



**SAPIENZA**  
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# MINDFULNESS-BASED MEDITATION, INTEROCEPTIVE AWARENESS AND HEART RATE VARIABILITY

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*I will stand with extreme care upon any other precipice;  
why not, then, upon that precipice which is a thousand worlds in depth and of immense  
duration?  
Perhaps death does not come today, but nonetheless I ought not to be at ease;  
inevitably the hour comes when I shall not exist.  
By whom is security given to me? and how shall I escape?  
Inevitably I shall not exist. How can the mind be composed?*

Śāntideva , Bodhicaryāvatāra (700 A.D.) 2<sup>nd</sup> ch., vs. 58-60.  
(Bibliotheca Polyglotta)



## **Introduction**

### **Unifying body and mind with awareness**

The experience of the body takes place continuously, (A D Bud Craig, 2009) although in a more or less implicit way, constituting over time our reserves of knowledge that allows us to adapt to the environment in a functional way, in the perspective of our past experiences.(Brugger & Lenggenhager, 2014). So there is a close relation between this embodied experience / memory and our behaviors, automatic and voluntary, directed to repeat pleasurable and positive experiences, mainly what have proved to be functional for our adaptation to the environment and that are properly evoked in the emotional experience. (Duschek, Werner, Reyes del Paso, & Schandry, 2015)

In this subtle and delicate balancing game, between subjective internal experience and the external environment, including of course our behavior and our relationships, mindfulness meditation is located as a subjective tool that allows one to know, recognize and modulate experience and behavior on the basis of multiple factors, through bottom-up and top-down processes (Chiesa, Serretti, & Jakobsen, 2013)

To this premise must be added that in my research questions I have been driven from my particular experience of being, before a scholar of western cognitive psychology, myself a scholar of buddhist meditation with more than 20 years of experience, including the in-depth study of the great Buddhist philosophical treatises in the tradition of Nalanda Mahavihara, the ancient Indian Mahayanist Buddhism monastic university, and becoming at the same time an instructor of various styles of meditation for almost two decades, as well as a mindfulness trainer. The purpose therefore, thanks to the received inspirations from all my precious masters of all kinds, is to add my small contribution to the benefit of the largest possible number of beings.

In the last 20 years, awareness, i.e. Mindfulness, has become the subject of considerable attention by the scientific community in both clinical and psychological fields.

Mindfulness, the English term with which the practice of awareness referred to in this work is best known, has been described as the process of bringing a certain quality of attention moment by moment to experience (Kabat-Zinn, 1982).

The ability to produce mindfulness has developed using various meditation techniques that come from Buddhist spiritual practices (Hanh, 1976). In fact, awareness plays a central role in Buddhist traditions, being part of a system that has developed as a path that leads to the cessation of personal suffering (Thera, 1962; Silananda, 1990).

Of course, awareness in its simplest and most superficial form is also part of our common experience in everyday life, where however we refer to the awareness of external objects, or to awareness understood as a moral conscience, inherited from Christianity. In the Western ancient philosophical tradition, however, reference is made to a state of awareness of oneself and of one's internal states as a prerequisite for wellbeing, even if this ancient knowledge proper to our culture is perhaps less integrated in our day.

Taking only one example, we can refer to the Neoplatonist philosopher Plotinus (204-270 d.C.), Hellenized Egyptian who in *Enneades* (253 d.C.) develops a concept of conscience not as awareness of any one's own internal state, but as a privileged field in which the highest truths to which man can reach manifest themselves. Indicating therefore the conscience as introspection or inner listening, which defines as "return to oneself", "return to interiority", "reflection on oneself", contrasting the attitude of the wise to that of those who rely solely on the knowledge of external things in leading one's life. P.Hadot, *Plotin ou La simplicité du regard*, Gallimard, (1997)

Currently, psychology in Western culture has embraced the responsibility to lead to states of greater well-being human beings, well-being understood not only individually but also relational and therefore social.

In this sense it can be said that all contemporary psychological approaches refer to the attachment theory of John Bowlby (1907-1990) the british psychologist, psychiatrist, and psychoanalyst, and then to the formation of a person's relational styles as a product of the kind of care and security that he could experience during the development period.

This reference comes into play not only in the way a person relates, learn to monitor their own behavior and to recognize their inner emotional world. But also, and perhaps above all, the experience of security comes into play in the formation of the complicated interplay of emotion regulation, based on subtle bodily interactions whose homeostasis is reached, or not, during the period of development, ie the indices of emotions that a child learns to recognize and to name with the help of the adult. Not by chance, in the Developmental Trauma Disorder (DTD), identified by the members of the Developmental Trauma Disorders Taskforce, traumatic developments take place by the attachment figure when, instead of offering security, is itself the source of feared and unpredictable experiences.

Traumatic experiences of abuse, maltreatment or neglect, negatively affect the introspective and relational abilities of the subject even at the neuronal level, thus inducing in the adult a chronically increased arousal state or the alternation of hyper and ipoarousal states, as the default response to uncertainty is the response to the threat (Thayer, Åhs, Fredrikson, Sollers, & Wager, 2012) while experiences of abandonment lead to an emotional flattening due to the chronic lowering of the arousal (Casey, Rogers, Burns, & Yiend, 2013).

This allows the identification of Traumatic Developmental Disorder (Blaustein et al., 2007) (Bessel A. Van Der Kolk, Roth, Pelcovitz, Sunday, & Spinazzola, 2005)

and complex PTSD in adults (Herman J., 1995) with vulnerabilities concerning integrating functions of memory and consciousness leading to dissociative symptoms (Liotti and Farina, 2011).

To explain how the dramatic neurovegetative dysregulation is a direct consequence of the chronic activation of the defense system as an effect of cumulative traumas, the polyvagal theory of (Porges, 2007) can be used, which explains the peritraumatic dissociative experience as the result of the activation failure of the parasympathetic ventral branch of the vagus nerve and of the sympathetic system, ie the failure of the search for help and the reactions of attack and flight. The parasympathetic dorsal branch of the vagus nerve is thus activated as an extreme defense, inducing a state of fake death due to the unintentional collapse of the arousal state. This rigidity of response to events is evidenced by a low heart rate variability indicating a lack of flexibility and adaptability, (Bernardi, Williams, Thayer, & Koenig, 2012) which may even lowers the perception of pain. (Diener et al., 2012). Dissociation is therefore seen as "a primary disruption of the fabric of consciousness and intersubjectivity, while protection from pain is a secondary and collateral aspect that often fails" (Liotti and Farina, 2011, pg. 85), experience close to disintegration limit with serious implications for the emotional regulation skills, the metacognitive capacity and identity.

Consequently, the therapeutic interventions that are considered more suitable for this kind of trauma, from which are generated many clinical disorders in adults, are precisely those which are based on the body, able to restore the integration of disintegrated functions, in particular the sensorimotor therapy of Pat Ogden, the different treatments proposed by Bessel Van der Kolk, Peter Levine's Somatic Experiencing, EMDR (Eye Movement Desensitization and Reprocessing), a psychotherapeutic technique devised by Francine Shapiro in 1989.

Precisely because the body is certainly the repository of traumatic memories, (B. a. Van Der Kolk, 2006) but also the reserve of awareness (Duschek et al., 2015) that



everyone can access, learning to integrate these memories and finally experience healthy emotions and a state of well-being.

And it is primarily within these therapeutic approaches based on the body, that is developed the connection with awareness, and its ancient tradition of observation of the body (Mahasi Sayadaw ,1994) and then we see that mindfulness abilities becomes part of therapeutic protocols of recognized efficacy, so not only mindfulness-based stress reduction (MBSR), mindfulness-based cognitive therapy (MBCT), but also Dialectical Behavioural Therapy (DBT) (MM Linehan, 1993), Acceptance and Commitment Therapy (ACT) (Hayes, 2016), Sensorimotor Psychotherapy (Fisher & Ogden, 2009; Ogden & Minton, 2000; Ogden, Minton & Pain, 2006) and other interventions based on these.

In this way the mindfulness approach, distilled from the experience that comes from an ancient philosophical and religious knowledge 2600 years old, can be a bridge that binds the body and the mind also for the contemporary lay man, forced by the very nature of reality to confront the transitory nature of experiences and still in search of security and healthy mental and bodily states.

The object of my study is therefore the relationship between the experience of the body that takes place explicitly, limited to the subtlest dimension that is interoceptive awareness, or implicitly in the course of the emotional experience, the heart rate variability understood as an indicator of adaptation to the environment and of emotion regulation (Thayer & Lane, 2009), and mindfulness meditation taking place in different context.

Such meditation must be understood as an introspective tool and at the same time a factor of emotion regulation, able to modulate automatic reactions, both at the physiological autonomic level that at the cognitive level, allowing to transform patterns of habitual behavior and at the same time internal experiences of external

events (Bishop et al., 2006) and then becoming recently also an useful tool in psychotherapy.

To do this, I studied a group of inexperienced participants who approached meditation for the first time by participating in an MBSR training. The choice is due to the fact that in this way the practice of meditation is, however, comparable to the existing scientific literature, unlike many studies on meditation. Although the MBSR training acts on different components, I have played in my favor this characteristic by studying different dimensions in three studies that have been carried out on the same participants, but analyzing several different factors. Before presenting the studies, with their results and related discussion, I present an overview of the factors of my interest, namely interoception as a measure of self awareness based on body identity with its implications, on heart rate variability seen mainly as a measure of change in emotional regulation, accompanied by the presentation of two main theories that support this link, and on mindfulness seen as a skill to be acquired as well as an impactful intervention on mental and physical health. Finally, in the conclusions I also present the limits of this study, in the direction of future continuations.

# Chapter 1

## 1.1. Interoceptive awareness

### Definition and characteristics of interoceptive awareness

The term "interoception" was introduced about a century ago in the neurophysiological field to refer to the sensory input coming from the receptors located inside the body, as opposed to the term exteroception which refers to the cutaneous receptors, activated by external stimuli. In that period, on the basis of embryological and morphological tests, the neurons of the vertebral cord and in the medulla oblongata were classified as "visceral" and "somatic".

However, at that time the definition of these conceptual categories could not be based on a more central location that reflected their characteristics. As a result, for many years the term "interoception" has been synonymous with "visceral sensory input". (Cameron, 2001)

Interoception therefore is the perception of the state of the body, which implies the conscious perception of the emotional indices coming from within the body. The most accurate interpretation of this definition ranges from the original restrictive meaning that is still respected by some (for example, Dworkin, 2007) which claims that only sensations arising from the viscera are interoceptive, to the very inclusive meaning now more commonly used (Strigo & Craig, 2016)(Critchley, Wiens, Rotshtein, Ohman, & Dolan, 2004) In the latter interpretation it is a generic term for the phenomenological experience of the bodily state, an experience that is ultimately a product of the central nervous system (CNS), regardless of what information the brain uses to build this experience. (Erik, 2016)

In any case, in both approaches the interoceptive representation reflects the perception of the body from within and contributes to the regulation of

physiological integrity and all that is associated with it, such as sensations, emotions and impulses. A central theme in all these approaches is that the self emerges based on elaborations of interoceptive representations and their integration with exteroceptive signals in cortical regions, in particular the anterior portion of the insula cortex, (AIC) (Suzuki, Garfinkel, Critchley, & Seth, 2013)

Currently, the process of integration between sensory stimuli and subjectivity has been located in the insula, a cortical region in which sensory information is processed in a postero-anterior direction, contributing to the establishment of subjectivity, or sense of self, which is located precisely in the anterior area.(A D Bud Craig, 2009)

There is in fact an increasing evidence that the interoceptive signals that transmit information on the internal state of the body influence perception and self-awareness. The insular cortex, which receives sensory input from both interoceptive and exteroceptive sources in its posterior part, is thought to be the place where the integration of these multimodal signals takes place in its medial part. This state of integration is what modulates, as well as subjectivity and differentiation from others, also other perceptions such as time,(Pollatos, Yeldesbay, Pikovsky, & Rosenblum, 2014) space, (Lenggenhager & Lopez, 2015)and of course the emotional states that are directly produced by interoceptive signals combined with cognitive processes.(Werner, Kerschreiter, Kindermann, & Duschek, 2013) (Lenggenhager, Azevedo, Mancini, & Aglioti, 2013)(Pollatos & Schandry, 2008)

Emotional states, for their part, are what is directly perceived by people, and which constitutes the environment, the perceived climate of our inner reality, the field of existence and experience, and which can therefore contribute to

well-being or discomfort. , and consequently be the symptomatic state (Brugger & Lenggenhager, 2014) object of any psychotherapeutic intervention. Interestingly, there is a study of (A. D.B. Craig, 2011) in which the functions of insula are addressed in an evolutionary way. Primary interoceptive cortex occupies the entire dorsal insula in monkeys, but only the posterior third in humans. While the anterior insula and the anterior cingulate together form a core control network that guides all mental activity and behavior in adult humans. What has become the medial insula in humans forms the basis of the integration (and lateralization) of the afferent activity that represents both the internal and the external environment, while the anterior region represents the feeling of subjectivity per se, the basis therefore for a sentient self within a specific present and the ability to compare necessary for an efficient decision-making process, which also provides the basis for introspective subjectivity...the ability to recognize itself in a mirror, skill that no Macaque possess. (F.de Waal, 2009).

### **Interoception-The self from the body**

Interoception is involved in two research traditions that describe the sense of ownership of their own bodies.

The possession of the body experience (experience of body ownership or EBO) is quite stable under normal circumstances, but depending on dynamic multi-sensory integration, is still subject to change. This model is based on the fact that the integration of internal interoceptive signals is affected by the perception of the body from the outside, and that is of exteroceptive input, as is shown in many works based on the illusion of enfacement or rubber hand, for example in the work of Sforza, Bufalari, Haggard, & Aglioti, (2010) or Tsakiris, (2008).

The other model instead emphasizes the importance of interoception, understood as a way of being aware of the internal state of the body, in producing the sense of self, see Craig, (2009), Critchley, Wiens, Rotshtein, Ohman, & Dolan, (2004 ), Damasio(2010)

In the perspective of a bodily self, understood as an embodied agent endowed with a first person perspective, (Blanke & Metzinger, 2009) all events that are the object of conscious attention depend on the three types of perception which build the bodily field of existence, seen as a multisensory and continuous space constituted from exteroceptive, proprioceptive and interoceptive perceptions and their multiple interactions (Brugger & Lenggenhager, 2014)

In more recent findings are evidences that the vestibular system is especially important for global aspects of the self, most crucially for implicit and explicit spatiotemporal self-location. (Lenggenhager & Lopez, 2015) Moving in an environment is necessary in itself and for the most basic aspects (or minimum) of the self, but also to the various implicated purposes and explicit aspects of our body's experience in everyday life as a perception of the body, body ownership, action and self-other distinction. The authors then connect the vestibular system to other sensory systems such as touch, pain, interoception and proprioception.

According to a study (Pollatos, Laubrock, & Wittmann, 2014), the experience of time emerges from emotional and interoceptive (bodily) states developed in the insular cortex through an interaction between conscious awareness of interoceptive states and the distortions of time induced by emotions. Such retrospective temporal distortions are directly influenced by attention to body responses and these effects could interact crucially with excitation levels. The authors conclude that the activation of the sympathetic nervous system that influences the accumulation of memory could be the decisive factor that influences the judgments on the retrospective time.

The interoceptive representation reflects the perception of the body from within and contributes to physiological integrity control and all that is associated with it, such as feelings, emotions and impulses. Interoception is a multifaceted process and its dysfunction is increasingly recognized in the clinical field as an important component of different mental health conditions, including anxiety disorders, mood disorders, eating disorders, addiction disorders and disorders somatic. Basically, interoception is a modulator of all those processes of social cognition that are based on the information that comes from emotions and in general from the sensations of the body, mainly the motivational systems that come into play in the experience of emotions and the consequent behaviors. (LeDoux & Pine, 2016) And since with an MBSR training it is proposed to learn to increase self-control, and to replace reactivity and impulses with an appropriate response to the situation, seems to be natural that interoception can be modulated by the practice of mindfulness, especially in its integrated presentation in everyday life as it happens in the MBSR training. (N.Elkins-Brown et al., 2013)

In addition, the interoceptive awareness, that is the sense of the internal condition of our body, can open us to the understanding of others, being involved in the processes of differentiation of the self, since the integration between the interoceptive and esteroceptive information is at the basis of body identity and therefore of the distinction between self and others.

It is important to point out here also the (Garfinkel, Seth, Barrett, Suzuki, & Critchley, 2014) study, in which a multidimensional model of interoception is proposed, from which derive the states of subjective sensations (emotions) according to interoceptive signals organized hierarchically.

In their work they identify different sources of interoceptive predictions, independent of accuracy as usually measured in tasks such as the HBD task, and wish for a better differentiation between interoceptive awareness and accuracy, as well as their interactions, as possible levels of interoceptive representation of the different psychological and psychosomatic clinical conditions. In this way it will be possible to construct a better neurobiological understanding of the contributions that body representation gives to emotion, cognition and self-awareness.

## **1.2.Measurement of interoceptive awareness**

### **The measure of Interoceptive Sensitivity: Heartbeat Detection Task**

In order to measure the interoceptive sensitivity, a test of detection of one's heartbeat has been chosen, which has a good test-retest reliability (eg81%) and which is widely used for this purpose, fully correlating with other techniques of detecting the heartbeat. . This evidence was first described by Schandry R. (1981), and the detailed description is found in the part devoted to the methods.

### **The measure of Interoceptive Sensitivity: the questionnaire Maia**

the interoceptive sensitivity measured on the perception of one's heartbeat is not necessarily correlated with a meditative practice which places the greatest emphasis on the observation of the breath, and this can be a problem. In fact it is possible that this lack of correlation can give the false idea that the practice does not improve the contact with oneself. For this reason I decided to administer a self-report questionnaire regarding the interoceptive sensitivity expressed by several factors and considered more widely in the whole body.



The Multidimensional Assessment of Interoceptive Awareness (W. E. Mehling et al., 2012a) is a self-report test for measuring the interoceptive awareness of one's body.

The authors consider interoceptive awareness as a construct consisting of 5 dimensions:

Awareness of bodily sensations, which concerns the ability to identify internal sensations (negative, positive, and neutral) regardless of whether the experience is active or passive.

Emotional reaction and the attentive response to sensations, which include the attentive response to a sensation, avoid the perception of sensations, judging and narrative awareness that analyzes sensations, and conscious and non-judgmental presence.

Ability to regulate attention, understood as an active process of control, which includes the ability to sustain awareness, actively direct attention to different parts of the body, regulate the size of the attentional focus, and allow sensations without trying to change them .

Confidence towards bodily sensations, concerning the importance that the subject attributes to his feelings in decision making or health aid;

Mind-body integration, which includes the 3 sub-dimensions of emotional awareness, the self-regulation of emotions, sensations and behavior, the ability to experience an embodied and integrated self in all its dimensions.

The MAIA questionnaire consists of 32 items, assessed through a 5-point Likert scale (from never to ever), distributed in 8 scales that reflect the dimensions of the construct of interoceptive awareness:

**Noticing:** which concerns the awareness of unpleasant, comfortable and neutral bodily sensations. Expresses the first dimension;

**Not-Distracting:** which indicates the tendency to ignore or distract from feelings of pain or annoyance and expresses the second dimension;

**Not- Worryng:** it involves converting emotional stress or worry into feelings of pain or discomfort. This scale also expresses the second dimension;

**Attention Regulation:** evaluates the ability to sustain and control the attention regarding the sensations coming from the body and expresses the third dimension;

**Emotional Awareness:** it concerns the awareness of the connection between bodily sensations and emotional states. Expresses the fourth dimension;

**Self-Regulation:** it describes the ability to regulate psychological stress through attention to bodily sensations. Expresses the fourth dimension;

**Body Listening:** is evaluating the ability to actively listen to the body in an intuitive way. Expresses the fourth dimension;

**Trusting:** it consider the experience of one's body as safe and reliable. Expresses the fifth dimension.

The best correlations between the scales that build up the instrument, are between Listening to the Body and Emotional Awareness (.60), Noticing and Attention Regulation (.56), and Self-Regulation and Attention Regulation (.55).

Since the MAIA evaluates the interoceptive awareness and the FFMQ the conscious attention to any perceptible stimulus, including thoughts and exteroceptive inputs, it is useful to evaluate the relationships between the scales of the two tests. Mehling et al. (2012) found that:

The MAIA Noticing scale, which evaluates the awareness of bodily sensations, is highly correlated with the aspects of conscious attention and body awareness assessed by the FFMQ scale Observe;

The MAIA scale Not-distracting, which concerns the tendency not to use distraction to cope with situations of discomfort, correlates positively with the

FFMQ scale Acting with awareness, moderately with the scale Do not react and minimally with the Observe scale;

The MAIA scale Do not worry, that evaluates the tendency not to experience emotional discomfort with physical discomfort, have a correlation with the scale of the FFMQ Do not react and Acting with awareness.

The MAIA scale Attention Regulation, which evaluates the ability to sustain and control the attention to one's bodily sensations, is positively correlated with the measures of careful awareness Observing, Acting with awareness and Not reacting;

The MAIA scale Emotional Awareness, which assesses the ability to understand the connection between bodily sensations and emotional states, a process involving a more developed interoceptive awareness, means a strong capacity for conscious observation. In fact, the authors found a positive correlation with the FFMQ scales Observe and a more moderate correlations with Describe and Not react;

The MAIA scale Self-regulation, that is the assessment of the ability to regulate stress paying attention to the sensations of the body, is positively correlated with the scale of the FFMQ Do not react consciously, with Observe, and moderately with Acting with awareness, which describes the competences in awareness of the way in which emotions affect one's behavior;

The MAIA scale Listening to the body, which assesses the ability to actively listen to the body, correlates with Observe and Do not react.

The MAIA Trusting scale, which represents the body's experience as reliable and based on stable body listening skills, correlates moderately with the FFMQ scales Observing, Acting with awareness and Not reacting.

Since all 5 dimensions represented by the scales are representative of the interoceptive sensitivity, the results of all scales were analyzed.

### **1.3. The relationship between Interoception and Mindfulness**

There are now numerous studies that explore the relationships between Interoceptive Sensitivity and Mindfulness, given the many dimensions common to both and which are rooted mainly in body awareness.

Mindfulness is a set of training based on self-regulation, self-monitoring and attention. The impact of this type of training on self-regulation mechanisms is well established, and all models and clinical approaches are based on them. On the other hand, the neural mechanisms that support these changes are not well known, but it is thought that the action is carried out through interoceptive salience and the emphasis on the control mechanisms of attention, even if until now the contrasting evidence that based on behavioral and neural measures makes it difficult to distinguish their respective roles.

## Chapter 2

### 2.1 Heart rate variability

#### Definition and characteristics of heart rate variability

Many approaches to the study of cardiac variability found a direct relationship between its modulation and subjective diversity, and some behaviors and individual responses.

Heart rate variability is seen as a trait that allows adaptation to the environment with a different sensitivity depending on the circumstances, and seem to be affected by experiences such as trauma or styles of care during development. The activity of the autonomic nervous system (ANS) is seen as an important component of emotional response in many recent theories on emotions, although it has been actively studied for already a century (Cannon et al., 1915). The positions on the degree of specificity of ANS activation in the emotions, however, vary widely, ranging from excitement and undifferentiated, until the recognition of strong aversive responses, and forecasts highly specific patterns of autonomic response to certain emotions. (Kreibig, 2010)

In this perspective lies the extensive work of Porges and his Polyvagal theory , (Porges, 2007) and numerous studies of J.Thayer and Lane regarding the variability rate and their neurovisceral theory (Thayer & Lane, 2000).

In this context of increasing interest in body awareness, are therefore studies in which is being addressed the interplay of interoceptive awareness with heart variability . See for example (Dunn, Evans, Makarova, White, & Clark, 2012) where HRV is considered in its aspects of specificity in the double activation of autonomic sympathetic and parasympathetic, and thus being able to account for an inhibitory response of emotional regulation that may be different depending on the individual interoceptive awareness.

There are also important theories that emphasize the importance of the perception of the body for self-consciousness, but it is currently not known whether the body perception is based on exteroceptive or interoceptive signals or the integrated signals from these systems anatomically distinct, (Aspell et al., 2013) (Brugger & Lenggenhager, 2014).

## **2.2. Measurement of heart rate variability**

### **HRV parameters**

The most widely used methods in psychophysiology research, can be grouped under time-domain and frequency-domain methods. A joint European and American task-force described standards in HRV measurements in 1996(Marek, 1996). Other methods have been proposed, such as geometric methods, non-linear methods and long term correlations, which are not widely used in the study of psychological variables.

### **-Time domain parameters**

These are based on the beat-to-beat or NN intervals, (NN is used to emphasize the fact that this are "normal" beats)which are analyzed to give variables such as: SDNN: Standard Deviation of Normal-Normal intervals, in practice the standard deviation of RR intervals. Often calculated over a 24-hour period, it is also calculated over short periods, usually 5 minutes. SDNN is therefore a measure of changes in heart rate due to cycles longer than 5 minutes, and reflects all the cyclic components responsible for variability in the period of recording, therefore it represents total variability.

RMSSD ("*root mean square of successive differences*"), the square root of the mean of the squares of the successive differences between adjacent NNs, that provide an index of cardiac vagal control

SDSD ("*standard deviation of successive differences*"), the standard deviation of the successive differences between adjacent NNs

### **-Frequency-domain parameters**

Frequency domain methods assign bands of frequency and then count the number of NN intervals that match each band. The bands are typically high frequency (HF) , low frequency (LF), and the very low frequency (VLF).

VLFP or VLF: Very Low Frequency Power. Very low frequencies, between 0.0033 and 0.04Hz

LFP or LF: Low Frequency Power. Low frequencies, between 0.04 and 0.15 Hz.

HFP or HF: High Frequency Power. High frequencies, from 0.15 to 0.36Hz

LFP / HFP or LF / HF ratio of LFP and HFP

## **2.3. Heart rate variability and emotion regulation**

Emotions are varied phenomena involving experience, behavior and bodily aspects. Thus, a person who is experiencing an emotion such as anger or sadness will experience rapid changes in the way he or she feels and behaves, accompanied by the bodily reactions they induce and at the same time make the experience itself knowable.

In the scientific world there is growing attention to understand how individuals regulate emotional reactions in order to be able to adapt effectively to a constantly evolving environment. Emotional regulation is therefore currently considered to play a central role in health and psychological well-being, and has been proposed as a cross-factor mental health index. (Gross and Muñoz, 1995; Fernandez et al.,

2016). There is therefore a growing interest regarding the implication of emotional regulation in the pathogenesis of psychopathology.

There are now several lines of research (Kemp & Quintana, 2013) (Bernardi et al., 2012) (Geisler, Kubiak, Siewert, & Weber, 2013) whose purpose is to study the relationships between the regulation of emotions measured through a well-recognized tool (DERS) and HRV, a psychophysiological indicator proposed for the ability to regulate emotions.

A broad ability to adapt to changing situations that come from the environment is supported by the ability to regulate physiological systems and beyond anxiety, there are initial results that demonstrate that low HRV is also associated with other psychological disorders (Gaebler, Daniels, Lamke, Fydrich, & Walter, 2013), (Friedman, 2007), depression (Kemp et al., 2010), worry and rumination (Brosschot, Van Dijk, & Thayer, 2007) (Ottaviani et al., 2015) (Brosschot, Gerin, & Thayer, 2006), PTSD (Yelboga et al., 2012), stress (Verkuil, Brosschot, Tollenaar, Lane, & Thayer, 2016) (Thayer et al., 2012), borderline personality disorder (Weinberg, Klonsky, & Hajcak, 2009) (Koval et al., 2013), alcohol addiction (Quintana, Guastella, McGregor, Hickie, & Kemp, 2013), somatoform disorders (Pollatos et al., 2011).

## **2.4. Polyvagal theory**

In his well-known Polyvagal Theory, (Porges, 2001) Porges is based on a conception of phylogenetic structure of the brain, organized in such a way that the newest structures control the oldest portions according to a phylogenetically organized hierarchy. The connection occurs between the neuronal regulation of the heart and the affective and emotional experience, facial and vocal expression, communication and social behavior. This occurs due to the connection between the neural control pathways of the heart and those responsible for the neural control of the muscles of the face and head.



This theory is therefore based on the evolution of the autonomic nervous system, in particular on the vagus nerve which is its main component. The vagus nerve is the X cranial nerve, which connects the encephalic trunk areas with some visceral organs. 80% of the vagal fibers are afferent and about 20% are efferent, and this allows a dynamic feedback process between the control brain centers and the organs, with the aim of regulating homeostasis.

The primary motor fibers of the vagus originate through two separate nuclei located in the medulla oblongata: the Dorsal Motor Nucleus of the Vago (DMNX) and the Ambiguous Nucleus (NA). The dorsal motor nucleus of the vagus is located in the medial back region of the medulla oblongata, from which departs the "vegetative" branch that connects to the heart through non-myelinated neurons that conduct the signal at low speed and do not lead the respiratory rhythm, branch that is also involved in the vegetative functions of digestion and respiration.

The ambiguous nucleus is located ventrally with respect to the dorsal motor nucleus in the ventrolateral reticular formation, from here it departs the "emotive" vagus, which is endowed with myelinated efferent fibers that lead the respiratory rhythm, and which in addition to the heart innervates also soft palate, pharynx, larynx and esophagus. The articulation of the different bundles of the vagus nerve, reflects the great behavioral difference between the reptilian ancestors, who lead a solitary existence, from the mammals that necessarily need to have social relations that promote mutual protection and care.

Therefore the autonomic nervous system following this evolutionary line has modified its structure and function, and to the original function of mobilization (to induce the attack or flight reaction) or extinction, to induce the extreme defense of immobility, added a third coordination and support function, able to modulate and make synergic the most primitive actions in the course of socializing activities through the phases of growth and moments of rest and play.

In fact, when no danger is detected in the upper brain structures, this is communicated to the brainstem and the activations usually used for the two main forms of defense are synergistically destined to other activities, such as play, social interactions and pleasure. This of course can only take place in a security context, where in the course of non-reactive mobilization, ocular contacts take place, social involvement in shared activities, and in the case of humans even emotional reciprocity transmitted through facial expressions and vocalizations.

The polyvagal name therefore derives from the identification of a multiplicity of vagal pathways, each with different functions. It should also be remembered that the vagus nerve is the major part of the parasympathetic nervous system, but that only in the mammals there is a second vagal pathway, myelinated, which has the function of coordination and regulation of the other vagal circuit as well as of the sympathetic nervous system.

This phylogenetic difference is reflected in the development in the period of gestation, during which the myelinated vagal ventral pathways develop only in the last weeks of gestation, and are therefore only the term infants that do not present the vulnerabilities to apnea and bradycardia, which are not other than manifestations of the Reptilian defensive reactions.

The vagal ventral pathway, being based on myelinated nerve bundles, has an electrical conduction faster than the others, and can modulate the cardiac variability adapting itself to complex social situations, which do not require the most ancient attack or flight reactions but rather the activation also joint of the sympathetic system, for example during the play, or of the dorsal vagal route during the manifestations of affection and the prosocial behaviors.

These skills are refined during the first years of life, during which the child through the play and the normal activities of interaction with the attachment figure, learns this complex game of regulation of the sympathetic system and of

the dorsal vagal pathway, within social environment in which he is involved in a situation of security.

In fact, during the attachment relationship, the system of social involvement is activated, the heart-face connection system that coordinates the muscles of the face responsible for communicating emotions with the heart, a system that allows trust and confidence to emerge spontaneously. Through this co-regulation activity during development, the child gradually learns to self-regulate, that is to maintain the feeling of safety even in the absence of another person who can send back this feeling.

When this condition of security fails, the defense systems are activated based on the oldest ways of the sympathetic system, and in case, by means of these more ancient forms of defense (attack or flight) the individual fails to restore the conditions of security, is activated the "vegetative" dorsal vagal pathway, which induces automatic behavioral responses of immobility, fear and fainting, or even dissociation.

Understanding these mechanisms allows us to recognize and identify the behaviors of people who have suffered traumas of various kinds, and who usually suffer social disapproval in response to their defense strategies, which appear so dysfunctional if implemented in the social environment in automatic and reactive mode.

This understanding, with the consequent acceptance in a compassionate atmosphere, can take place within the therapeutic relationship and thus extends to the subject himself, restoring the climate of security and trust that allows us to restore also the reconnection with the body.

Therefore, in the Polyvagal perspective, interoceptive awareness is also placed, understood as the metacognition of physiological responses to emotionally salient events, which can then be promoted in the therapeutic field in order to restore integration of the self and self-regulation.

## **2.5. Neurovisceral Integration Model (NIM)**

Thayer and Lane in 2000 proposed the model of Neurovisceral Integration, according to which there are different aspects, physiological, behavioral, affective, cognitive, social and environmental that contribute to produce the ability to adapt to environmental changes and allow adaptive survival.

In the model of neurovisceral integration the cardiac vagal tone, measured through the heart rate variability (HRV), can give information about the functional integrity of the neural network involved in the emotional-cognitive interactions because the neural circuits involved in the autonomic, emotional and cognitive self-regulation are also involved in the control of cardiac activity.

A higher resting HRV is therefore associated with a greater capacity for modulation in the response to emotional stimuli, whereas a low resting HRV is associated with a state of hypervigilance and incorrect cognitive responses to neutral emotional stimuli.

The central autonomic network (CAN) is involved in the visceral-motor, neuroendocrine and behavioral responses to allow a flexible response to the different environmental realities and consists of the anterior cingulate, the insula, the pre-frontal ventro-medial cortex, from the central nucleus of the amygdala, the paraventricular nuclei and the hypothalamus, from the gray periaqueductal, from the parabrachial nuclei, from the nucleus of the solitary tract, from the ambiguous nucleus, from the ventrolateral and ventromedial medulla, and other nuclei.

All of these structures are interconnected within the CAN, and information can flow freely. Pre-cortical subcortical inhibitory circuits play a fundamental role in self-regulation functions. Under normal circumstances the prefrontal cortex has the task of identifying the safety points present in the environment and exerts its inhibitory control on the cortical sympathetic excitatory circuits, including the central nucleus of the amygdala. In situations of uncertainty, the prefrontal

inhibitory regulation decreases and the sympathetic subcortical exciters circuits respond automatically, with consequent prolonged activation of the defense mechanisms like for example, hypervigilance. The dynamic connections between the amygdala and the prefrontal cortex, especially in its medial part, responsible for assessing the degree of risk of the environment, act on the regulation of HRV through their connections with the Solitary Tract Core (NTS). HRV therefore reflects the functional capacity of the brain structures involved in self-regulation processes.

Due to the blockage or decrease in activation of the frontal cortex by the CAN, the cardiac variability decreases while the heart rate increases. The prefrontal cortex is deactivated when a threatening situation is perceived, but a prolonged inactivity of the prefrontal cortex leads to a state of hypervigilance and social isolation.

A higher resting HRV is associated with the activation of the prefrontal subcortical inhibitory circuits, in order to allow a flexible and adequate response, from the cognitive, emotional and behavioral point of view, to the different environmental situations, and this feature facilitates a correct expression of the emotions.

The presence instead of a low resting HRV is associated with less effective prefrontal regulation and consequently with the manifestation of emotional and cognitive attitudes that are not adequate to the situation and with self-regulating systems deficiency. For example, these individuals have difficulty in recognizing safety situations or neutral stimuli.

These people show a phasic suppression of HRV, with inadequate responses following exposure to trivial events, identified as representing important stressors. In a more recent study, (Williams et al., 2015) report a significant negative association between resting vmHRV and self-reported difficulties in emotional regulation, as measured by the Difficulties in the Emotion Regulation Scale DERS (Gratz & Roemer, 2004). Greater anxiety and rumination are associated with low vmHRV and greater difficulty in emotional regulation.

Other studies have confirmed correlations between factors of emotional regulation and cardiac variability.(Berna, Ott, & Nandrino, 2014)

## **2.6. A measure of Difficulties in the Emotion Regulation**

“Emotion regulation consists of the extrinsic and intrinsic processes responsible for monitoring, evaluating, and modifying emotional reactions, especially their intensive and temporal features, to accomplish one's goals.” (Thompson, 1994, pp. 27-28) and the ability to tolerate stress is increasingly considered important for the development of new understandings concerning both models of production and maintenance of psychopathology in adults, and to generate interventions for the prevention and treatment.

Therefore, in order to be able to introduce effective therapeutic interventions, it becomes important to understand in depth the construct of emotional dysregulation and its relationship with DT. As defined by (Leyro, Zvolensky, & Bernstein, 2011), “emotion dysregulation is a multidimensional construct involving a lack of awareness and understanding of emotions, nonacceptance or avoidance of emotions, an unwillingness to experience negative emotions as part of pursuing desired goals, difficulties controlling behaviors in the face of emotional distress, and deficits in the modulation of emotional arousal, including a lack of access to effective strategies for modulating the intensity or duration of emotions”

Gratz and Roemer (Gratz & Roemer, 2004) have developed a measure of emotional dysregulation based on this model, the multidimensional Difficulties in the Emotion Regulation Scale (DERS).

The aim of the authors is to verify how emotional regulation can be understood as a unifying factor of operation of different dysfunctional symptoms and behaviors

in psychopathology. At that time there was existent only the work of Linehan M.M. (1993) concerning the borderline personality disorder, in which some symptoms such as self-harm or violent acts against others were explained as an attempt by the subject to regulate their emotions out of control.

They devote the first part of the work to review the existing conceptualizations regarding emotional regulation, emphasizing how attempts to control emotions and expression often have opposite effects to those desired, while the most adaptive emotional adjustments are based on acceptance and flexibility. In practice, some authors have been able to show that the most effective regulations involve a different experience in terms of intensity and duration, but not the change in the emotion experienced itself. With exercise, individual can instead learn to regulate himself in terms of arousal and of behaviors that derive from it, but not to change the emotion that is recognized and accepted. (Thompson & Calkins, 1996) According to the results of some research, (Thompson & Calkins, 1996), it seems that the adaptive regulation of emotions involves the monitoring and evaluation of the emotional experience as well as its change, processes in which the awareness and understanding of emotions are fundamental.

The purpose of the (DERS) is to evaluate the emotional dysregulation more completely than the existing measures. The DERS items have been identified to measure difficulties in four main dimensions of emotion regulation: (a) awareness and understanding of emotions; (b) acceptance of emotions; (c) the ability to engage in directed behavior and to abstain from impulsive behavior when negative emotions occur; and (d) access to strategies to regulate emotions perceived as effective. The final dimension identifies the attempt to measure the adaptive use of appropriate strategies to be able to modulate emotional responses. As expected, due to the multifaceted conceptualization of emotional regulation on which the DERS was based, the measure was made up of different factors (even if

associated), each of which reflected a dimension of emotional regulation in which difficulties can occur.

I report the 6 factors that have been identified, as they are described by the authors in the text, and which reflect precisely this conceptualization.

“Factor 1 can be labeled Nonacceptance of Emotional Responses (NONACCEPTANCE). It is composed of items reflecting a tendency to have negative secondary emotional responses to one’s negative emotions, or non accepting reactions to one’s distress.

Factor 2 can be labeled Difficulties Engaging in Goal-Directed Behavior (GOALS). It is composed of items reflecting difficulties concentrating and accomplishing tasks when experiencing negative emotions.

Factor 3 can be labeled Impulse Control Difficulties (IMPULSE) and is composed primarily of items reflecting difficulties remaining in control of one’s behavior when experiencing negative emotions.

Factor 4 can be labeled Lack of Emotional Awareness (AWARENESS) and consists of items reflecting the tendency to attend to and acknowledge emotions. When these items are appropriately reverse-scored, this factor reflects an inattention to, and lack of awareness of, emotional responses.

Factor 5 can be labeled Limited Access to Emotion Regulation Strategies (STRATEGIES) and consists of items reflecting the belief that there is little that can be done to regulate emotions effectively, once an individual is upset.

Factor 6 can be labeled Lack of Emotional Clarity (CLARITY) and is composed of items reflecting the extent to which individuals know (and are clear about) the emotions they are experiencing.” (Gratz & Roemer, 2004)

The results empirically support a multidimensional conceptualization of emotion regulation. Already in this first work the DERS proves to have a high internal consistency, good test-retest reliability, adequate constructs and predictive validity. On the other hand, the limit identified by the authors is that the



emotional responses are provided in a self-referenced way, and because it is likely that some individuals are not fully aware of their emotional responses, the accuracy in the compilation is so correlated.

In more recent findings another factor that is considered important as a modulator of the stress experience is attentional control. (Bardeen, Tull, Dixon-Gordon, Stevens, & Gratz, 2015). In fact, individuals with low attentional control have greater difficulty in accessing effective emotional regulation strategies during stressful experiences. In fact, the distress tolerance (DT) construct is defined as the ability to remain focused on one's own goal even during negative and psychologically difficult experiences(Leyro et al., 2011).

## Chapter 3

### 3. Mindfulness: from Buddhism to secular programs

#### 3.2. Mindfulness in Buddhism

Mindfulness is the English translation of the Pali word *Sati*, but the modern Western meanings of “mindfulness” may not be an appropriate translation for how *sati* is used in the suttas, where this word means both a “mental faculty” (one of the five faculties) and also a practice that could be refined, and that is different from the mere conscious observation of external and internal events to the self. In the Satipatthana sutta it is described as a combination of awareness or alertness of the present moment, an appropriate attention to it and a skillful effort to maintain the focus.

So *sati* is something that one has and it is also a state within which one is, and we could say that the purpose of mindfulness practice is to establish a strong degree of awareness, while the experience is taking place, and with the appropriate practice and techniques this state can be prolonged over time.

#### 3.3. Defining and measuring mindfulness

##### Defining mindfulness

Mindfulness is a "practice" currently very popular in the world, proposed both in the preventive field to improve the psychophysical balance of people and also in the clinical field, having proved to be an effective therapeutic approach for some pathologies of a psychological nature. It helps the individual to achieve self-awareness, and as a result this practice helps to regain contact with oneself and control of one's mind, often completely invaded by an uninterrupted rumination, and distorted by hyperactivation that never finds peace and an anticipatory anxiety that can become difficult to manage.

How can we understand the meaning of this state, or activity? Mindfulness corresponds to that moment of direct knowledge, before we can access or conceive a definition, the moment which corresponds to our experience itself, in the present moment. It is therefore essential to understand that it is an experience and not a learning process, which can certainly be repeated, and therefore that can become more intense with practice. Just as the pleasure and the knowledge of a symphony happens with the repetition of listening, and for this reason it always happens in the present, and not in the future.

### **Measuring mindfulness**

The FFMQ is a self-report questionnaire built by Ruth A. Baer, et al. (2006) starting from other tests (MAAS, IMF, KIMS, CAM, MQ) which provide a total score but not scores corresponding to the individual skills that make up the mindfulness. After determining the good internal coherence of these questionnaires, which also correlate with each other and with the meditative experience, in the same work Baer analyzes the factorial structure of the mindfulness construct, administering in a single set the items of the 5 tests examined previously, to a sample of 613 students. The total number of items was 112 and the results led to the identification of five factors:

Factor 1: attention and observation of one's own thoughts, feelings, perceptions and emotions (observe);

Factor 2: the ability to put into words your thoughts, feelings, perceptions and emotions (describe);

Factor 3: act in a non-automatic way, with awareness, concentration and attention (acting with awareness);

Factor 4: Nonjudgmental attitude towards the experience (non-judge);

Factor 5: tendency not to react and not to reject inner experience (non-react).

These factors therefore concern the ability to observe the sensations of the body among various other stimuli (Observe), describe emotions (Describe), participate in the activities performed in that very moment (Act with awareness), and do not judge (Do not judge) and accept (Non-reactivity) bodily sensations. The correlations between the different factors are modest, but significant and all in a range between .15 and .34. In this study a positive correlation was observed with openness to experience (Observe), emotional intelligence (Describe), compassion towards oneself (Nonreact) and negative with Alesitimia (Describe), distraction (Actaware), neuroticism, suppressive thinking, difficulty in emotional regulation and experiential evasion (Nonjudge). The authors then propose a questionnaire, the FFMQ, consisting of 39 items on a 5-point Likert scale (1 = never or very rarely true, 5 = very often or always true) divided into 5 scales, corresponding to the 5 identified factors.

The FFMQ was then validated by a further study by Bear et al. (2008) with a sample composed of groups of meditators and non-meditators, in which the significant correlation of most of the components of mindfulness with the experience of meditation, to psychological symptoms and well-being is further demonstrated.

It should also be noted that although mindfulness has both status and trait quality (Brown & Ryan, 2004; Segal et al, 2004), it has also been described as a skill (or set of competences), which can be developed with practice (Bishop et al., 2004; Linehan, 1993b).

### **3.4. Mindfulness based programs**

What we know as Mindfulness derives from buddhist Vipassana and Zen meditation and Yoga practices, and mostly during the last two decades this approach has been used as an autonomous paradigm in some Western psychotherapeutic interventions, in particular in the cognitive behavioral therapy.

It was used by Jon Kabat Zinn in the early 80s for the first time in a health context (Health Department of the University of Massachusetts), which has developed a structured protocol lasting 8 weeks, the Mindfulness Based Stress Reduction . Currently, Mindfulness-based interventions are increasingly proposed in hospital and outpatient settings, individual or group, and find clinical applications in the prevention and treatment of disorders related to stress, to psychosomatic illnesses, to anxiety and depressive disorders, to obsessive-compulsive disorder, in substance abuse, eating disorders, suicidal tendencies and borderline disorder, as well as in somatic disorders such as psoriasis, chronic pain and in the field of oncology, where protocols and validated therapeutic models of proven efficacy are developed.

### **3.5. Mindfulness Based Stress Reduction (MBSR)**

#### **From Mindfulness to the MBSR protocol**

Much of the interest in clinical applications of mindfulness was produced by the introduction of the Mindfulness-Based Stress Reduction Protocol (MBSR), a standardized treatment program based on a strictly controlled procedure that was originally developed for the management of chronic pain (Kabat-Zinn, 1982; Kabat-Zinn, Lipworth, and Burney, 1985; Kabat-Zinn, Lipworth, Burney, and Sellers, 1987). MBSR is currently widely used to reduce the psychological morbidity associated with chronic diseases and for the treatment of emotional regulation and behavioral disorders (Kabat-Zinn, 1998)

The MBSR program combines general theories on knowledge and practices of two very different and until recently divergent traditions, both engaged in empirical research, although using very different methodologies: that of science, medicine and psychology, on the one hand, and that of Buddhist meditative traditions with their teachings and practices, known in their whole as the Dharma, on the other.

One reason why MBSR has proved viable in traditional clinical settings is that Dharma is essentially universal. Awareness, often called "the heart of Buddhist meditation" is an expression of its universal applicability, since it is essentially a systematic training and a progressive improvement of attention and awareness, compassion and wisdom.

### **The MBSR training**

In the MBSR training various components that can be object of study come into play, since mindfulness, seen as a phenomenon more similar to a state that is evoked and maintained by regulating attention (Bishop et al., 2006), has effects not only on the attentional capacity, but also helps to cultivate a mode of open relation to all cognitive, emotional and sensorial experiences, to intentionally deactivate the automatic thoughts and to let go of the tendency to mental proliferation liberating itself thus from the automatic rumination, especially in regard to painful and unwanted experiences.

All this can be achieved through training in a gradual process that unravels perceptions, emotions and thoughts that are usually perceived as a single instance, a process which is based precisely on awareness.

### **MBSR in psychology**

In contemporary psychology, Mindfulness, especially in its aspect of complete acceptance of the present moment, has been adopted as a direct approach to increase awareness and consequently an appropriate response to mental processes that contribute to emotional stress and maladaptive behavior.

An MBSR training acts at multiple levels, influencing different components of the person and his behavior. The circular model proposed by Shapiro L. et al (2006) identifies three main elements, which are intention, attention and attitude, seen as aspects of a single cyclical process that is activated during the training.

Then there are additional processes, which are touched by the training and which contribute to obtaining the globally positive results produced by the practice.

These additional processes are identified by Shapiro et al, (2009) to be Self-regulation and Self-management, emotional, cognitive and behavioral flexibility, clarification of values, exposure.

Without deepening them in detail here, one can simply note that each of these dimensions can be studied, comparing performance in tasks or answers to questionnaires of participants and control group, before and after an MBSR training, to understand its effectiveness in the treatment of many disorders.

### **3.6. Mindfulness Based Cognitive Therapy (MBCT)**

Studies by Zindel Segal (Toronto), Mark Williams (Wales) and John Teasdale (Cambridge) have created the Mindfulness-Based Cognitive Therapy (MBCT) program, a protocol, which is a reworking of Jon Kabat-Zinn's work on Stress reduction program (Mindfulness-Based Stress Reduction MBSR

MBCT is an intervention program developed specifically for the vulnerability to depressive relapses. Throughout the program, patients learn mental management skills leading to heightened metacognitive awareness, acceptance of negative thought patterns, and the ability to respond skillfully. During MBCT patients learn to decentralize their negative thoughts and feelings, allowing the mind to move from a pattern of automatic thinking to conscious emotional processing. MBCT can be used as an alternative to maintenance antidepressant treatment.

Mindfulness-Based Cognitive Therapy (MBCT) includes simple guided meditations to learn to become more aware and able to accept the present as it is, by contacting changes of mind and body moment by moment. The MBCT also includes moments of psychoeducation about depression, metaphors and poems on various topics, exercises from cognitive therapy that identify the links between

thought and emotion and teach how to take care of oneself when depression seems to threaten to take over.

The MBCT therefore allows us to understand more clearly how the mind works and consequently to recognize a drop in mood in its initial phase. The goal is therefore to produce in the participants the metacognitive skills that can support the setting up of a new way of being and living. In this way the automatic connection between negative mood and negative thought is interrupted.

The participants then become able to accept the fluctuations of negative mood, with the thoughts and feelings connected to it, without necessarily having to fight them. In this way the circle of rumination is interrupted, while the comprehension and kindness towards oneself are increased and the link between the activity of rumination on past events and the depressive symptoms is broken.

### **3.7. Other mindfulness based programs**

All therapeutic models using interventions based on mindfulness, have as their main purpose to bring the person to change the root of the relationship with their internal experiences and in general to develop the natural ability to observe their experience as it happens and not only that of being the subject and protagonist. This ability of the self to observe itself in action in a non-judgmental way and not oriented to modify what is being observed, creates the distance and decentralization necessary to maintain its health goals and functional behaviors, even in the presence of painful and threatening life experiences. Hence the emergence of psychological models based on the recognition of the transversality of human suffering and of the human condition that makes it necessary to face continuous changes, from which derives the acceptance of the impossibility of freeing oneself from suffering, stimulating rather the development and the application in the therapeutic field of different approaches that enhance some



innate components of human nature, and that can lead to different and new interpretations of events as well as their behaviors and emotional states experienced. These components share the characteristic of directing attention to their internal states, emotions, thoughts and their mutual relationship of interdependence and mutual influence with the body. (Goleman, 1991).

This different view is the main component that induces change, determined by an attitude able to harmonize and normalize the intra and interpersonal variables by coming into greater contact with oneself. These components can be identified in the acceptance of experience (Hann, 1998, Hayes, Strosahl, Wilson 1999), in the compassionate attitude towards one's own and others' suffering (Gilbert & Procter, 2006) (Gilbert, 2005), in the capacity for non-judgmental self-observation (Kabat -Zinn, 1990), in the idea that the mind can observe itself and understand its own nature (Dalai Lama, Benson, Thurman, Goleman and Gardner, 1991).

Mindfulness therefore does not change the contents of our mind, but our relationships with them and presents itself as a tool that can be integrated into a therapy.

In the clinical field, mindfulness is part of the therapeutic guidelines of the so-called third wave of cognitive behavioral therapy with many Mindfulness Based-Interventions (MBI).

In addition to MBSR and MBCT, many very effective protocols have been developed to address and overcome chronic pain and stress, depressive relapses, relapses in alcohol and substance dependency, the MindfulnessBased Relapse Prevention (MBRP); the treatment of eating disorders

MinfulnessBasedEatingAwareness Training (MB-EAT), Cognitive therapy based on mindfulness for cancer patients (MBTC-Ca), interventions dedicated to the treatment of Obsessive Compulsive Mindfulness-Based Cognitive Therapy for OCD.

## Chapter 4

### 4. A study on Mindfulness Based Stress Reduction and Interoceptive Awareness

#### 4.1. Introduction

In the last decade the studies on interoception have multiplied, being a particular index and still not well understood that defines the range of sensations we receive from within the body, together with their subjective and conscious evaluation. For this reason interoceptive awareness is often used to check the incidence of contemplative practices on the sense of self (Farb et al., 2015), and I also wanted to study the variations of this parameter before and after an MBSR training.

In order to evaluate the effects of the MBSR training on the experience of the subtle self (G.Arciero & G.Bondolfi,2009) , I used two different methods to measure interoception as a pre/post tasks. In fact I used the classic test of detection of the heartbeat (HBD), (Schandry, 1981) which calculates a subjective index (SI). This was done in order to compare the results with the study of (Khalsa et al., 2008). I also wanted to add a questionnaire to measure larger areas of the body perception, the MAIA (W. E. Mehling et al., 2012b) in addition to the awareness of the heartbeat. This was done in order to compare the results with the study of (Bornemann, Herbert, Mehling, & Singer, 2015)

In this study I explored the possible interactions and correlations between the effects of an MBSR training and the interoceptive sensitivity of the participants, compared with that of a control group (waiting list), in an exploratory way.

The study confirmed the hypothesis that SI measured using HBD is not affected by meditation practice. On the other hand, some scales of MAIA have made a significant improvement modulated by training on the total group of participants, confirming other studies. Have also been confirmed the findings of other studies, showing that an MBSR course in only 8 weeks can be as effective as longer

trainings, focused on selected practices. It also made it clear that it is useful to compare the interaction between physiological parameters and conscious reports of the meditative experience, to give strength to its understanding and its impact in the subjective experience.

## **4.2. Methods**

### **Participants**

We enrolled 34 people interested in participating in a MBSR training naïve to meditation (mean age = 36.29, SD = 11.34; F=31). Participation was advertised through the network of Sapienza University and through a newsletter sent to a mailing list of people interested in participating to psychological research. Participant signed an informed consent before to be enrolled in the study. They were assigned then to one of two groups randomly, with 16 participants in the meditation (experimental) group (mean age = 36.69, SD = 8.42; F=16) and 18 participants in the control group (mean age = 35.94, SD = 13.64; F=15). While the first group attend the MBSR course, the second group did not participate to any activity during the same period, but they take a MBSR training afterwards (i.e. they are enrolled in a 'waiting list'). We conducted t-tests for independent samples for comparing the two groups in age, interoceptive sensitivity at baseline, and interoceptive capacity at baseline and we did not find any significant difference between them. Gender has a female predominance, with the presence only of 3 males in the control group.

We included in the analysis reported above only participants who attended to 6 out of 9 classes, reported a regular meditation experience at home, and completed all the experimental sessions.

## Materials

The questionnaire MAIA consists of 32 items, assessed by a Likert 5-point scale (from never to always), distributed in 8 scales which reflect the size of the interoceptive awareness construct:

Note (**Noticing**) concerning the awareness of unpleasant bodily sensations, comfortable and neutral. It expresses the first dimension; Not Distracted (**Not-Distracting**): indicating a tendency to ignore or to get distracted by feelings of pain or discomfort and expresses the second dimension; Do not Worry (**Not-Worrying**): it relates to the fact of converting or less emotional stress or worry in sensations of pain or discomfort. Also this scale expresses the second dimension; Adjusting attention (**Attention Regulation**): evaluates the ability to support and monitor the care concerning the feeling coming from the body and expresses the third dimension; Emotional awareness (**Emotional Awareness**): concerns the awareness of the connection between emotional states and bodily sensations. It expresses the fourth dimension; Auto(**Self-Regulation**): ability to regulate psychological stress through attention to bodily sensations. It expresses the fourth dimension; Listening to the body (**Body Listening**): evaluating the ability to actively listen to the body intuitively. It expresses the fourth dimension; Trust (**Trusting**): Consider the experience of one's body as a safe and reliable. It expresses the fifth dimension.

Cronbach's Alpha for all subjects = .909 (MBSR group =.900 Control group =.920)

The questionnaire FFMQ is a 39-item 5-point Likert scale psychological assessment of mindfulness, including five subscales: Observe, Describe, Acting with awareness, Non-judging of inner experience, and Non-reactivity to inner experience (Baer et al. 2006; Baer et al. 2008). Subscales of the FFMQ can be characterized as follows: **non-reactivity** to inner experience (e.g, through the item

"I watch my feelings without getting lost in them"); **observe** (or notice) sensations, perceptions, thoughts, and feelings in the present moment (e.g., through the item "When I am walking, I deliberately notice the sensations of my body moving"); **acting with awareness** (e.g., through the item "I find myself doing things without paying attention"); describe (or label) with words emotional or affective experiences in the present moment (such as with the item "I am good at finding words that describe my feelings"); and **non-judging** of internal experience in the present (e.g., with the item "I criticize myself for having irrational or inappropriate emotions").

## **Procedure**

Each participant should complete two experimental sessions, one before and one immediately after the MBSR training period of eight weeks. The experimental sessions for both groups followed the same procedure.

At the beginning of each experimental session, participants filled out both the FFMQ and the MAIA questionnaires. We administered the two questionnaires before and after the training (or to an equivalent time interval in the group of control) to verify training effectiveness (FFMQ) and any changes in the interoceptive perception of the body (MAIA).

Afterwards, participants completed the HBD task to measure the interoceptive sensitivity before and after the training and to record also the HRV baseline. To measure the interoceptive awareness was chosen a test of detection of one's heartbeat, which has a good test-retest reliability and which is widely used for this purpose, fully correlating with other heart rate detection techniques and that produces an index of interoceptive sensitivity. In the task of heart beat detection were measured four time intervals: 25 seconds, 35 seconds, 45 seconds to 100 seconds, in accordance with the method described by R.Schandry (Mental Tracking Method, 1981). The interoceptive sensitivity was calculated as the

average score among the four perceptual intervals in which they were detected and recorded heartbeats, according to the following formula:

$$1/4 \sum (1 - (|\text{heartbeats recorded} - \text{heartbeats reported}|) / \text{registered heartbeats})$$

According to this formula, the interoceptive sensitivity score can vary between 0 and 1, with higher scores indicating minor differences between the large number of heartbeats recorded and the one set (thus a higher interoceptive sensitivity).

### 4.3. Results

**TABLE 1. Descriptive statistics of dependent variables FFMQ scale**

	<i>DV</i>	<b>Before training</b>		<b>After training</b>	
		<b>Mean</b>	<b>SD</b>	<b>Mean</b>	<b>SD</b>
<b>MBSR group</b>	<i>Observe</i>	28.31	2.91	32.13	3.87
	<i>Describe</i>	30.25	4.59	31.69	4.60
	<i>Acting with awareness</i>	24.63	4.71	26.56	4.912
	<i>Nonjudge</i>	25.94	4.52	30.56	4.33
	<i>Nonreact</i>	21.06	4.86	24.81	3.54
	<i>FFMQ Tot</i>	120.50	34.037	145.75	11.914
<b>Control group</b>	<i>Observe</i>	26.94	5.81	26.82	4.26
	<i>Describe</i>	26.39	5.65	29.00	5.45
	<i>Acting with awareness</i>	26.00	5.05	27.06	5.66
	<i>Nonjudge</i>	24.94	4.92	28.24	6.05
	<i>Nonreact</i>	21.50	5.33	22.06	4.11
	<i>FFMQ Tot</i>	125.41	23.284	133.18	19.698

**TABLE 2. Descriptive statistics of dependent variables MAIA scale**

	<i>DV</i>	<i>Before training</i>		<i>After training</i>	
		Mean	SD	Mean	SD
MBSR group	<i>Noticing</i>	3.48	.722	3.91	.523
	<i>No Distraction</i>	1.96	.730	2.00	.559
	<i>No Worry</i>	1.94	.474	3.04	.437
	<i>Attention Regulation</i>	3.13	.738	3.60	.365
	<i>Emotional Awareness</i>	3.85	.781	4.13	.602
	<i>Self Regulation</i>	3.11	.780	3.81	.649
	<i>Body Listening</i>	2.77	.641	3.35	.784
	<i>Trust</i>	2.79	.797	3.81	.973
	Control group	<i>Noticing</i>	3.54	.763	3.25
<i>No Distraction</i>		1.93	.730	1.76	.798
<i>No Worry</i>		1.93	.372	2.00	.741
<i>Attention Regulation</i>		2.94	.597	2.79	.881
<i>Emotional Awareness</i>		3.79	.880	3.36	1.22
<i>Self Regulation</i>		3.17	.485	2.88	.904
<i>Body Listening</i>		2.83	.916	2.76	.934
<i>Trust</i>		2.67	1.017	2.87	1.178

**TABLE 4. Descriptive statistics of dependent variables HBD task**

	<i>DV</i>	Before training		After training	
		Mean	SD	Mean	SD
MBSR group	<i>Interoceptive Sensitivity</i>	.546	.237	.582	.256
Control group	<i>Interoceptive Sensitivity</i>	.587	.225	.541	.243

All analysis reported were conducted with the SPSS 21.0 Social Science Statistical Package for Windows (SPSS Inc. Chicago, Illinois, USA). First, we compared the two groups for each dependent variables as measured at the first time (pre) by means of t-tests for independent samples, to verify that the two groups did not differ for any of these variables before the intervention. We found no significant difference between the two groups.

For each measures, we conducted a 2x2 repeated measures mixed ANOVA with group(MBSR vs control) as between factor and time (before and after) as within factor. For each dependent variable, we reported the main effects as well as the interaction effect, and, if the interaction existed, then a post-hoc analysis comparing the different levels. Table 5 reported all the effects founded for each dependent variable.

As reported in the table, the only FFMQ scale that showed a significant interaction effect was the observe,  $F(1,32)=6.700, p=.015$ . In particular, this indicated that the MBSR group incremented the observe score, from 28.31 to 32.13 respectively before and after the training, while the control group did not show any increasing between the two times, respectively 26.76 and 26.82. We also find a significant main effect of time for observe, describe, acting with awareness and non judge scales (please refer to the Table 5 for all statistical values).



Interestingly, we found no significant main effects nor interaction effect for the interoceptive sensibility ability, all  $p > .223$ . However, we found significant interaction effect for four out of the eight scales of the MAIA. In particular, we found significant interaction for the scales No worryng,  $F(1,32)=16.793$   $p < .001$  Alfa Cronbach .775, Emotional awareness,  $F(1,32)=4.656$   $p = .039$  Alfa Cronbach .889, Self regulation,  $F(1,32)=11.447$   $p = .002$  Alfa Cronbach .651, and Trusting,  $F(1,32)=4.856$   $p = .032$  Alpha Crombach .928. For all these scales, the experimental group scored significantly higher after the training whereas the control group did not show any increased values (see Table 2 for comparing the mean values of the two groups before and after the training/waiting period). Post hoc comparisons were conducted by means of t-tests comparing within each groups the measures from the first and the second phases. The t-tests revealed that the MBSR group significantly increased in Oserve (pre=28.31, post= 32.13),  $t = -4.111$ ,  $p = .001$ , whereas the control group did not show any difference (pre=26.76, post=26.82),  $t = -.053$ ,  $p = .958$ .

For the MAIA scales, the t-tests revealed that the MBSR group significantly increased in No Worrying (pre=1.94, post=3.04),  $t = -5.559$ ,  $p = .000$ , whereas the control group did not show any difference (pre=1.93, post=2.00),  $t = -.466$ ,  $p = .647$ . For the scale Self Regulation the MBSR group significantly increased (pre=3.11, post=3.81),  $t = -3.318$ ,  $p = .005$ , whereas the control group did not show any difference (pre=3.17, post=2.88),  $t = 1.434$ ,  $p = .170$ . For the scale Emotional Awareness the MBSR group increased (pre=3.85, post=4.13),  $t = -1.530$ ,  $p = .147$ , whereas the control group did not show any difference (pre=3.79, post=3.36),  $t = 1.636$ ,  $p = .120$ . For the scale Trusting the MBSR group significantly increased (pre=2.79, post=3.81),  $t = -3.744$ ,  $p = .002$ , whereas the control group did not show any difference (pre=2.67, post=2.87),  $t = -.802$ ,  $p = .434$

**Table 5. ANOVA results for all FFMQ variables in Study 1.**

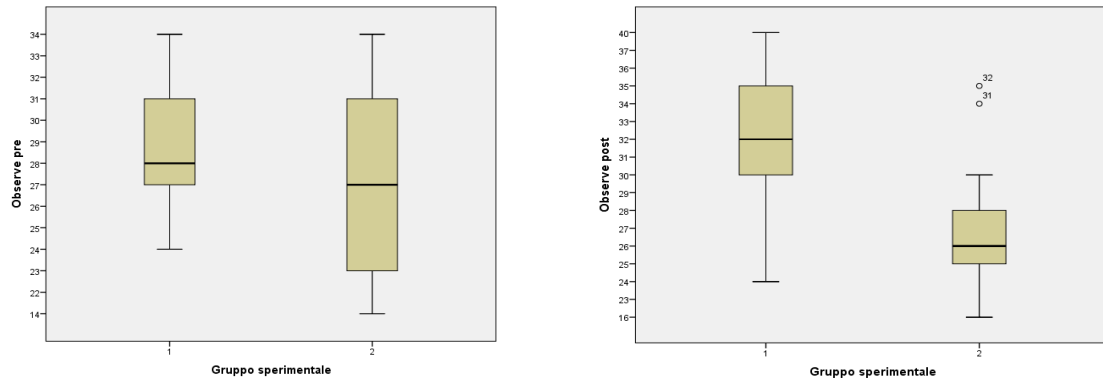
<i>DV</i>	<i>Effect</i>	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>p</i>
<b>Observe</b>	Group	1	193.336	193.336	7.454	<i>.010*</i>
	Time	1	61.765	61.765	7.126	<i>.012*</i>
	Group*Time1		58.068	58.068	6.700	<i>.015*</i>
<b>Describe</b>	Group	1	160.039	160.039	3.836	<i>.059</i>
	Time	1	57.388	57.388	5.379	<i>.027*</i>
	Group*Time1		3.024	3.024	0.283	<i>.598</i>
<b>Acting with awareness</b>	Group	1	12.674	12.674	0.320	<i>.576</i>
	Time	1	39.963	39.963	3.024	<i>.092</i>
	Group*Time1		2.387	2.387	0.181	<i>.674</i>
<b>Non judge</b>	Group	1	50.485	50.485	1.493	<i>.231</i>
	Time	1	270.098	270.098	15.769	<i>.001*</i>
	Group*Time1		5.492	5.492	0.321	<i>.575</i>
<b>Non react</b>	Group	1	26.214	26.214	0.910	<i>.347</i>
	Time	1	84.001	84.001	6.626	<i>.015*</i>
	Group*Time1		36.728	36.728	2.897	<i>.099</i>

*Note. DV = dependent variable.*

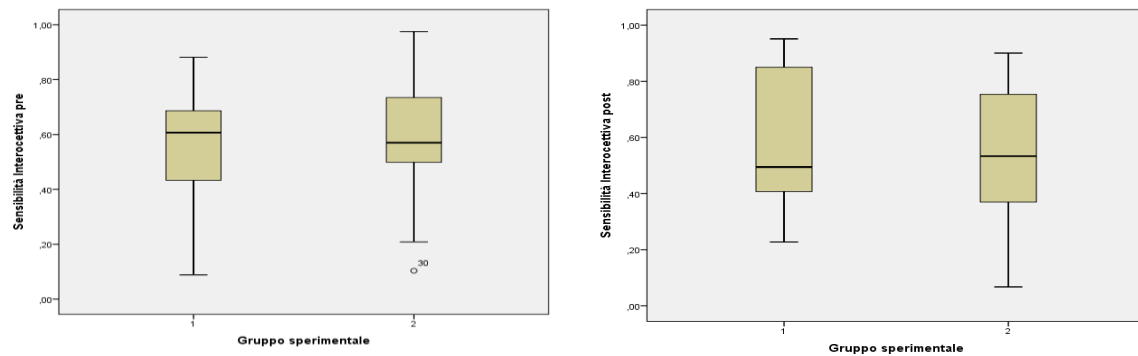
*Significant p values are marked with italic font and \* Trend are marked with italic font*

## Fig.1- Results

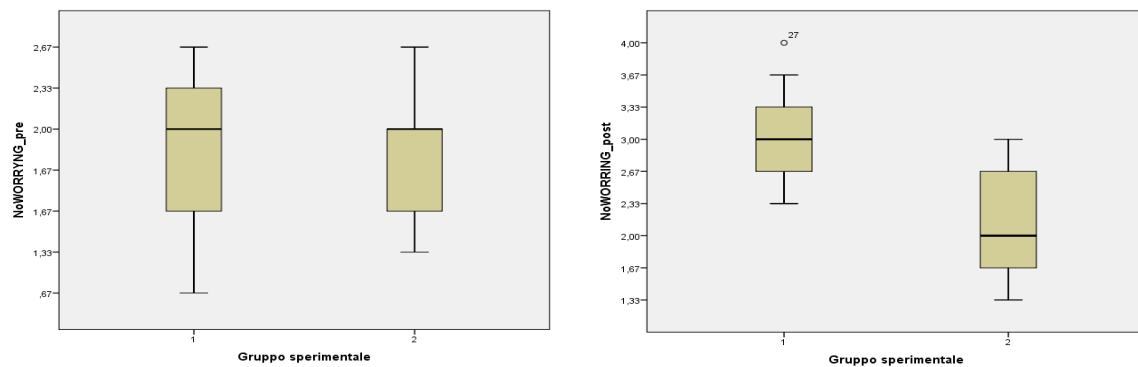
FFMQ- Observe scale Obs\*Group  $F(1.31)=6.700$   $p= .015$



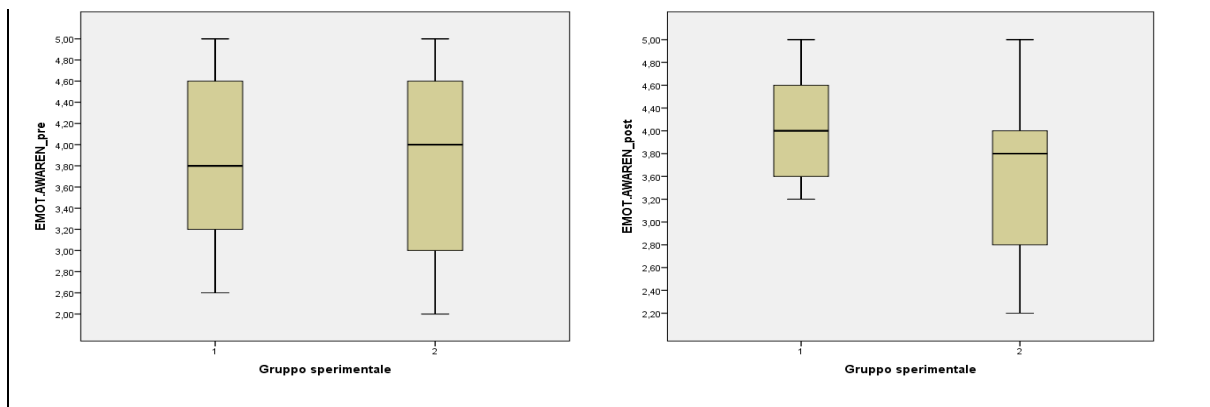
HBD- Interoceptive Sensitivity scale IS\*Group  $F(1.32)=1.542$   $p= >.05$ .



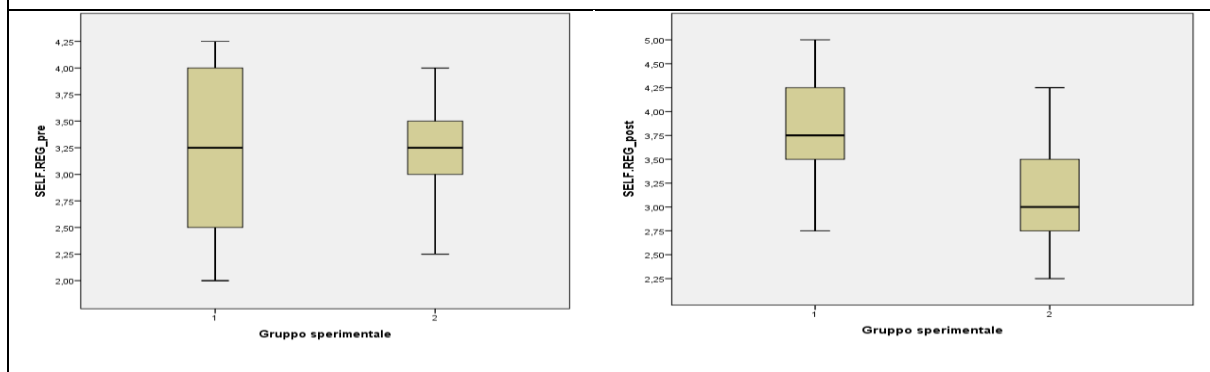
MAIA -No Worrying scale NoWorr\*Group  $F(1.32)=16.793$   $p= .001$  Alfa Cronbach .775



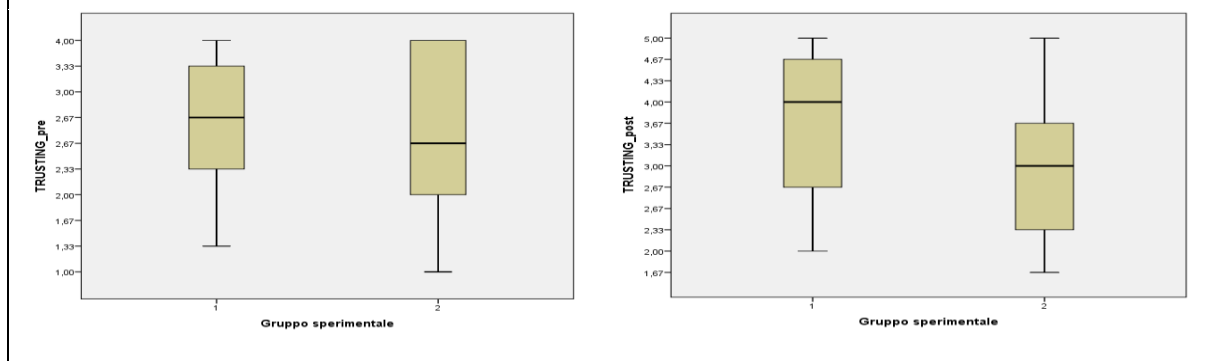
MAIA-Emotional Awareness scale EmAwar\*Group  $F(1,32)=4.656$   $p=.039$  Alfa Cronbach .889



MAIA-Self Regulation scale SelfReg\*Group  $F(1,32)=11.447$   $p=.002$  Alfa Cronbach .651



MAIA-Trusting scale Trust\*Group  $F(1,32)=4.856$   $p=.032$  Alfa Cronbach .928



## 4.4. Discussion

From this first study are emerging some interesting results.

The first is that the result of several other studies is confirmed, namely that an MBSR training does not affect the Interoceptive Sensitivity of the participants, when this is measured with HBD task. It is not clear from the study whether this depends on the type of perception measured, or whether this result is not to be

considered a possible effect of the MBSR training. In fact, the training consists of many components that make it difficult to understand what is, in different occasion, the one responsible for the effect. But certainly there is no training of listening to your heartbeat, whose mastery is not sought during the MBSR. In future studies it might be interesting to repeat a similar study in which to measure the interoceptive sensitivity of another type of perception, such as the respiratory or tactile body, which are already directly part of an MBSR training. Regarding the analysis of the interaction of the training with the interoceptive sensitivity detected with the MAIA questionnaire, all the MAIA scales were used in the 2 experimental phases in the interaction with the training.

The significant results concern the scales of No Worrying, Emotional Awareness, Self regulation and Trusting.

These results demonstrate that the Interoceptive Sensitivity, measured differently than in the task of HBD task appears to be positively modulated by the MBSR training and opens the way for further studies.

In fact, in addition to increasing the sample size which can be useful for the purposes of statistical power, it seems important in the future to balance the two experimental groups also according to some dimensions of interoception measured before the experimental phase through self-administrated questionnaires. In fact, greater accuracy in this way could make to bring out more forcefully the results that will surely suffer from a very high-subjective variability, emotional components being more difficult to be measured relative to other cognitive components, such as attention.

The problem of the great intersubjective variability appeared evident in the case of the parameters of cardiac variability, which is precisely one of the main reason for wich did not seem to respond to the training.

At the same time this fact is the main motivation that led me to deepen the study of HRV, in order to verify the desired change in MBSR training.

In fact, self-administered questionnaires can be strongly affected by individual cognitive biases, as shown by the poor response that the FFMQ questionnaire, which measures cognitive dimensions. In fact only the Observe scale was sensitive to treatment, unlike the MAIA questionnaire, which measures body perception dimensions, and in which the response to the training was significant for 5 out of 8 scales.

## Chapter 5

### 5. A study on Mindfulness Based Stress Reduction and Heart Rate Variability

#### 5.1. Introduction

After the first study, it seemed crucial to me to compare the interaction between physiological parameters and conscious reports of the meditative experience, to give strength to its understanding and its impact in the subjective experience. Since I had already detected the cardiac signal of the participants in order to be able to perform the HBD task, I decided to use the collected signal to detect resting heart variability, which was always collected before running the task, in both phases and experimental groups.

I measured the baseline heart rate variability (HRV) as an indicator of a more objective physiological regulation induced by training, in order to compare it later with the scales of the different self-administered questionnaires.

I considered SDNN as HRV indicator and I got a value which testifies to an increase in HRV in the experimental group compared to the control group. This finding suggests that a MBSR training may induce in the participants an increase in HRV, that although at the limits of significance, authorizes further investigations.

#### 5.2. Methods

##### Participants

I enrolled 34 people interested in participating in a MBSR training naïve to meditation (mean age = 36.29, SD = 11.34; F=31). Participation was advertised through the network of Sapienza University and through a newsletter sent to a mailing list of people interested in participating to psychological research.

Participant signed an informed consent before to be enrolled in the study. They were assigned then to one of two groups randomly, with 16 participants in the meditation (experimental) group (mean age = 36.69, SD = 8.42; F=16) and 18 participants in the control group (mean age = 35.94, SD = 13.64; F=15). While the first group attend the MBSR course, the second group did not participate to any activity during the same period, but they take a MBSR training afterwards (i.e. they are enrolled in a 'waiting list'). We conducted t-tests for independent samples for comparing the two groups in age, interoceptive sensitivity at baseline, and interoceptive capacity at baseline and we did not find any significant difference between them. Gender has a female predominance, with the presence only of 3 males in the control group.

I included in the analysis reported above only participants who attended to 6 out of 9 classes, reported a regular meditation experience at home, and complete all the experimental sessions.

## **Materials**

For this study I analyzed the cardiac signal previously collected in order to perform the HBD task.

## **Procedure**

### **Analysis**

The experiments were conducted in accordance with the Helsinki Declaration. The measurements were carried out in two separate phases, after about 2 months, corresponding to a pre-training (MBSR) and a post-training phase. The control group, which did not perform the mindfulness-based program, also performed both measurements.

All the participants during the first meeting received and signed the informed consent and obtained written information regarding the experimentation.



An electrocardiogram was obtained using Ag-AgCl electrodes placed on both wrists and an ankle. The signal was sampled at 500 Hz rate.

After completing the questionnaires and after applying the electrodes, the subjects were asked to normally breath and their heart rate variability baseline was detected for a period of 5 minutes.

The cardiac signal collected in this way was manually filtered to eliminate any artefacts, therefore different parameters were obtained from its analysis.

At the beginning I used a standard measures included in the time-domain method that "is the standard deviation of the NN interval (SDNN), i.e. the square root of variance. Since variance is mathematically equal to total power of spectral analysis, SDNN reflects all the cyclic components responsible for variability in the period of recording".(Marek, 1996)

Then I considered SDNN as indicator of cardiac variability and made a multivariate Anova to verify the incidence of the experimental group. The difference of the two groups in the SDNN gave a significance of .089.

Then I verified the extreme variability of the SDNN parameter in the first phase, included among the parameters of the subjects with lower and higher HRV which goes from 20.253 to 121.738 respectively.

Then I repeated the analysis of the variance, this time doing a univariate analysis and inserting the post SDNN as a dependent variable, the group to which each subject belong as an independent variable, and the SDNN pre as covariate, in order to eliminate the incidence of variability in the sensitivity to training.

All analysis were conducted with the SPSS 21.0 Social Science Statistical Package for Windows (SPSS Inc. Chicago, Illinois, USA).

### 5.3. Results

**TABLE 3. Descriptive statistics of dependent variables HRV indexes**

	<i>DV</i>	Before training		After training	
		Mean	SD	Mean	SD
MBSR group	<i>Mean NN</i>	778.59	95.53	763.31	94.46
	<i>Average HRV</i>	78.20	10.02	79.67	9.26
	<i>SDNN</i>	57.08	28.31	50.35	20.69
	<i>SD of delta NN</i>	46.48	36.38	42.48	29.13
	<i>RMSSD</i>	46.42	36.33	42.43	29.09
	<i>LF</i>	994.25	830.16	799.26	710.45
	<i>HF</i>	1246.98	1823.70	837.83	1107.20
	<i>LF/HF</i>	2.17	2.43	1.89	1.9
	Control group	<i>Mean NN</i>	786.17	147.88	755.82
<i>Average HRV</i>		78.72	13.80	80.95	11.57
<i>SDNN</i>		61.68	24.06	80.39	54.47
<i>SD of delta NN</i>		57.70	39.09	84.27	87.38
<i>RMSSD</i>		57.62	39.04	84.15	87.38
<i>LF</i>		1449.34	1321.32	1796.34	2037.21
<i>HF</i>		1320.30	1261.30	4282.28	9503.75
<i>LF/HF</i>		1.76	1.60	1.49	1.40

For this study, we follow the same analysis method of the Study 1, by conducting a 2x2 repeated-measures mixed ANOVA for each dependent variable considered. In particular, for this study we focused on the HRV indexes computed from the cardiac activity recorded in the two groups before and after the training/waiting period. We found no significant main or interaction effects for any of the considered dependent variables, all  $p > .05$ .

Thus, we tried a different approach by conducting a one-way ANCOVA in which we included the effect of group as factor and the measure scores at pre-interval as covariate, so to correct the statistics for the first assessment. With this design, we found a trend toward significance for the interaction effect of the SDNN variable,  $F(1,32)=3.900, p=.057$ .

#### **5.4. Discussion**

These results together prove the effectiveness of MBSR training by explaining it in terms more based on the body, honest and impartial witness of our changing experiences and our ability to adapt.

In fact, the increased interoceptive capacity, found in the first study, although aimed at a greater awareness of the body is still mediated by the awareness of these processes.

This awareness could be polluted by expectations, even if, of course, one of the main objectives of the MBSR is precisely to eliminate them and to accept one's internal states whatever they are.

While at the opposite the body, that always keep the score, (B A van der Kolk, 1994) can tell his personal history of regulation and integration, even if this happened during only 2 months of training.

## Chapter 6

### 6. A study on the impact of an MBSR training on emotion regulation.

#### 6.1. Introduction

After the very encouraging value of the previous study, that testifies to a trend of increase in HRV in the experimental group compared to the control group, I decided to test if the change was due to emotional regulation due to training. I used a parameter index of vagally mediated inhibitory regulation of the resting heart rate variability (vmHRV), using it as a covariate in order to test the MAIA scales that have been shown to be sensitive to training and to repeat the same analysis with the DERS questionnaire scales.

I found a significant interaction effect of group  $\times$  time for the dependent variables MAIA scale no worrying and self regulation, and for the DT total DERS scale, with a strong trend toward a significant effect for the DDD DERS scale (difficulty in distraction), and for the DERS DRA scale (difficulty in self-regulation). All these results are correspondence of the self-regulation ability induced by the MBSR training.

#### 6.2. Methods

##### Participants

I enrolled 34 people interested in participating in a MBSR training naïve to meditation (mean age = 36.29, SD = 11.34; F=31). Participation was advertised through the network of Sapienza University and through a newsletter sent to a mailing list of people interested in participating to psychological research. Participant signed an informed consent before to be enrolled in the study. They were assigned then to one of two groups randomly, with 16 participants in the meditation (experimental) group (mean age = 36.69, SD = 8.42; F=16) and 18 participants in the control group (mean age = 35.94, SD = 13.64; F=15). While the

first group attend the MBSR course, the second group did not participate to any activity during the same period, but they take a MBSR training afterwards (i.e. they are enrolled in a 'waiting list'). We conducted t-tests for independent samples for comparing the two groups in age, interoceptive sensitivity at baseline, and interoceptive capacity at baseline and we did not find any significant difference between them. Gender has a female predominance, with the presence only of 3 males in the control group.

I included in the analysis reported above only participants who attended to 6 out of 9 classes, reported a regular meditation experience at home, and complete all the experimental sessions.

## **Materials**

For this study I analyzed the previously collected cardiac signal. In addition to the questionnaire MAIA previously described, to measures larger areas of body perception, I analyzed the results of the questionnaire DERS a recognized measure of emotional regulation skills.

The questionnaire DERS (Gratz e Roemer, 2004) in its original version consists of 36 multi-choice items that measure characteristic patterns of individual emotions regulation. It contains six scales: (1) NON ACCEPTANCE (not acceptance of emotional responses) reflect the tendency to experience negative secondary emotions in response to one's negative emotions, or to have non-acceptance reactions to one's discomfort, (2 ) GOALS (difficulty in adopting goal-oriented behaviors) reflect difficulties in concentrating and performing a task when experiencing negative emotions, (3) IMPULSE (ie difficulty in impulse control) difficulty in maintaining control of one's behavior when one experiences negative emotions, (4) AWARENESS (lack of emotional awareness) tendency to pay attention to emotions and their ability to recognize them, (5) STRATEGIES (limited access to strategies of emotional regulation) belief that it is particularly difficult to regulate emotions effectively once they are felt, (6) CLARITY (lack of

emotional clarity) reflect the degree to which people can distinctly understand what emotion they are experiencing.

I used here the translated version adapted to the Italian population, (Sighinolfi, Pala, Chiri, Marchetti, & Sica, 2010), that also consists of 36 multi-choice items that measure characteristic patterns of individual emotions regulation, and in which the six final factors largely reflect the conceptualization of emotional regulation suggested by Gratz and Roemer (2004). They are:

Lack of Acceptance of the Emotional Response, (**Mancanza di Accettazione, DMA**) tendency to experience negative emotions in response to a primary negative emotion, as well as the person's difficulties in accepting the negative emotion he experiences.

Difficulty to Distract from Emotion and Perform Alternate Behaviors (**Difficoltà nella Distrazione, DDD**) Difficulty completing one's work or concentrating when negative emotions are felt.

Lack of Confidence in Own Emotional Adjustment Skills (**Mancanza di Fiducia, DMF**) The level of trust of the person regarding the personal abilities to manage and modulate their negative emotions.

Difficulty in the Control of Behaviors (**Mancanza di Controllo, DMC**) difficulty in maintaining control over one's own behavior when one experiences negative emotions.

Difficulty in the Recognition of the Experienced Emotion (**Difficoltà nel Riconoscimento, DDR**) reflects the degree to which a person recognizes the emotion he is feeling.

Reduced self-awareness (**Ridotta Autoconsapevolezza, DRA**) the degree of attention and awareness given to one's emotional state.

The total DERS measure is maintained (**Ders Totale, DT**).

## Procedure

The parameter that is considered the most appropriate for measuring inhibitory regulatory action is HF, following the Guidelines (Marek, 1996)“ An understanding of the modulatory effects of neural mechanisms on the sinus node has been enhanced by spectral analysis of HRV. The efferent vagal activity is a major contributor to the HF component, as seen in clinical and experimental observations of autonomic manoeuvres such as electrical vagal stimulation, muscarinic receptor blockade, and vagotomy.” Even if they recommend to rely on this parameter, included in the frequency domains methods, only when measurements of cardiac activity are measured for 24 hours, I decided to understand the meaning of the SDNN variation by checking the correlation with HF. Since the correlation is very strong and it is also maintained in the post phase, I decided to assume that the variation of the SDNN parameter due to the training is caused by a greater vagally mediated inhibitory control.

Each participant should complete two experimental sessions, one before and one immediately after the MBSR training period of eight weeks. The experimental sessions for both groups followed the same procedure.

At the beginning of each experimental session, participants filled out both the MAIA and the DERS questionnaires. We administered the two questionnaires before and after the training (or to an equivalent time interval in the group of control) to verify any changes in the interoceptive perception of the body (MAIA) and the level of emotion regulation, measured with the DERS questionnaire.

I decided to test the MAIA scales that have been shown to be sensitive to training (see study 1) looking for an interaction with the HRV parameters that can tell how much of the increased interoceptive sensitivity is evidenced by increased inhibitory regulation.

In order to deepen the study of the emotional regulation induced by the MBSR training, I decided to repeat the same analysis with the DERS questionnaire scales,

which specifically measures different dimensions that all refers to the ability of self-regulate (see description above), even if it did not give significant results by performing repeated measures Anova analysis between the two experimental groups, and I have done the correlations in order to verify whether they are inverse correlation.

All analysis were conducted with the SPSS 21.0 Social Science Statistical Package for Windows (SPSS Inc. Chicago, Illinois, USA)

### **6.3. Results**

A Pearson's 2 tailed correlation was run to assess the relationship between HF and SDNN

There was a high positive correlation between:

HF pre and SDNN pre  $r(98) = .883$   $p < .005$

HF post and SDNN post  $r(98) = .879$   $p < .005$

I performed multivariate analysis of the MAIA scales in the interaction with the group, inserting as a covariate the value of HF in post phase. Results were reported in Table 7. While controlling for the HF parameters, I found a significant interaction effect of group x time for the dependent variables No Worrying,  $F(1.31) = 13.401$ ,  $p < .001$ , and Self Regulation,  $F(1.31) = 9.114$ ,  $p = .005$ , but no significant effects for the scales Emotional Awareness,  $F(1.31) = 2.386$ ,  $p > .05$ , and Body Listening,  $F(1.31) = 2.656$ ,  $p > .05$ .

Then, I conducted the same analysis for the DERS scales as for the MAIA scales, by using 2x2 repeated measures ANCOVA, with time (within) and group (between) factors and HF post as covariate. All the statistical data were reported in Table 7 but I reported here only dependent variables for which we found significant interaction effect. In fact, I found a significant interaction effect only for the DT total DERS scale,  $F(1.31) = 4.989$ ,  $p = .033$ , and a strong trend toward a significant effect for the DDD scale,  $F(1.31) = 3.491$ ,  $p = .071$ , and



for the DRA scale,  $F(1.31)=3.228$ ,  $p=.082$ .

Post hoc comparisons were conducted by means of t-tests comparing within each groups the measures from the first and the second phases. The t-tests revealed that the MBSR group diminished in DT (pre=75.56, post=74.75),  $t=.164$ ,  $p=.872$ , whereas the control group increased (pre=70.61, post=77.50),  $t= -1.136$ ,  $p=.272$ . For the scale DDD the MBSR group diminished (pre=14.81, post=13.75),  $t=.167$ ,  $p=.115$ . and the control group remained stable (pre=13.94, post=13.56),  $t=.390$ ,  $p=.701$ . For the DRA scale the MBSR group increased (pre=6.13, post=12.63),  $t= -3.375$ ,  $p=.004$  and the control group also increased (pre=5.67, post=16),  $t= -5.088$ ,  $p=.001$ )

TABLE 5. Descriptive statistics of dependent variables DERS scale					
	Scales	Before training		After training	
		Mean	SD	Mean	SD
MBSR group	<i>Ders Total</i>	75.56	18.875	74.75	18.947
	<i>DMA</i>	13.19	5.648	11.50	5.514
	<i>DDD</i>	14.81	3.885	13.00	4.590
	<i>DMF</i>	17,75	5.710	15.38	5.110
	<i>DMC</i>	13.56	5.609	11.81	3.920
	<i>DDR</i>	10.13	2.680	10.44	2.683
	<i>DRA</i>	6.13	1.708	12.63	8.090
Control group	<i>Ders Total</i>	70.61	15.443	77.50	28.847
	<i>DMA</i>	12.50	5.711	12.06	6.310
	<i>DDD</i>	13.94	3.489	13.56	4.853
	<i>DMF</i>	16,61	3.680	13.22	4.710
	<i>DMC</i>	11.28	3.102	11.22	4.570
	<i>DDR</i>	10.61	3.109	11.44	4.630
	<i>DRA</i>	5.67	1.715	16.00	9.242

Table 6-Correlations between HFpost and DERSpost scales								
HF_post		DT	DDD	DMA	DMF	DMC	DDR	DRA
	Correlazione di Pearson	-.399*	-.374*	-.213	-.408*	-.344*	-.385*	-.204
	Sig. (2-code)	.019	.029	.225	.017	.047	.024	.248
	N	34	34	34	34	34	34	34

**Table 7- Summary table comparing the results of Anova and Ancova to highlight the interaction of HF**

Scales	Anova	Ancova	
Ders Total	DT * Group F(1.32)= .938 P=>.05	DT*Group F(1.31)=4.989 p= .033*	DT*HF F(1.31)=18.660 p=.001*
Ders DMA	DMA * Group F(1.32)= .400 p=>.05	DMA*Group F(1.31)=2.757 p=>.05	DMA*HF F(1.31)=14.288 p=.001*
Ders DDD	DDD * Group F(1.32)= .936 p=>.05	DDD*Group F(1.31)=3.491 p= .071	DDD*HF F(1.31)=10.534 p=.003*
Ders DMF	DMF * Group F(1.32)= .222 p=>.05	DMF*Group F(1.31)=.028 p=>.05	DMF*HF F(1.31)=7.359 p=.011*
Ders DMC	DMC * Group F(1.32)= 1.190 p=>.05	DMC*Group F(1.31)=2.617 p=>.05	DMC*HF F(1.31)=4.251 p=.048*
Ders DDR	DDR * Group F(1.32)= .169 p=>.05	DDR*Group F(1.31)=1.893 p=>.05	DDR*HF F(1.31)=13.499 p=.001*
Ders DRA	DRA *Group F(1.32)= 1.851 p=>.05	DRA*Group F(1.31)=3.228 p= .082	DRA*HF F(1.31)=3.120 p=.087
MAIA Attention regulation	AttReg *Group F(1.32)= 3.500 p= .071	AttReg*Group F(1.31)=1.447 p=>.05	AttReg*HF F(1.31)=17.186 p=.001*
MAIA Noticing	Notic*Group F(1.32)= 3.585 p= .067	Notic*Group F(1.31)=1.423 p=>.05	Notic*HF F(1.31)=25.850 p=.001*
MAIA No Distraction	NoDistr *Group F(1.32)= .701 p= .021*	NoDistr*Group F(1.31)=0.13 p=>.05	NoDistr*HF F(1.31)=10.99 p=.002*
MAIA Non Worrying	NoWorr *Group F(1.32)= 16.793 p=.001*	NoWorr*Group F(1.31)=13.401 p= .001*	NoWorr*HF F(1.31)=3.937 p=.056*
MAIA Emotional Awareness	EmAwar*Group F(1.32)= 4.656 p= .039*	EmAwar*Group F(1.31)=2.386 P=>.05	EmAwar*HF F(1.31)=34.749 p=.001*
MAIA Self Regulation	SelfReg *Group F(1.32)= 11.447p= .002*	SelfReg*Group F(1.31)=9.114 p= .005*	SelfReg*HF F(1.31)=18.576 p=.001*
MAIA Body Listening	BodyList *Group F(1.32)= 3.390p= .075	BodyList*Group F(1.31)=1.389 p=>.005	BodyList*HF F(1.31)=15.743 p=.001*
MAIA Trusting	Trust *Group F(1.32)= 4.856p= .032*	Trust*Group F(1.31)=2.656 p=>.005	Trust*HF F(1.31)=10.939 p=.002*

## 6.4. Discussion

All these results are correspondence of the self-regulation ability induced by the MBSR training which is expressed by the HF or SDNN parameter, as evidenced by the correlation between these two parameters, among which HF is the cardiac index that reflects in a cleaner way the activity of the parasympathetic system, therefore regulatory through the inhibition, as index of inhibitory activity mediated by the vagus.

The correlations between scales of the MAIA post are all significant with SDNN post, but not pre.

Conversely, the scales of the MAIA pre do not correlate with the parameters, either in pre or post.

This could mean that the variation in the regulation that corresponds to changes in HRV, correlates with the interoceptive sensitivity meant by MAIA, and also with an acquired greater interoceptive awareness, that allows the participant to respond to the questionnaire by more accurately describing one's bodily feeling and increased capacity for inhibitory regulation.

The scales that show significant changes mediated from HF, are Non Worrying and Self Regulation and both testify the greater ability in self regulation and ultimately the inhibitory regulation induced by the MBSR training, which correlates with the variation of HRV.

Results confirmed that higher self-reported difficulties in emotion regulation were negatively associated with resting vmHRV (Visted et al., 2017).

In regard to the observation of the results in the DERS scales, we can see that they do not seem to be affected by the effects of training, as evidenced by the analyzes of variance that do not give any significance.

On the contrary, we note some interesting results if we insert the HF parameter of cardiac variability as a covariate. The Total Ders scale that changes significantly using HF parameter as covariate, in studies for associations with psychopathology

measures (Sighinolfi et al., 2010) is positively correlated with negative affectivity and coherently negatively correlated with positive affectivity. Although further evidence is appropriate, it seems that high scores at DERS are associated with both general emotional instability and the difficulty in experiencing positive emotional states. Trait anxiety is also related to the total DERS score and in particular to the subscales Difficulty in Self Awareness (DRA) and Difficulty in Distraction (DDD). This indicates that high levels of anxiety could be characterized by a greater difficulty in the management of attentional resources and consequently of cognitive activity. According to Wells (2002) it is precisely the reiteration of specific cognitive-attentive responses, that appears strongly associated with psychological suffering in general and with many anxiety disorders specifically. (Sighinolfi et al., 2010)

Thus, in this study we can see that anxiety and distraction induced by anxious states, are positively modulated through vague-mediated regulation, which is in turn induced by training.

## Chapter 7

### 7. Conclusions and perspectives

This work is part of the vast and initial field of study, which seeks to understand and to shed light on the mechanisms of functioning and effectiveness of mindfulness, in order to better apply the interventions in the therapeutic field. In particular, is highlighted the effectiveness of mindfulness skills in self-report with the capacity for emotional regulation, confirming other studies (Hill & Updegraff, 2012). In fact, it is well know that emotion regulatory strategies could be adaptive and maladaptive.

The two strategies of emotional regulation that seem to be adaptive in many different contexts are the re-evaluation and resolution of problems. The reappraisal process implies the generation of favorable or positive visions and interpretations concerning a situation perceived as stressful or negative, in order to reduce anguish (Gross, 1998).

According to various models that explain the production and maintenance of depression and anxiety (Beck, 1976; Clark, 1988; Salkovskis, 1998), maladaptive appraisal processes are considered central to the development of these disorders. As a consequence, cognitive-behavioral therapies for depression and anxiety are focused on teaching appraisal skills (Beck, Rush, Shaw, & Emery, 1979) in order to generate a different approach to reality and consequently self-esteem, self-efficacy and a greater perceived mastery.

Gross's model (1998) identifies in the revaluation a strategy of emotional regulation that implies positive emotional and physical responses to the stimuli that have produced the emotion, and it is in this direction that I wanted to deepen the study, since this strategy is a central goal objective of an MBSR training.

In fact, one of the main components of mindfulness, on which there is agreement between different studies, is the awareness of the present moment in a non-

judgmental way, maintaining an equanimous glance both towards positive and negative situations.(Lalot, Delplanque, & Sander, 2014) On the basis of this awareness, that takes place in a neutral space of suspension of judgment, it is possible to identify with greater clarity the elements that are producing our experiences. Emerging from this state, during the process of appraisal, it is therefore possible to give new, different labels to some of these components, from the point of view of new, possible perspectives and in a more adaptive manner, and thus facilitating the maintenance and increase of self-esteem and mastery. Self-esteem is associated with a sense of security and consequently a reduction in the sensitivity and severity of the response to threats. Preliminary results suggest a potential physiological connection between cardiac vagal tone and self-esteem, both of which work to provide protection against responding to threats and are affecting one another.(Martens, Greenberg, & Allen, 2008)

Self-esteem reserves mediate the response to threats, in a similar manner to the effect attributed to the vagus nerve, one of the primary nerves of the parasympathetic nervous system. It has been suggested that self-esteem and cardiac vagal tone are interconnected both as a trait and as a state especially in the male gender, by observing cardiac control and fluctuations of self-esteem during the day. (Schwerdtfeger & Scheel, 2012). This result, which point up a very subtle and difficult to grasp relationship, also reminds us of one of the limitations of this study, where the sample of subjects is almost entirely made up of the female gender.

To use a simple metaphor about the connection between appraisal and-self esteem, it can be said that, if I evaluate the glass half empty I will be a bit 'sadder, if I evaluate it instead half full I will be a little' happier, and of course, the most important object undergoing continuous evaluation is one's self. A very high risk, however, is that people tend to hide from themselves the emotions they experience, both the negative and the positive ones, when they are difficult to

manage for some reason, and these processes are heavily involved in the production of negative mental states. and psychopathology.

A fundamental limitation of the MAIA is that it is a self-assessment, which can be said of all the psychological self-assessment scales.(W. E. Mehling et al., 2012a)

One consequence is that it is largely able to capture intra-individual variability rather than inter-individual, since the respondents have almost no information on the awareness of other people's bodies; and obviously will report deviations from their own baseline. On the other hand, have the advantage that allow more easily a greater first-person assessment of sensitivity and interoceptive awareness, which covers not only sensitivity to bodily signals, but also regulatory aspects, beliefs, attitudes, thoughts and emotions related to perception. (W. Mehling, 2016)

Another limitation is that a questionnaire, if applied repeatedly, can lead to a new understanding of the underlying constructs and therefore can measure the effect of conceptual learning rather than an actual change in the considered dimension. (W. E. Mehling et al., 2012a)

And above all, interoception is a broad concept that continually seeks a precise definition, as it implicitly suggests integration of different kinds of sensory information, which are constituted by the physical responses in the body and related representation of the brain up to the metacognitive interoception, available to reflection and explicit awareness as well as to intuition, as happens for example in emotional experiences.

For all this reasons it seemed important to be able to detect not only the internal states consciously perceived by the participants of the two experimental groups, but also the physical and emotional states that accompany them, or rather that induce such awareness, through objective methods, different from self report questionnaires in which it is possible that the participants, even if unknowingly, wish to please the experimenter and try to nurture self-esteem and self-image desired and/or perceived as positive.



Although the studies reported here are based on the detection of HRV during neutral states of resting state, have nevertheless produced interesting results, and although it can be seen as a limit, is already relevant in itself. In fact, during the resting state it is testified a physiological tract, more stabile, and not a state, context-dependent, since at that time the participants are invited to remain in a neutral state of mind in the absence of environmental stimuli.

My purpose for future studies is to look for the same results also in stressful or emotional situations, where we could find more marked results which can be compared with a baseline emotional adjustment ability.

In any case, the change of a physiological index that identifies with a discrete precision a mental and psychological condition, is certainly more reliable than internal states detected with self-report questionnaires, which are affected as I said of the need to perceive oneself in a certain way. On the other hand, it is only through the questionnaires that we can explain in detail the mechanisms that make the MBSR training effective.

In fact, in the first study is the FFMQ questionnaire that allows us to identify the factor that has most developed during training, the Observe scale, on the basis of which we can also understand the discrepancy between the interoceptive sensitivity measured with HBD task (in this case it is the objective measure, since it is based on an activity that returns a discrete measure and is based on a physiological data collected separately) and the interoceptive sensitivity measured with the MAIA questionnaire.

One of the strengths of the MAIA tool is its multidimensionality, that permits to improve our understanding of the mechanisms of psychosomatic action for a variety of mind-body interventions. While other tools were not able to distinguish between beneficial and maladaptive aspects of the body's interoceptive awareness, the new scales allow a more differentiated assessment of the essential psychological aspects of the perception and assessment of bodily sensations. In

fact, if the factor most developed during the training is the ability to observe, this is clearly based on what is observed during the usual meditations of the MBSR, namely the body with its sensations during body scan and walk meditation, and in particular those induced by the breath during the meditation that observes the breath. The capacity of observation induced by the training is often generalized in the participants, who in daily situations more ecological than the MBSR setting, are more aware of the body experiences, for example taking a shower or during a meal. Since at the opposite during the MBSR training the perception of heartbeat is never emphasized, it seems likely that the task of interoceptive awareness based on this cannot witness any improvement.

On the opposite, when the interoceptive awareness is investigated with the Maia questionnaire that investigates body dimensions, we see that the participants are able to transfer the capacity of observation acquired from the training to the corporeal world of perceived sensations, without needs to reference to thoughts and mental states.

We know that an increase in HRV in its vagal component is an index of emotional regulation, so the interactions that emerge between the MAIA scales that have been positively affected by the training and the indexes linked to the vagally mediated inhibitory component, can explain this greater interoceptive awareness with a greater capacity for emotional regulation.

In fact it is not a result of a dispositional correlation, if that were the case it should also emerge in the control group and before participating in the training. The MAIA scales that show significant changes mediated from HF, are Non Worrying and Self Regulation and both testify the improved ability in the emotion regulation that allows greater accuracy in the compilation of the questionnaire, that is in a greater interoceptive sensitivity.

Not-Worryng involves converting emotional stress or worry into feelings of pain or discomfort, part of the appraisal process. This scale expresses the second

dimension of the questionnaire, attentive response to sensations and to emotional reaction, which include attentive response to a sensation, avoid judging the perception of sensations, a narrative awareness that analyzes sensations, and conscious and non-judgmental presence.

Self-Regulation describes the ability to regulate psychological stress through attention to bodily sensations, expressing the fourth dimension, confidence towards bodily sensations, concerning the importance that the subject attributes to his feelings in decision making or supporting own health and wellbeing.

Adding to the results obtained with the variations of the Maia scales those obtained with the DERS scales, it is possible to find confirmations to these observations.

In fact, the negative correlation between the dimensions of difficulty in the emotional regulation of DERS and resting vmHRV, which is also confirmed in this study, has already been demonstrated in several studies (Visted et al., 2017). In particular, continuing what emerged in the previous discussion, the most interesting results seem to me to be those that seem to indicate the impact of the training, testified by the variation in the DT scale and by the tendency of the DDD scale in the direction of the capacity, acquired by the participants, in autonomously regulating their anxious states with a consequent improvement in self awareness and an increased capacity not to be distracted.

These skills in the DERS questionnaire are expressed in a functional way, to the ability to maintain decentralization and be focused on strategies of emotional regulation, and this is in fact evidenced by the negative correlation with cardiac parameters, linked to the inhibitory regulation. This trend, highlighted by this work, is affected by the limit of the small number of participants almost entirely female, and certainly in future studies are limits that can be overcome quite easily. On the other hand, with further opportune studies, it could be investigated whether this improved self-regulation capacity can be generalized in more

ecological contexts, for example in attention and concentration tasks that also allow to separate the additional stress induced by the test itself.

A curiosity, which derives from my practice as an MBSR instructor, is to understand the incidence over time of the skills acquired during the training, which has a duration of only 2 months. In fact, a problem reported by many participants during follow-up meetings, is the loss of the habit of a daily meditative practice, as it is required during the training. So a further interesting object of study that can stem from this one, is the verification of the maintenance over time of this state of greater capacity for emotional regulation, with further collection of physiological data (HRV) delayed in time. These skills could be modulated by everyday practice if and how much was maintained after training, and other acquired factors such as cognitive decentralization capacity and a greater capacity for cognitive re-evaluation of adverse events and negative mental states, demonstrating of an interaction between thoughts and bodily states reshaped in a more stable and secure way.

## Chapter 8

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## Index

<b>Introduction- Unifing body and mind with awareness</b> .....	Pag.1
<b>Chapter 1 - Interoceptive awareness</b> .....	Pag.7
Definition and characteristics of interoceptive awareness .....	Pag.7
Interoception-The self from the body .....	Pag.9
Measurement of interoceptive awareness .....	Pag.12
The measure of Interoceptive Sensitivity: Heartbeat Detection Task .....	Pag.12
The measure of Interoceptive Sensitivity: the questionnaire Maia .....	Pag.12
The relationship between Interoception and mindfulness .....	Pag.16
<b>Chapter 2 - Heart rate variability</b> .....	Pag.17
Definition and characteristics of heart rate variability .....	Pag.17
Measurement of heart rate variability .....	Pag.18
HRV parameters .....	Pag.18
Heart rate variability and emotion regulation .....	Pag.19
Polivagal theory .....	Pag.20
Neurovisceral Integration Model (NIM) .....	Pag.24
A measure of Difficulties in the Emotion Regulation .....	Pag.26
<b>Chapter 3 - Mindfulness: from Buddhism to secular programs</b> .....	Pag.30
Mindfulness in Buddhism .....	Pag.30
Defining and measuring mindfulness .....	Pag.30
Defining mindfulness .....	Pag.30
Measuring mindfulness .....	Pag.31
Mindfulness based programs .....	Pag.32
Mindfulness Based Stress Reduction (MBSR) .....	Pag.33
Mindfulness Based Cognitive Therapy (MBCT) .....	Pag.35
Other mindfulness based programs .....	Pag.36
<b>Chapter 4 - A study on Mindfulness Based Stress Reduction and Interoceptive Awareness</b> .....	Pag.38
Introduction .....	Pag.38
Methods .....	Pag.39
Results .....	Pag.42
Discussion .....	Pag.48
<b>Chapter 5 - A study on Mindfulness Based Stress Reduction and Heart Rate Variability</b> .....	Pag.51
Introduction .....	Pag.51
Methods .....	Pag.51
Results .....	Pag.54
Discussion .....	Pag.55
<b>Chapter 6- A study on the impact of an MBSR training on emotion regulation.....</b>	Pag.56
Introduction .....	Pag.56
Methods .....	Pag.56
Results .....	Pag.60
Discussion .....	Pag.64
<b>Chapter 7 – Conclusions and perspectives</b> .....	Pag.66
<b>Chapter 8 – References</b> .....	Pag.73