I'm upset, I have difficulty getting work done.	.75
11. When I'm upset, I have difficulty focusing on other things.	.88
13. When I'm upset, I have difficulty concentrating.	.83
Awareness-Clarity (α = .74)	
1. I pay attention to how I feel.*	.38
4. I care about what I am feeling.*	.39
6. When I'm upset, I acknowledge my emotions.*	.27
2. I have no idea how I am feeling.	.70
3. I have difficulty making sense out of my feelings.	.78
5. I am confused about how I feel.	.71

Note. * = reverse scored item

Table S4.2 Within-measure subscale correlations for Model 3 of the F-DERS-SF in an adolescent sample

Only Awareness-Clarity subscale correlations are presented here as correlations between other subscales (i.e., Strategies, Nonacceptance, Impulse, and Goals) remain the same as in Model 1 and can be found in Table 3 in the main text.

	Strategies	Nonacceptance	Impulse	Goals
Awareness-Clarity	.37**	.31**	.19*	.16

Note. Strategies = F-DERS-SF Limited Access to Strategies for Regulation subscale; Nonacceptance = F-DERS-SF Nonacceptance of Emotional Experiences subscale; Impulse = F-DERS Impulse Control Difficulties subscale; Goals = F-DERS-SF Difficulty Engaging in Goal-Directed Behavior subscale; Awareness-Clarity = F-DERS-SF Lack of Emotional Clarity and Lack of Emotional Awareness subscale. *p < .05, **p < .01

Table S4.3 Convergent validity correlations for Model 3 of the F-DERS-SF in an adolescent sample

Only Awareness-Clarity convergent validity correlations are presented here as convergent validity correlations for the other subscales (i.e., Strategies, Nonacceptance, Impulse, and Goals) remain the same as in Model 1 and can be found in Table 17 in the main text.

	Awareness-Clarity
CAMM Total	-.53**
DASS-21 Depression	.47**
DASS-21 Anxiety	.30**
DASS-21 Stress	.36**
DASS-21 Total	.42**

Note. CAMM = Child and Adolescent Mindfulness Measure; DASS-21 = Depression, Anxiety, and Stress Scale-21

Test-retest reliability

The test-retest reliability of the Awareness-Clarity subscale is: ICC = .86, $p < .001$, [95%: .73-.93] considered good according to the guidelines of Koo and Li (2016). Test-retest reliability indices for the other subscales (i.e., Strategies, Nonacceptance, Impulse, and Goals) are the same as those of Model 1 and can be found in the Psychometric Properties sub-section of the Results section in the main text.

Appendix F: Chapter 6 Appendices

S1: debriefing questions asked in the BAIA per time point.

At baseline (Time 1) and immediately after the interventions (Time 2)

1. What did you think of the experiment?
2. In your opinion, what was the purpose of the study?
3. Was the procedure clear?
4. Did you notice or feel anything?
5. Do you have any questions?
6. Are there any aspects of the experiment that need to be modified (instructions, order, etc.)?
7. Thank participant for their participation.

Three months after the interventions (Time 3)

Questions 1-6 same as above.

7. Did you notice the vibration?
8. If so, did you use it to perform the task?
9. Thank participant for their participation.

S2: provides an overview of the MBCT program for adolescents used in the present study.

As described in Deplus et al. (2016), the intervention used in the present study was adapted for French-speaking adolescents aged 11 to 18 years old from Mindfulness-Based Cognitive Therapy (MBCT; Segal et al. 2002). This adaptation was based on the authors' clinical experience and on recommendations in the literature. The program includes the practices and the progressive nature of MBCT but the following modifications were made: (1) the number and length of the sessions was modified to nine 90-minute weekly sessions, (2) the formal practices were shortened to a length of 10 minutes, and (3) psychoeducation about depression was suppressed and replaced by information on emotions and emotion regulation (distinguishing thoughts, feeling and body sensations). The only emotion regulation skills taught were mindfulness training. The utility of

mindfulness practices in everyday life was emphasized by teaching participants to apply mindfulness techniques to their own difficulties using different entertaining and multisensory exercises and games, such as listening to short segments of music and identifying the feelings that arise. Table S2 shows an overview of the main themes of each of the nine sessions. The treatment manual can be found in Chapter 7 of Deplus and Lahaye's book, *La Pleine Conscience Chez l'Enfant et l'Adolescent*.

Table S2: MBCT program

Session	Theme	General goals
1	The Alien's attitude	Developing community; defining the setting; introduction to mindfulness.
2	Paying attention to the body	Becoming more mindful of body sensations.
3	Stopping and breathing	Breathing as an anchor to the present moment.
4	Welcoming emotions	Identifying judgement of the emotional experience; exploring emotion.
5	Not doing what the emotion tells me to do	Inhibiting automatic responses to emotions.
6	Keeping a distance from thoughts	Changing one's attitude towards thoughts.
7	Moving forward towards what is important to me	Reflection about values; engagement in actions.
8	Acting	Defining constructive actions and distressful situations.
9	It is only the beginning…	Sharing experiences of the intervention; discussing the upholding of the practice.

S3: an overview of the Health Psychoeducation program for adolescents used in the present study.

Table S3 shows an overview of the main themes of each of the nine Health Psychoeducation program sessions. The treatment manual can be requested by contacting the authors.

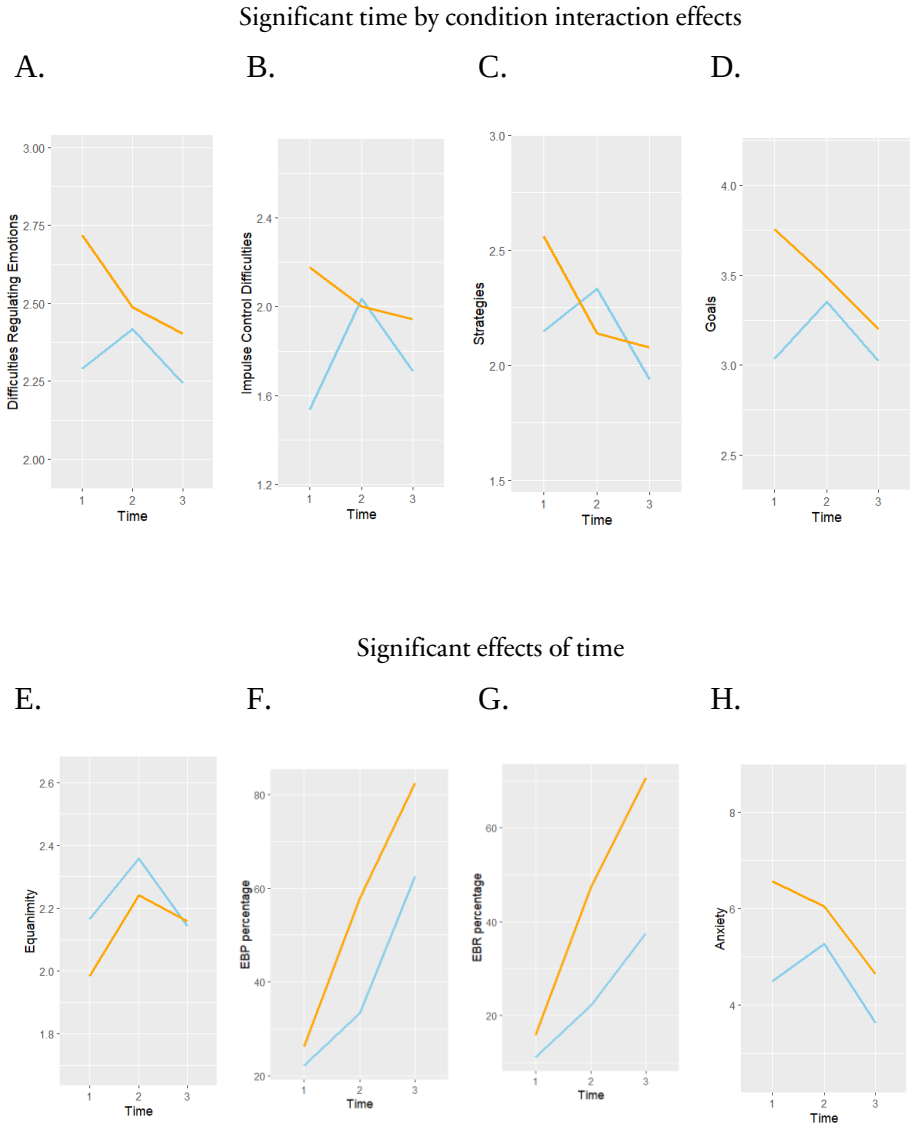
Table S3: Health psychoeducation program

Session	Theme	General goals
1	Program presentation and getting to know each other	• Establishing the framework and group dynamic • Presentation of the program • Self-assessment of one's personal values • Self-observation (health-related behaviors)
2	Internet/video games/cell phone addiction	• Self-reflection on one's internet/video game/cell phone use habits. • Psychoeducation on the topic. • Formulate a specific, concrete objective to improve internet/video game/ cell phone use habits and self-observation during the week.
3	Sleep/tiredness	• Self-reflection on one's sleeping habits. • Psychoeducation on the topic. • Formulate a specific, concrete objective to improve sleeping habits and self-observation during the week.

4	Nutrition	• Self-reflection on one's nutrition habits. • Psychoeducation on the topic. • Formulate a specific, concrete objective to improve eating habits and self-observation during the week.
5	Physical activity	• Self-reflection on one's physical activity habits. • Psychoeducation on the topic. • Formulate a specific, concrete physical activity objective and self-observation during the week.
6	Addiction and substance abuse	• Self-reflection on one's substance use habits. • Psychoeducation on the topic. • Formulate a specific, concrete objective regarding substance use habits and self-observation during the week.
7	Stress management 1 (time management)	• Self-reflection on one's stress and time management habits. • Psychoeducation on the topic. • Formulate a specific, concrete objective to improve time management and self-observation during the week.
8	Stress management 2 (conflict resolution)	• Self-reflection on one's way of handling conflicts. • Psychoeducation on the topic. • Formulate a specific, concrete objective to improve conflict resolution habits and self-observation during the week.
9	This is just the beginning	• Program evaluation • Maintaining one's chosen health-related behaviors and practices

S4: A summary of the observed significant effects.

Figure S4



Note. The orange line is the MBCT group and the blue line is the active control group. (A) DERS-SF total score, (B) DERS-SF Impulse, (C) DERS-SF Strategies, (D) DERS-SF Goals, (E) MBAQ Equanimity, (F) Body Awareness Indirect Assessment Explicit Body Perception: the percentage of people who detected the bodily signal at each time point, (G) Body Awareness Indirect

Assessment Explicit Body Reliance: the percentage of people who relied on the bodily signal at each time point (H) DASS21 Anxiety.

S5: shows the correlations between outcome variables at baseline.

Table S5

Correlations among variables at baseline

		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
1.	MBAQ Equanimity	-														
2.	MBAQ Listening	-.13	-													
3.	MBAQ Nonavoid	-.20	.15	-												
4.	BAIA EBP	-.08	-.12	-.09	-											
5.	BAIA EBR	.04	-.31	-.29	.70*	-										
6.	DERS-SF total	-.30	-.28	-.48*	.32	.39*	-									
7.	DERS-SF Strategies	-.54*	-.14	-.28	.20	.23	.69*	-								
8.	DERS-SF Non-accept.	-.29	-.15	-.23	.05	.15	.65*	.42*	-							
9.	DERS-SF Impulse	-.13	-.18	-.47*	.26	.32	.79*	.54*	.42*	-						
10.	DERS-SF Goals	-.44*	-.09	-.25	.67*	.43*	.80*	.58*	.35*	.55*	-					
11.	DERS-SF Awareness	.36*	-.45*	-.12	.10	.20	.15	-.26	-.05	.04	-.04	-				
12.	DERS-SF Clarity	-.10	-.16	-.52*	.22	.32	.79*	.40*	.39*	.50*	.62*	.08	-			
13.	DASS-21 Total	-.38*	.06	-.23	.33	.28	.61*	.58*	.33*	.54*	.52*	-.13	.48*	-		
14.	DASS-21 Depression	-.31	-.08	-.24	.30	.26	.70*	.58*	.43*	.57*	.61*	-.04	.55*	.88*	-	
15.	DASS-21 Anxiety	-.29	.01	-.13	.33*	.02	.42*	.41*	.31	.32	.32	-.05	.31	.89*	.68*	-
16.	DASS-21 Stress	-.41*	.24	-.24	.21	.07	.46*	.53*	.12	.53*	.44*	-.26	.37*	.86*	.61*	.67*

Note. MBAQ = Mindful Body Awareness Questionnaire; BAIA = Body Awareness Indirect Assessment; DERS-SF = French version of the Difficulties in Emotion Regulation Scale Short Form; DASS-21 = Depression, Anxiety, and Stress Scale-21; Nonavoid = Non-avoidance; EBP = Explicit Body Perception; EBR = Explicit Body Reliance; Non-accept = Non-acceptance; * = correlation is

significant at $p < .05$. All correlations are Pearson's correlations except those between categorical variables, EBP and EBR, and continuous variables which are point biserial correlations.

S6 multilevel models adjusted for baseline differences.

Table S6

	Est. (*SE*) Intercept	Est. (*SE*) – T2	Est. (*SE*) – T3	Est. (*SE*) – Condition	Est. (*SE*) – T2:Condition	Est. (*SE*) – T3:Condition	Est. (*SE*) – Baseline
F-DERS-SF Total	0.02 (0.09) *p* = 0.78	0.05 (0.04) *p* = .20	0.01 (0.04) *p* = .83	0.03 (0.05) *p* = .61	-0.15 (0.06) *p* = .01*	-0.12 (0.06) *p* = .05	0.34 (0.03) *p* = .00*
F-DERS-SF Impulse	0.26 (0.21) *p* = .22	0.50 (0.19) *p* = .01*	0.34 (0.20) *p* = .09	0.11 (0.23) *p* = .67	-0.68 (0.26) *p* = .01*	-0.53 (0.27) *p* = .055	0.83 (0.09) *p* = .00*
F-DERS-SF Goals	0.44 (0.34) *p* = .20	0.31 (0.21) *p* = .13	0.04 (0.22) *p* = .86	0.10 (0.26) *p* = .71	-0.58 (0.29) *p* = .0498*	-0.53 (0.30) *p* = .08	0.85 (0.10) *p* = .00*
F-DERS-SF Clarity	0.41 (0.18) *p* = .03*	-0.07 (0.17) *p* = .67	0.11 (0.18) *p* = .54	0.13 (0.18) *p* = .53	-0.22 (0.24) *p* = .36	-0.39 (0.25) *p* = .11	0.81 (0.06) *p* = .00*

Note: * $p < .05$; Est. = Estimate. SE = Standard error. T2 = post-assessment phase a few adays after the intervention. T3 = follow-up assessment 2-3 months after the intervention. Impulse = Impulse Control Difficulties subscale; Goals = Difficulty Engaging in Goal-Directed Behavior subscale; Clarity = Lack of Emotional Clarity; Baseline = Baseline levels.

S7 results of regression to the mean corrections.

Table S7

Regression to the mean corrections for significant effects

Variable	Group	N	Mean observed at T1 (SD)	Mean corrected for RTM at T2 (SD)	Mean difference (T1-T2)	Paired sample t-test
F-DERS-SF total	MBI	19	2.72 (0.63)	2.49 (0.83)	0.23	$t(18) = 2.15$, $p < .05$*
F-DERS-SF strategies	MBI	19	2.56 (0.89)	2.14 (1.15)	0.42	$t(18) = 2.72$, $p < .05$*
F-DERS-SF goals	MBI	19	3.75 (0.94)	3.49 (1.38)	0.26	$t(18) = 1.27$, $p = .22$
F-DERS-SF impulse	Control	18	1.54 (0.72)	2.04 (1.28)	-0.50	$t(17) = -2.35$, $p < .05$*

Note: The following equation was used to obtain RTM-corrected T2 values: $x_2(\text{corrected}) = x_2 + (1-r)*(x_1-m_1)$, where x_1 are the observed baseline values, x_2 are the observed post-intervention (T2) values, r is the correlation between x_1 and x_2, and m_1 is the baseline mean (Nielsen et al., 2007). Strategies = Limited Access to Strategies for Regulation subscale; Goals = Difficulty Engaging in Goal-Directed Behavior subscale; Impulse = Impulse Control Difficulties subscale.