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Chapter 13

MOVEMENT-BASED STRATEGIES FOR EMOTION REGULATION

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ABSTRACT

The present chapter reviews various techniques for emotion regulation using voluntary changes in motor behavior. Emotion regulation is defined as a person's active attempt to manage his emotional state by enhancing or decreasing specific feelings, or by reducing stress, anxiety or depression. According to Damasio's somatic marker hypothesis, emotions are generated by conveying the current state of the body to the brain through interoceptive and proprioceptive afferent input. The resulting brain activation patterns represent unconscious emotions and correlate with subjective feelings. This proposition implies a corollary, that through deliberate control of motor behavior and its consequent proprioception and interoception, one could regulate his feelings. Thus, one of the strategies to achieve emotion regulation could be through voluntary changes to one's posture and movements. Different types of motor-behavior modifications contribute to emotion regulation based on different underlying mechanisms. *Quantitative* changes in motor behavior, i.e., increased movement intensity for a period of time, such as during aerobic exercise, produce metabolic processes, which generate a myriad of physiological changes (e.g., alterations in the levels of hormones, neurotransmitters, trophic factors, endocannabinoids and immune system function) that contribute to the reduction of stress, anxiety and depression. In addition, there is evidence to suggest that *qualitative* modifications of motor behavior such as engaging in specific facial expressions, postures and whole body movements which are associated with specific emotions, probably use a different mechanism to enhance the corresponding affect: a mechanism that is based on afferent (proprioceptive) input to the brain regarding the current state of the body's muscle activation pattern and joint configuration. Two other movement-based strategies for emotion regulation are progressive muscle relaxation, which reduces stress, and utilizing specific breathing patterns, which are capable of reducing stress and inducing differentiated emotional states.

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INTRODUCTION

One of life's great challenges is successful regulation of our emotions [1]. Emotion regulation plays a crucial role in adaptive functioning, and inability to effectively manage and regulate emotions has been associated with longer and more severe periods of distress that may evolve into depression or anxiety [2].In addition, models of eating disorders and alcohol abuse suggest that individuals with poorly regulated emotions often turn to food or alcohol to escape from, or down-regulate their emotions [3]. Thus, learning and adopting effective emotion regulation strategies is essential for good mental health. In recent years, many studies have investigated a variety of emotion regulation strategies, in order to determine which strategy works best under what circumstances and for which type of person. Many of these studies discussed strategies that involve attention and cognitive processes, such as attention-bias modification, thoughts suppression, mindfulness, acceptance, problem solving and reappraisal, but these leave out the persistent and major effects our body has on our emotional state. Thus, changing the body's state through motor behavior may be an important strategy for emotion regulation in conjunction with cognitive processes or on its own. Inasmuch as the emotion regulation literature relates to behavioral suppression of emotional expressions as maladaptive and a less effective strategy [4], the older literature less often presented constructive body-related strategies for emotion regulation. In this chapter, I will summarize evidence supporting the notion that one can effectively regulate emotions through voluntary control of motor behavior.

The term "emotion regulation" has been defined by James Gross, one of the leading researchers in this field, as the "processes by which individuals influence which emotions they have, when they have them, and how they experience and express these emotions" [1, 5]. Gross further differentiated between emotion regulation and other constructs related to it such as coping, mood regulation, mood repair, and affect regulation, and claimed that "affect regulation is superordinate to the other constructs which are closely related and have permeable boundaries between them" [5]. Thus, according to Gross, emotion regulation is one of the several major forms of affect regulation. While Gross's definition of the term "emotion regulation" is very precise and relatively restricted, some other researchers gave this term a wider meaning. For example, Koole in his review (2008) defined emotion regulation as "the set of processes whereby people seek to redirect the spontaneous flow of their emotions" and argued that although it is possible to distinguish semantically between emotion regulation and related constructs such as mood regulation, coping with stress, and affect regulation, these constructs' substantive overlap is considerable [6]. Thus, according to Koole, "At the heart of all emotional states is core affect [7], basic states of feeling good or bad, energized or enervated. The regulation of specific emotions, moods, stress, and diffuse affect is therefore always aimed at changing core affect. Moreover, the empirical borders between these different emotion constructs are very fuzzy [7]. In view of these considerations, it seems most productive to conceive of emotion regulation broadly, as relating to the management of all emotionally-charged states, including discrete emotions, mood, stress, and affect." [6]. In this chapter I will adopt Koole's broader approach to emotion regulation and will discuss the use of motor behavior for initiating changes to any emotionally-charged state.

Another important issue related to the definition of emotion regulation is the distinction between emotion regulation and emotion generation [8]. This distinction can be problematic at times, because there are cases in which one emotion-generative process apparently regulates another emotion-generative process. Some of the processes that will be discussed in this review belong to this category, where mood or affective state regulation is achieved through emotion generation processes. Thus, I chose to avoid getting into the distinction between emotion regulation and generation, and as long as the discussed processes can be activated to achieve the goal of regulating a general affective state, they will be included in this review.

Peripheral theories of emotion argue that the origins of emotional feelings stem from bodily responses. This notion which already was suggested in the 19th century by Darwin [9] and James [10], has been reformulated in neurophysiological terms by Damasio's somatic markers hypothesis. According to Damasio, the current state of the body is conveyed to the brain through the processes of proprioception (afferent input representing muscle length and joint angle) and interoception (afferent input representing physiological (e.g., thermal, metabolic) status of all body tissues), which create in the brain unique neural activation patterns. These neural activation patterns represent unconscious emotions that guide behavior and influence decisions, and they correlate with the conscious feelings of those emotions [11, 12]. The uncovering of neuronal underpinnings of interoception [13, 14] and the identification of anterior insular cortex as the brain region in which representation of internal bodily states becomes available to conscious awareness [15, 16], provide plausible neurocircuits in support of this hypothesis (see also [17]).

One important implication of Damasio's hypothesis is the potential to regulate one's feelings through deliberate control of motor behavior and its consequent proprioception [18] and interoception. By increasing quantitative aspects of motor behavior, that is, by increasing the intensity and duration of physical activity and muscular activation such as during aerobic exercise, one produces changes in autonomic system activation (e.g., increased heart rate) and in metabolic processes. These changes are transferred to the brain through interoception and generate a myriad of physiological responses (e.g., alterations in the levels of hormones, neurotransmitters, trophic factors, endocannabinoids and immune system function), which contribute to reduction of stress, anxiety and depression and to elevation of mood and positive affect. Conversely, there is evidence to suggest that proprioceptive input to the brain regarding the current state of the body's muscle activation pattern and joint configuration, might also influence one's emotional state. Thus, in addition to exercise, one can influence his affective state also through qualitative changes to his motor behavior. One can choose which body-parts to move and which muscles to contract, for particular postures, whole body movements, and facial expressions are associated with specific emotions. Additional well-known motor-behavior based strategies for emotion-regulation are muscle relaxation to reduce stress, and specific voluntary controlled breathing patterns, which are capable of reducing stress and inducing differentiated emotional states. While these latter strategies are probably based on voluntary modifications to autonomic system activation and vagal afferent discharge, which are transmitted to the brain through interoception [19], they also involve specific muscle activation patterns (of the muscles involved in breathing, or relaxation of all skeletal muscles in progressive muscle relaxation). Future research will have to determine the relative contribution of proprioception vs. interoception to the effect of these motor behaviors on affective state. In the following sections, I will summarize the evidence for each of these strategies for emotion regulation.

Effects of Exercise on Mood, Stress, Depression and Anxiety

Exercise has been long known for its mood-enhancing effects. Most of the early studies were performed with healthy subjects. They had numerous methodological limitations, and they did not provide a thorough explanation for the underlying mechanism. In recent years, however, there have been an increasing number of methodologically sound studies performed with various clinical populations, as well as animals' studies, which thoroughly investigated underlying mechanisms. Thus, several recent systematic reviews and meta-analyses have shown that for mild and moderate depression, exercise reduces depressive symptoms in both clinical and non-clinical populations [20-24]. Similarly, there are reviews which demonstrate anxiolytic effects of exercise in a variety of anxiety disorders: panic disorder, social anxiety disorder (SAD), general anxiety disorder (GAD), post-traumatic stress disorder (PTSD), and obsessive-compulsive disorder (OCD) [25, 26]. Recently, exercise has even been suggested as a base for treatment in substance use disorders [27]. As a result, exercise is now recommended more and more as a natural, healthy (no risk and no side effects), low-cost alternative or augmented intervention to medication or treatment as usual, for a series of mental conditions and disorders.

Studies have looked at different types of physical activity interventions, and although there are not yet definite guidelines regarding recommended exercise type, frequency, intensity and duration, it seems that both resistance training and aerobic exercise can be effective [28]. Some other types of exercise such as tai-chi [29], yoga and Qigong [30] have also been found to be effective, but as their practice involves relatively low energy expenditure, their effects are probably based more on other underlying mechanisms, such as proprioception (e.g., from opening the chest in Yoga, or keeping the back erect in yoga, tai-chi and Qigong), practice of specific breathing patterns, and mindfulness (they all have a meditative component and require being mindful to the movements performed) [20, 30, 31].

Several psychological and biological mechanisms have been proposed to explain the regulating effects of exercise. The suggested psychological mechanisms for alleviating depressive symptoms include social interaction (when the exercise is performed in a group or with a friend); increased self-efficacy that is intricately linked with self-esteem which, in turn, is considered to be one of the strongest predictors of overall subjective well-being [24]; and distraction and diversion from negative thoughts and ruminations [32]. Distraction from stressors and a "time out" from daily activities were also suggested as mechanisms for reducing anxiety [33]. Other suggested psychological mechanisms for the reduction of anxiety symptoms are an increased sense of mastery and the belief that one has the power to influence his environment and bring about the desired outcome [25]. A further mechanism may be the reduced sensitivity to (i.e., reduced catastrophic interpretation of) anxiety physiological symptoms, such as elevated heart rate and shortness of breath, which occurs by increasing exposure to these sensations during exercise [33].

The biological mechanisms are also numerous and include mechanisms for both the acute, short-term effects following an individual exercise session and the enduring effects of long-term habitual exercise (i.e., changes taking place in the brain as part of its adaptation to repeated/chronic exercise) [34, 35]. The immediate mood elevation or euphoria effects of exercise can be explained by the release, following a sustained physical exercise, of endogenous opioids in brain regions belonging to frontolimbic circuits, which are known to play a key role in emotional processing [36]. Other immediate analgesic, sedative, anxiolytic and euphoric effects might be explained by activation of the endocannabinoid system [37, 38].

Exercise is a stressor that causes increased cortisol secretion immediately after the increased physical activity. However, chronic exercise has effects of stress reduction and a preventative effect of reduced vulnerability to stress, which are produced by the down regulation of the hypothalamic-pituitary-adrenal axis and the sympathetic nervous system, caused by long-term regular exercise [39, 40]. These systems tend to become dysregulated as a function of chronic stress, and exercise has been found to reduce arousal and distress by normalizing the release of cortisol and catecholamines. Stress has also been found to acutely deplete brain levels of norepinephrine, and long-term exercise preserves or increases brain norepinephrine levels [34]. These mechanisms underlie also the effects of exercise on the reduction of depressive symptoms, as one of the mechanisms involved in depression is the hyperactivity of the hypothalamic-pituitary-adrenal axis, due to the increased release of cortisol and corticotropin-releasing factor, and another hypothesis regarding the mechanism underlying pathophysiology of depression involves abnormal activities of serotonin, dopamine and norepinephrine [41]. In relation to the effects of exercise on neurotransmitters, animal studies have shown that exercise influences central dopaminergic, noradrenergic and serotonergic activity, release and metabolism, and that exercising produces specific adaptations in basal neurotransmitters output in rat striatum [42]. Rethorst et al. (2009) and Dishman et al. (2006) list several additional mechanisms by which exercise reduces stress and depression symptoms through its effects on serotonin, such as small increases in basal levels of serotonin in the dorsal raphe nucleus, increased levels of 5-HT1A inhibitory autoreceptor mRNA in the dorsal raphe nucleus, increased turnover of serotonin in brain cortex, and more [21, 43].

Recent advances in cell biology and imaging have led to the notion that altered neurogenesis plays a role in the etiology and treatment of depression [44-46]. Research has supported the role of brain-derived neurotrophic factor (BDNF) in neurogenesis, mood disorder development, and antidepressant drug action. Other neurotrophic factor families also play a role, including insulin growth factor-I (IGF-I) [47]. Exercise has been shown to increase the levels of BDNF [48, 49], IGF-I [50], vascular endothelial growth factor (VEGF) [51], and several other growth factors [50], to promote neurogenesis [52], and to reduce depressive symptoms [53, 54]. Thus, it has been suggested that one of the mechanisms by which exercise may reduce depression is by contributing to adult hippocampal neurogenesis [53].

Several studies support the existence of reciprocal communication pathways between nervous, endocrine and immune systems, suggesting that inflammatory responses have an important role in the pathophysiology of depression [55-57]. Inflammatory response system activation and exogenous administration of pro-inflammatory cytokines may induce depressive symptoms [58]. Pro-inflammatory cytokines are potent activators of the HPA axis [59], increase 5-HT turnover and decrease 5-HT synthesis [57], and significant differences in plasma levels of IL-1, IL-6 [60, 61], and other cytokines were found in depressed compared to healthy subjects [62]. An increase in plasma concentrations of the pro-inflammatory cytokines IL-1 and IL-6 that was observed in depressed patients correlated with depression severity and with HPA axis hyperactivity [60, 61]. During exercise, IL-6 is produced by muscle fiber activation, and its level in circulating plasma increases in an exponential fashion, before declining in the post-exercise period [63]. IL-6 stimulates the appearance in circulation of the anti-inflammatory cytokines IL-10 and IL-1ra, which reduces the amount of the pro-inflammatory IL-1. Thus, similar to its effects on chronic disorders associated with systemic low-level inflammation [64], exercise may contribute to alleviation of depressive symptoms also by reducing the systemic low level inflammation associated with depression.

Another potential mechanism by which exercise might reduce depressive symptoms is through its stimulation of mitochondrial activity. There is growing evidence suggesting a link between impaired mitochondrial function and depressive-like behaviors in rodents, and exercise has been shown to increase the activity of brain mitochondrial complex I as well as to increase the expression of mitochondrial transcription factor A-Tfam [65].

Lastly, sleep disturbances have been found in stressful situations, depression and anxiety. Exercise improves sleep by enhancing physiological processes that promote sleep, such as depleting energy stores, breaking down tissue and elevating body temperature. By improving sleep quality and quantity, exercise reduces depressive symptoms and trait anxiety [25, 66, 67].

In summary, both acute and chronic exercise elicit physiological responses that through various mechanisms contribute to mood elevation, improve stress tolerance and increase resiliency [40].

EFFECTS OF QUALITATIVE MODIFICATION OF MOTOR BEHAVIOR ON AFFECTIVE STATE

Following Darwin's and James's ideas, several other theorists in the field of emotion have postulated that sensory feedback from facial and postural movements can cause an emotional experience [68, 69], and Laird proposed that such experience can be generated even by an experimenter-manipulated facial expression [70, 71]. The effects of facial expressions on corresponding affective states have been widely studied and demonstrated since then (for a review see [72]), and smiling is now regularly used in dialectical behavioral therapy as a behavioral intervention for mood regulation. Evidence suggesting that the effects of facial expressions on affective state are attained through proprioception comes from studies of mimicry and of botulin toxin treatment, which investigated the effects of the magnitude of muscle activation during facial expressions on brain activation and affective state. During voluntary mimicry, the facial expressions, that is the facial muscle activation and consequently the proprioceptive feedback from these muscles, are stronger compared to their activation during mere observation of facial expressions. Carr et al. (2003) demonstrated that mimicry, compared to just observation of facial expression, more strongly activated emotional processing regions in the brain [73], indicating potential connection between proprioception and emotional processing. Continuing on this line of thought, Lee et al. (2006) found that mimicry of emotional facial expressions but not of ingestive (chewing and licking) facial expressions, activated emotional processing regions in the brain, and the magnitude of facial movement during emotion-imitation predicted responses within the right insula [74]. Botulin toxin injection, which is used as a beauty treatment for reducing facial lines, induces a temporary muscle denervation by blocking the release of acetylcholine at the neuromuscular junction, and consequently reduces afferent, (i.e., proprioceptive) input to the brain from the injected area [75]. Davis et al. (2010) demonstrated that reduced muscle activation during facial expressions and the corresponding changes in proprioceptive feedback following botulin toxin treatment weakened emotional experience [76], and Hennenlotter et al. (2009) demonstrated attenuated neural activation in the amygdala during mimicry of angry facial expression following a Botulin toxin treatment [75].

Activation of specific muscles in other parts of the body has also been shown to affect attitude and general affective state: A handful of studies have shown that isometric arm flexion, which is associated with approach (e.g., bringing food towards one's mouth) and arm extension, which is associated with rejection and pushing away, affected evaluative cognitive processing. For example, Cacioppo et al. (1993) found that people liked neutral novel stimuli more when they saw these stimuli while flexing their arms than when they saw them while extending their arms [77]. Neumann and Fritz (2000) found that participants categorized positive words more quickly than negative words while flexing the arm and negative words more quickly than positive words while extending the arm [78]. Briñol and Petty (2003) found that during listening to a persuasive message, when the message arguments were strong, nodding (moving the head up and down as if saying "yes") produced more persuasion than shaking (moving the head from side to side, as if saying "no"). When the arguments were weak, the reverse occurred [79]. Forster (2004) explored the effects of object presentation on a screen, on consumer evaluation of well-known consumer goods. Pictures of the products were presented moving horizontally or vertically on a screen, thereby inducing either head-shaking or head-nodding movements. Induced nodding led to more favorable evaluations of positively-valenced products but did not affect the evaluation of negatively-valenced ones. Similarly, head-shaking led to more unfavorable evaluations of negatively-valenced products, but did not affect the evaluation of positive ones [80]. Lastly, Hung and Labroo (2011) demonstrated in a series of studies that firming one's muscles can help firm willpower and that firmed willpower mediates one's ability to withstand immediate pain, overcome food temptation, consume unpleasant medicines, and attend to immediately disturbing but essential information, provided that doing so is seen as providing long-term benefits [81].

A few other studies have shown that assuming certain postures (e.g., upright, slumped, expansive) immediately induces the corresponding feelings (pride, sadness, power, respectively) [82-85]. Huang et al. (2010) showed that when individuals were placed in high- or low-power roles while adopting an expansive or constricted posture, even though role had a stronger effect than posture on self-reported sense of power, only posture affected the implicit activation of power as measured by word-completing task, the taking of action, and abstraction in thoughts, which are the main outcomes associated with powerful behavior. Carney et al. (2010) further demonstrated that holding for only two minutes a posture that expresses power not only increased subjective feelings of power and powerful behavior, but also resulted in emotion-related physiological responses: reduced cortisol which is associated with stress reduction, and increased testosterone which is associated with increased feeling and expressions of dominance [82].

Duclos et al. (1989) demonstrated that adopting emotion specific facial expressions or body postures of fear, sadness and anger can increase feelings of these particular emotions, and not only feelings on the dimension of pleasantness-unpleasantness, and Flack et al. (1999) showed that assuming both posture and facial expression of anger, sadness, fear or happiness, produced stronger feelings of the corresponding emotion than did either posture or facial expression alone [83, 86]. These results, according to Flack, strengthened the suggestion that the mechanism for emotion generation involves bodily feedback, since "the simultaneous combination of multiple, consistent sources of expressive bodily feedback should result in greater magnitudes of emotional response than those caused by separate, individual sources". Whereas the studies described so far have examined effects of emotional expression on immediate emotional experience, Schnall and Laird (2003) have shown a more lasting influence: in their study, repeated holding of posture and facial expression of anger, sadness and happiness induced the corresponding emotion and feelings for up to 10 minutes after subjects stopped these behaviors, as was evident from their recall during this time, of more life events with an emotional content associated with the enhanced feelings than life events with an emotional content associated with other feelings [87].

In addition to facial expressions and postures, whole body movements also influenced affective state. Duclos and Laired (2001) demonstrated that sad whole body motor expressions, such as drooping one's shoulder, letting the head hang down, letting the body go limp, and sighing induced sadness, while angry motor expressions such as clenching the teeth and both fists, pounding or punching a pillow, forcefully throwing a pencil on a table and slamming a door, induced anger. Moreover, when sadness and anger were induced through recalling a relevant meaningful autobiographical memory, inhibition of the associated motor behaviors (by standing up straight with the head up as inhibition of the sad movements, and sitting down while relaxing all muscles as inhibition of the angry movements), attenuated the corresponding feelings [88]. Interestingly, Duclos and Laired found that people differ in their affective response to their motor behavior, based on their trait to be more responsive to personal cues or more responsive to external-situational cues. The expressive behavior was effective at inducing the target emotion (sadness or anger), only for participants who were more responsive to personal cues. Similar results were found also in Scnall and Laired's (2003) study in which the effects of posture and facial expressions on the corresponding feelings were stronger in people who were responsive to bodily personal cues, compared to people who were responsive to situational cues, who hardly showed such effects [87].

Shafir et al. (2013) demonstrated that about three minutes of motor execution of happy, sad, fearful or neutral movements enhanced the corresponding affective state. Moreover, for the sad and fearful movements, imagining oneself doing those movements or watching other people expressing sadness or fear through movements, also enhanced the corresponding emotion [89]. Such imagination and observation effects were not found for the happy movements probably only because the effects of imagination and observation were weaker than the effect of motor execution, and therefore were not strong enough to significantly increase happiness in healthy subjects who were most likely quite happy and content to begin with. The movements used in Shafir's study were taken from a set of video clips of whole body emotional expressions created by Atkinson [90]. This set included 10 different video clips for each emotion, where each video clip was comprised of a variety of movements. Thus, as opposed to facial expressions, in which all people activate the same muscles to produce a certain facial expression, when it comes to whole body expressions, different people, or even the same person on different occasions and under different circumstances, may express the same emotion in a variety of movements and actions, using a variety of body parts. This variety of motor choices available for elicitation or enhancement of each specific emotion raises the question: when it comes to the use of movement for emotion regulation, how can we determine, for each individual, the most effective and efficient movements for enhancing each emotion? A possible solution to this problem would be to identify the motor characteristics common to all movements that express a certain emotion, and to incorporate these qualities into one's personal movements when he aims to enhance that emotion, or to consciously avoid those qualities, when aiming to reduce the associated feelings. For example, if happy movements are characterized by expanded torso, some people could enhance happiness through practicing yoga postures aimed at opening the chest, while others could enhance happiness through stretching the arms and front upper body, etc. Conversely, if sad movements are characterized by holding the head down and closing/rounding the shoulders and chest, to avoid enhancing sadness, one should be aware of his posture and make sure that he sits erect and avoids rounded chest, while sitting in front of the computer or when watching TV on a soft sofa.

While there are not yet any published studies that examined the motor characteristics of movements that *enhance* each emotion, these motor qualities should be the same as those that characterize movements that *express* the same emotion. This suggestion is based on the idea that we perceive emotions from other people's expressive movements because we feel those emotions when we move similar movements. Indeed, the movements that were used in Shafir's (2003) study to enhance specific emotions were the same movements as those seen in Atknson's (2004) clips, which were validated as expressing those emotions. Several studies have tried to identify the characteristics of movements that express specific emotions. These were described in a recent paper by Kleinsmith and Bianchi-Berthouze [91]. To mention just the main motor qualities that were found to characterize the basic emotions: happy movements were characterized by quick/fast movements [92-98], vertical upward movements [90, 94, 99, 100] and expanding the torso and/or limbs [93, 97]. Sad movements were characterized by a contracted, shrinking posture [92, 93, 97], by a collapsed or slumped torso [101, 102], by slow movements [92-95, 97, 102, 103], and by keeping the arms close to the body [93, 94, 98, 102]. Anger was characterized by bending the head forward [104, 105], making fists [90, 106] and stretching the arms forward [90, 94, 101, 107], while fear was described by downward and backward movements [90, 94, 100, 108]. It will be the role of future research to demonstrate that any movement with those specific motor characteristics can enhance the corresponding emotions.

EFFECTS OF WHOLE BODY MUSCLE RELAXATION AND BREATHING PATTERNS

Two additional emotion regulation strategies commonly used for stress reduction are muscle relaxation and specific breathing patterns. Although these techniques are not based on movement per se, they are based on a specific pattern of voluntary muscle activation (either the entire body's skeletal muscles in muscle relaxation or the respiratory muscles), and the afferent feedback from the body to the brain that this muscle activation pattern creates.

Progressive muscle relaxation (PMR) is a technique for learning to monitor and reduce muscular tension that was originally developed in the early 1920s by the American physician Edmund Jacobson. The technique involves learning to monitor tension in each specific muscle group in the body by deliberately inducing tension in each group. This tension is then released, with attention paid to the contrast between tension and relaxation. The original method required dozens of training sessions and Bernstein and Borkoveclater shortened this technique and found it to be equally effective [109]. Pawlow and Jones (2005) have compared 25 minutes of progressive muscle relaxation to 25 minutes of sitting quietly in the same room. Increased subjective level of relaxation, decreased state anxiety, decreased level of perceived stress, and decreased heart rate were observed only in the progressive muscle relaxation group. More importantly, only the progressive muscle relaxation significantly reduced the level of salivary cortisol and increased the levels of salivary immunoglobulin A (sIgA), which is an antibody that plays a critical role in mucosal immunity [110]. Rausch et al. (2006) compared the effects of PMR to those of meditation and resting with the eyes closed. Rausch found that PMR was associated with greater reduction in somatic anxiety than the other two relaxation methods [111]. A recent systematic review demonstrated that providing progressive muscle relaxation might alleviate psychological distress and state anxiety and might improve subjective well-being in persons with schizophrenia [109]. Additionally, an older review showed that PMR may be effective in reducing self-reported anxiety, depression, or pain and physiological stress-related measures such as blood pressure and heart rate, in a variety of other psychophysiological and stress-related disorders, such as hypertension, headache, chronic pain, and during cancer chemotherapy [112].

The suggested underlying mechanism for the above-mentioned effects of PMR is reduction in sympathetic nervous system activity as a result of negative afferent feedback from the relaxed skeletal muscles to the ascending reticular activation system and hypothalamus. Resting muscles send little or no proprioceptive information from the muscle to central brain structures; the lack of such feedback information is believed to result in decreased sympathetic activation [113]. According to Bernstein (2007), direct supportive evidence from human studies of this model has been sparse. However, indirect evidence (e.g., decreased heart rate and blood pressure) from human research supports the efficacy of PMR in reducing autonomic activation [113]. Recent studies which showed reduced saliva cortisol [110], reduced pulse rate and increased skin temperature [114] following a PMR session, also support this suggestion.

As for respiration, some specific breathing patterns have been associated with general mood and distinct emotions: Boiten et al. (1994) have reviewed the psychophysiological literature pertaining to respiratory patterns associated with emotions. They concluded that although the literature that was reviewed suffered from a number of important limitations, certain patterns of respiration appeared to be correlated with dimensions that define general aspects of emotions. Patterns suggestive of respiratory hypo- and hyperfunction appeared to be tied to passive/depressed and active/excited affective state, respectively. In addition, breathing that seemed metabolically appropriate (norm-ventilation) appeared generally tied to adaptive coping behavior, while breathing that was in excess of metabolic demands (hyperventilation) appeared to be typical of passive or unsuccessful coping. Fast and deep breathing was associated with excitement, such as in anger, fear, or sometimes even joy. Rapid shallow breathing was typical of tense anticipation, including concentration, fear, and panic. Slow and deep breathing was most often observed in relaxed resting state. Finally, slow and shallow breathing was associated with states of withdrawal and passiveness, such as depression or calm happiness [115].

Philippot et al. (2002) reported two studies that investigated the relationship between specific emotions and respiration. In the first study, participants were asked to produce joy, anger, fear or sadness and to describe the breathing pattern that fits best with the generated emotion. The results revealed that the breathing patterns reported during voluntary production of emotions were clearly differentiated among joy, anger, fear, and sadness, and were consistently similar across individuals. These subjective patterns were also congruent with the patterns reviewed by Boiten et al. (1994). The second study used breathing instructions based on the first study's results, in order to investigate the impact of the manipulation of respiration on emotional state. A cover story was used so that participants could not guess the actual purpose of the study. This manipulation produced significant emotional feeling states that were differentiated, for the most part, according to the type of breathing pattern; joy, anger, and sadness were successfully induced with the breathing instructions derived from the observations of the first study. However, execution of the breathing instructions intended to produce fear, generated both fear and anger [116].

Raiville et al. (2006) asked their subjects to induce anger, fear, happiness or sadness using autobiographical memories, and they recorded physiological aspects of the subjects' cardio-respiratory activity during the experience of those emotions. Univariate statistics indicated that the four emotions differed from each other and from the neutral control condition on several linear and spectral indices of cardio-respiratory activity, confirming the association of each emotion with a distinct somatic state. Furthermore, the results demonstrated the multidimensional nature of the somatic states that characterize basic emotions [117]. Although these findings may be considered preliminary in view of the small sample on which the multivariate approach has been applied in this study, and more research will be needed to better characterize the cardio-respiratory factors required for elicitation of each specific emotion, practice of specific breathing patterns for general enhancement of emotional (and physical) health has been widely applied for hundreds of years in eastern body-mind methods such as yoga.

Breathing practices entail voluntary changes in the rate, pattern, and quality of respiration. Different schools of yoga have developed over thousands of years diverse breathing patterns that include numerous variations of specialized techniques such as abdominal breathing, alternate nostril breathing, breathing against airway resistance, and breath holding. Specific breath practices have been shown to be beneficial in reducing symptoms of stress, anxiety, insomnia, posttraumatic stress disorder, obsessive compulsive disorder, depression, attention deficit disorder, and schizophrenia [118]. Slow breathing at 4.5 to 6.5 breaths per minute has been shown to optimally balance sympatho-vagal stress response for most adults [118], but other breathing patterns have beneficial effects too.

Similar to exercise, regular practice of specific breathing patterns has both acute and chronic effects. For example, regular practice of slow yoga breathing (6 breaths per minute with 5-second inspiration and 5-second expiration) decreases chemoreflex sensitivity, improves cardiovascular and respiratory function, and increases respiratory sinus arrhythmia, arterial baroreflex sensitivity, oxygenation, and exercise and carbon dioxide tolerance [119]. The reduction in chemoreflex sensitivity which enables the body to tolerate higher levels of carbon dioxide is especially important in the context of emotion regulation, considering that increased carbon dioxide levels can trigger panic attack and feelings of fear even in the absence of external threat from the environment [120]. Spicuzza et al. (2000) demonstrated that long-term practice of yoga breathing (as opposed to regular slow breathing) independently reduced chemoreflex sensitivity [121]. According to Brown, adaptation of peripheral/central chemoreceptors to chronic carbon dioxide retention and/or adaptation of pulmonary stretch receptors to a habit of deep slow respiration may increase vagal afferent discharge to the brainstem center (nucleus tractus solitarius) that sends projections to the thalamus and limbic systems. These vagal effects are physically and emotionally calming [119]. In a series of papers, Brown and colleagues portrayed the physiological mechanisms underlying the regulatory effects of several additional yoga breathing patterns. These include modulation of the autonomic nervous system function, stress responses, cardiac vagal tone, heart rate variability, vigilance, attention, chemoreflex and baroreflex sensitivity, central nervous system excitation, and neuroendocrine functions [119, 122, 123].

Both PMR and breathing practices involve mindfulness, for they require constant awareness and attention to the body. Mindfulness has been shown to have positive effects of stress reduction and increased psychological well-being [124, 125]. Although mindfulness might be an important component responsible for the positive effects of these strategies, the evidence summarized above indicates that the component of voluntary control of muscle activation and breathing pattern is not less important, since proprioception from the relaxed muscles during PMR and interoception from the lungs and other internal organs during different breathing patterns also contribute to the positive effects of these emotion regulation strategies.

CONCLUSION

As demonstrated in this chapter, through proprioception and interoception, the state of our body has a strong effect on our affective state. Thus, using a range of motor behaviors, we can regulate our emotions by changing the state of the body. Regular exercise and certain breathing practices cause adaptations to the autonomic system responses to stress, which reduce depression and anxiety symptoms and increase resilience. Exercise, progressive muscle relaxation and specific breathing patterns also have acute immediate effects that can improve affective state. In addition, there is accumulating evidence that specific movement patterns, postures, facial expressions and breathing patterns are associated with specific emotions, and that engaging in these motor behaviors can enhance the associated emotion. The abundant evidence that has been described for body-mind and movement-emotion interactions and their underlying mechanisms demonstrates the importance of regular physical activity for improving mental health and enhancing psychological resilience. It also indicates the unique value that body- and movement-based interventions such as body psychotherapy and dance-movement therapy can contribute to the treatment of psychological problems; and, as a result, suggests that these methods should be used more frequently as an integral part of treatment for mental disorders.

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