

The Therapeutic Role of Guided Mental Imagery in Treating Stress and Insomnia: A Neuropsychological Perspective

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Abstract

Excessive distress and insomnia are much too common in the modern world and often lead to a myriad of detrimental effects including loss of cognitive ability and even physical ailments such as cancer. Current pharmaceutical treatments can be addictive, detrimental to health, and in the case of insomnia don't produce naturalistic sleep. We present a viewpoint on a potential adjunctive treatment of distress and insomnia that harnesses specific mental imagery as a component of mind/body relaxation technique. Via our perspective on the modern nature of stress and insomnia, our theoretical perspective on how specific guided mental imagery can be used to treat these ailments, and our review on the current literature on treatment with mental imagery, we hope to stimulate further research into mental health treatment with mental imagery which has traditionally been neglected. This perspective on the pathology of insomnia and distress is founded in prevailing "dysevolution" and hyper-arousal theories. Hyper-arousal is characterized in part by a vicious cycle of chronic physiological and emotional stimulation/distress. We argue for spatially based mental imagery in the form of nighttime-sky imagery to attenuate such pathology by breaking one away from a vicious cycle of stimulation and distress and discuss neuropsychological bases for its potential treatment mechanisms which include the autonomic nervous system and a phenomenal foundation of conscious cognition.

Keywords

Mental Imagery, Guided Imagery, Insomnia, Chronic Stress, Hyperarousal, Vicious Cycle

1. Introduction

In the United States, an estimated 110,000 vehicular crashes and 6500 deaths are attributable to sleep-related fatigue [1] with well over 70 million Americans suffering from chronic to occasional insomnia which significantly interferes with daily life [2]. This has been estimated to cost Americans reaching near half a trillion dollars per year in reduced productivity and work hours (10 million hours lost), not including medical and other costs [3]. A great deal can be said about the negative effects of sleep-deprivation of which include mental deficits and disorders such as increased incidents and severity of depression [4], addiction [5], anxiety [6], attention and learning difficulties [7], and physical ailments such as obesity [8], heart disease [5], and even cancer [9]. The pharmaceutical drugs such as the z-drugs used to promote sleep in insomniacs not only can be habit-forming [10], increase mortality chances and mental issues such as depression [11], but do not produce the naturalistic sleep or sleep architecture needed for the full health necessities of sleep [12] [13] [14].

In opposition to “good stress”, or eustress, which is exhilarating and occurs in response to short-term challenging events over which we may master or leave a sense of accomplishment, distress is “bad stress” which occurs over more prolonged events where we have little control and are draining, exhausting, and/or dangerous [15]. Chronic distress can be promoted by insomnia and insomnia promoted by chronic distress [16]. Like insomnia, there are many negative health outcomes due to chronic distress in part due to the harmful effects of long-term exposure to stress hormones [17]. The sympathetic nervous system is in a large part responsible for their release [17]. Some of these negative health outcomes include accelerated aging [18] [19], heart disease, panic disorders, depression, anxiety, anger [20] [21], neurotoxicity, cognitive impairment [22] [23], gastrointestinal issues [24], and autoimmune disease [25]. The ailments brought about by distress and insomnia can cause further distress and/or insomnia, producing a vicious cycle which can be difficult to escape [25]. Pharmaceutical treatments for chronic stress and anxiety such as benzodiazepines have many of the same negative side effects as insomnia drugs [26].

In this article, we discuss and promote a non-pharmaceutical treatment and non-pharmaceutical treatments in general for hyperarousal based insomnia and chronic distress that focus on stopping the vicious cycle just mentioned. Hyperarousal, a key component of all modern etiological models of insomnia [27], is thought to be a 24-hr condition in which patients are near constantly aroused physiologically and often emotionally/psychologically, even during sleep [16]. Several factors may contribute to the onset and maintenance of a viscous cycle of arousal including neurotic personality traits, stressful life events, sleep reactivity (the degree to which stress disrupts sleep) [27], genetic predispositions, and age-related homeostatic decline [16]. Primary sleep disorders such as sleep apnea do not appear to significant cause of insomnia [28]. Medical disorders causing chronic pain or discomfort as well as substance abuse may cause chronic in-

somnia/distress [29] and we note the guided imagery we describe would likely not be as effective in treating insomnia caused by these conditions. Stressful events are a main trigger for the initiation of such a cycle and insomniacs are less able to deal with such events, possibly due to poor personal relationships and self-perceptions [29]. Chronic insomniacs with such arousal problems and inability to deal with stress positively tend to be more prone to depression, anxious rumination, lack the ability to inhibit emotions, and lack the ability to express their anger [30].

We address the role of a spatial and naturalistic based form of mental imagery, nighttime-sky imagery as a part of a greater mind/body intervention in treating such a viscous cycle. When experiencing a nighttime-sky, one is looking into a potentially infinite expanse of space. We assert a neuropsychological perspective on why such a spatial form of imagery is most effective in treating hyperarousal and neurotic rumination based on a prominent neuropsychological theory in consciousness and cognition which posits that a three-dimensional (3D) coordinate matrix is the foundation of one's conscious and cognitive reality [16] [31] [32]. Mind/body relaxation techniques which include a synergistic combination of methods such as deep breathing, meditation, and mental imagery have been reported as the most favored and effective non-pharmacological interventions by patients [21]. In addition to mental imagery, we hope to persuade healthcare providers to when possible aim for non-pharmaceutical interventions for stress and insomnia such as various meditation techniques [33] [34] [35] [36] [37], deep breathing techniques [38] [39] [40], exercise, lifestyle alterations, reduced evening light exposure, reduced evening temperature, and various forms of stress management [41] [42] [43] [44] [45].

2. A Vicious Cycle

We address the origins of chronic stress and insomnia here largely from the basis of an evolutionary perspective, namely the evolutionary mismatch hypothesis. This hypothesis identifies the pathophysiology of many human diseases as resulting from traits that were once advantageous to our cave dwelling and primal ancestors but that are maladaptive in modern life, thus a mismatch between environments exists [46] [47]. For instance, we have evolved over millions of years to crave high calorie (sugars and fats) foods due to the scarcity of food in our ancestor's environments, however today we have large surpluses of food and these primal cravings have led us to ever increasing rates of obesity [47]. Chronic stress leads to a state of sustained autonomic imbalance [48]. Such a mismatch due to the frenetic nature of modern life has led to maladaptations in the daily functioning of our autonomic nervous system due to stress, specifically a tendency towards the sympathetic mode which is evolutionarily purposed for short-term activation [49] [50]. The toxic and long-term arousal of the sympathetic system, a component of hyper-arousal, likely further promotes the development and maintenance of many modern cases of chronic distress [50], and

insomnia [38] [39]. Arousal stimulates the sympathetic nervous system and the sympathetic nervous system promotes arousal [48].

Chronic insomnia and/or distress has been previously described as arising from a vicious cycle of emotional and physiological arousal (in which the arousal causes more arousal in a snowball like effect) due to personality and neurophysiological traits [29] [51]. Those who don't cope well with stress tend to be discontent and have poor self-perspectives and interpersonal relationships [29]. One older hypothesis describing such a vicious cycle associates insomnia (and we assert describes chronic stress) with inhibited and repressive personality traits [52] which after initiation by a stressful life event, may lead to a state of constant emotional arousal which results in physiological arousal [16] [29]. This "Internalization Hypothesis" describes these patients as handling stress by internalizing emotions [16]. They ruminate about personal issues such as work and relationships [16]. As a result of their constant arousal, they lose sleep and further become fearful of sleeplessness, intensifying their emotional arousal and perpetuating their insomnia (and stress) [29] [51]. This vicious cycle thus becomes independent of its origin over time [16]. Most insomnia (and we assert promoting chronic stress) has also been described as a result of general twenty-four hour central nervous system hyperarousal rather than a nighttime-specific sleep loss disorder [16] [53] [54] [55]. Sleep-loss (and chronic stress) may thus be manifestations of such hyperarousal [16] which resembles normal temporary anxiety or emotional distress [56].

A 24-hr hyperarousal disorder neurologically involves an increase in activity in the reticular activating system which is a complex and diffuse network of projections from multiple brainstem sources [57]. A complex arrangement of neurotransmitter-specific signaling in this system such as an increase in aminergic input compared to cholinergic largely determines arousal level [57] [58]. This reticular system is thus involved in alertness, wakefulness, and even emotional arousal via its projections to the cortex [57] [59]. Descending projections from the reticular formation to autonomic centers of the brainstem and spinal cord can increase bodily arousal such as an increase in heart and respiration rate [60]. Other brainstem regions such as the locus coeruleus also play a role in arousal and should be considered when determining a neurological model of hyperarousal [61].

There is an intimate relationship between stress and insomnia as they may promote or cause one other, potentially feeding each other in a vicious cycle. Good sleep causes emotional experiences to be remembered more positively and less distressful than when they occurred and compared to after poor sleep [56]. Exposure to emotional stimuli results in more autonomic arousal and erratic emotional responses in those getting little/no sleep compared to those who got good sleep [62] [63]. Chronic insomnia may result in a lasting deficiency in the ability to neurologically downregulate distress [64], and unlike good sleepers, insomniacs are unable to dissociate limbic activity and autonomic reactivity from distressing and/or shameful long-term memories [56]. They may be

“haunted by the past”. We have described potential mechanisms in which respiration may play a role in arousal activity of the brain via cardio-respiratory synchronization. We in part assert the power of mental imagery in synergistic combination with the mind/body technique of deep-slow breathing via such a mechanism in which cardiorespiratory feedback from the body modulates signaling among the reticular activating system and hypothalamus and via modulation of the autonomic nervous system [65] [66]. We assert mental imagery may provide an adjunctive means to attenuate the viscous cycle and will now review research supporting the therapeutic power of mental imagery in general.

3. Guided Mental Imagery for Therapy

Mental imagery, phenomenal (we focus on visual) representations without a direct stimulus, functions cognitively and neurologically as a weak form of stimulus perception [67]. Imagined stimuli can be considered as a type of top-down perception [67] and has similar effects as real stimuli on physiology such as on pupil dilation [68]. Mental Imagery is increasingly being recognized via research and theory as playing an important role in mental health treatment including stress/anxiety and insomnia treatment [67] [69] [70] [71] [72]. Guided imagery therapy has also shown effectiveness in treating chronic pain [73], fatigue [70] [74], food cravings [75] [76], arthritis [77], hypertension [78], and even fibromyalgia [79]. Positive mental imagery (imagining a nice place) has been reported by patients as the most effective relaxation technique and the most likely to be used at home [80]. In addition to being cost-effective, imagery of beautiful scenes may improve quality of life [81]. It may distract patients away from their pain, stress, and personal/emotional problems (such as fear of sleeplessness) and teach them general self-regulatory coping skills to assist with these problems [69] [82]. “Private” imagery or that which isolates one from social aspects of life is thought to be key to effective relaxation imagery [80].

Unsurprising from an evolutionary perspective, natural environments such as a forest atmosphere or can provide relaxation/comfort, reduce stress, and promote a deep connection with nature [83]. From the same perspective, our “artificial” modern environments may create stressful feelings [83] [84]. Considering visual mental imagery and perception of actual stimuli neurologically resemble one another as early as V1 [67], mental imagery of natural environments should promote identical relaxing effects. In addition to shifting the autonomic state toward the parasympathetic, naturalistic stimuli decrease functional connectivity in hubs of the default mode network corresponding to self-referential thought processes [48]. Thus, naturalistic mental imagery may attenuate ruminative self-referential neural activity which may be the source of many distressing, depressive, and arousing thoughts [85] [86] [87].

Traditionally neglected from a treatment perspective [67], intrusive, emotional imagery matching the concerns of the individual is a distressing aspect of many mental conditions such as post-traumatic stress, depression, and anxiety

disorders [88] [89]. Insomniacs have fewer, but a significantly greater fraction of unpleasant mental images compared to good sleepers [90]. These involuntary mental images of insomniacs are more emotionally charged compared to the “random” images of good sleepers [90]. Intrusive mental images are not just a symptom of certain mental disorders, but may actively drive the maintenance of the disorders [67] [91]. Guided mental imagery has been supported as an effective means to treat intrusive mental imagery either by producing tolerance/desensitization (voluntarily imagining stressful images) [92] or by positively transforming the intrusive imagery content [67] [93] [94]. We assert a spatially based form of mental imagery will be optimal in decelerating and even halting the vicious cycle discussed by dissociating one from the incessant rumination on personal/professional stressors and distressing memories which feed further emotional and physiological arousal. This may be effective as the foundation of consciousness and cognition is a spatial, internal, “virtual” reality.

4. A Phenomenal and Cognitive Foundation

We and several consciousness researchers have proposed a fundamental phenomenological and cognitive foundation to consciousness and mind. This is a sub-conscious and unifying, 3D “virtual”, spatial coordinate matrix in which all conscious qualia are embedded and in which key cognitive mechanisms are performed [31] [32] [95] [96] [97] [98] [99]. Consciousness can be thought to be identical to the contents of this space and conscious perception occurs from the perspective of the mathematical origin or center of this space [96]. The first-person sense of self is located at this center [97] [98] [100]. This space is theorized to house a simulation or model of the internal and external world and our relationship to it [31] [101] [102] [103] [104]. Even the self can be thought of as a simulation housed within this space [98] [100]. Instead of experiencing this simulation of the self and external world as a virtual model heavily influenced by expectations and biases, we indeed experience it as if it were the actual physical world [99] [100] [103] [105]. The neurophysiological and cognitive research supporting this 3D space, world-simulation theory [106] is predominated by research into the nature of contralateral neglect syndrome [107]. Structure is proposed to be an axiom of any type of consciousness [108] and this space may provide an explanation and means for its global unity, both phenomenally and in its isomorphic neurophysiology [32] [109].

Just like all mental aspects, this virtual space has a neural equivalent and is proposed to be formed by slow neural oscillations which are a part of the global bioelectric field of the brain [109] which has been asserted to be isomorphic to consciousness and aspects of cognition [110]. Just as the virtual space connects and organizes all aspects of consciousness into a singular whole, these slow oscillations act as a foundation for higher frequency activity to form upon and thus connect and organize higher frequency activity into a global whole [111]. This includes the multimodal integration of all sensory types [109]. Several research-

ers have investigated how slow oscillations modulate [112] [113] [114], group [115] [116], organize, and entrain faster ones [117] [118]. Slow oscillations are able to globally coordinate and unify activity in dispersed and distinct neural assemblies because they facilitate longer range communication [119] and affect greater populations of neurons than fast oscillations which act more locally within assemblies [112]. Just as the 3D virtual space allows distinct phenomenal qualities and objects such as a red ball to be unified into a single conscious experience, these slow oscillations allow individual neural assemblies formed by fast oscillations [120], which are likely responsible for more finely detailed aspects of consciousness and cognition, to be part of the global brain operation [111]. Thus, slow oscillations may provide a means to neurophysiologically explain the effectiveness of a spatially based form of mental imagery.

5. Nighttime-Sky Mental Imagery as a Mind/Body Component

In promoting a specific form of mental imagery for treatment of distress and insomnia in adjunct with other mind/body techniques, we have considered the current literature on imagery as well as prominent theory on the phenomenal and cognitive foundation of mind. We propose that nighttime-sky mental imagery is optimal for treating nighttime stress and insomnia as there is a close relationship between the two. The proposed purpose of using this type of imagery may provide insight into treating daytime stress and may also be appropriate for daytime stress. This type of imagery may work to reverse the vicious cycle described which is proposed to perpetuate hyper-arousal. Although this and other mental imagery would be helpful during the day, targeting this arousal when it is time to sleep would be most optimal as it would negate many of the stressful effects of sleep deprivation. This relaxation may be initiated by replacing negative emotions and thoughts which fuel arousal with relaxing feelings of awe and wonder induced by the nighttime sky. As discussed on the effects of naturalistic images, some images (such as the image of a snake or looming shadow of a bird) are likely evolutionarily/genetically “programmed” in humans/animals to have certain emotional, neurophysiological, and physical responses relevant to survival [121] [122] [123] [124] [125]. Such phylogenetic “memories” are no less relevant than those acquired by experience and likely have similar biological underpinnings as memories established throughout life [126]. In addition to the profound effects of light and the lack of it on the circadian rhythm [127], we assert the image of the nighttime sky may also be phylogenetic, possibly stimulating relaxation and/or the production of melatonin.

Mental imagery preserves the spatial characteristics of the environment that is being mentally represented [128]. Even eye movement and focus reflect the spatial content of the mental image [128]. Assuming that a 3D virtual space is a cognitive foundation of mind, and given that all personal and social problems which may cause distress and insomnia occur in a space “immediate” to the

person's real or imaged perspective, we assert that diverting attention away immediate space will attenuate the stresses which occur in such immediate space. In imagining a nighttime-sky, imagining the stars is not near as important as imagining the supreme spatial vastness that one looks into when looking up into the depths of the universe. Imagining a potentially infinite expanse of space should disassociate one from the personal and social problems that occur here on earth (**Figure 1**) and provide a "private" experience shown to be key to relaxing imagery [80]. Although temporary, this technique may temporarily but significantly break one out of the vicious cycle of stress and arousal discussed which builds upon itself, thus allowing one to get the sleep needed to further break down the cycle (**Figure 2**). We hope to inspire research into this and potentially other forms of spatially based imagery. Although such research does not currently exist, anecdotal reports of success from the authors and author's (RJ) medical patients warrant investigation.

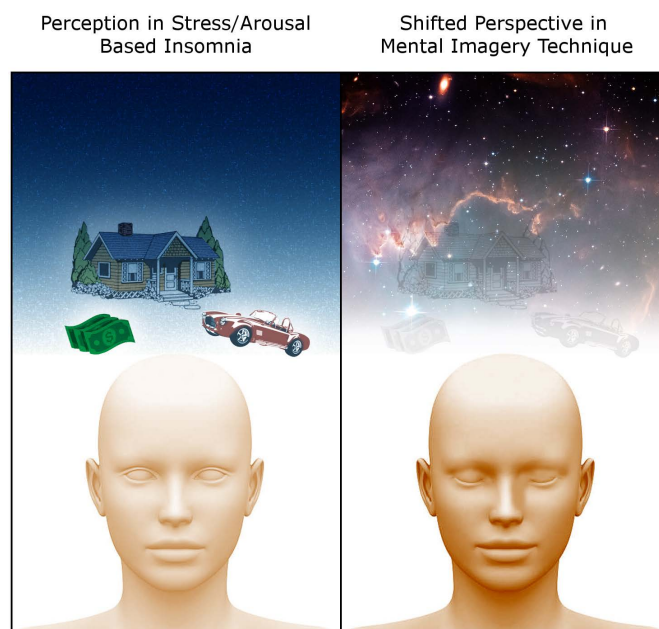


Figure 1. Spatially based disassociation from stressors. This graphic depicts in an easy to understand manner the shift in consciousness brought about by nighttime sky imagery. The mechanism of this treatment in part assumes that a virtual 3D coordinate space is the foundation of consciousness and conscious cognition. Other mechanisms are discussed in the article. In the person emotionally aroused at nighttime by various personal, professional, and social problems, their attention lies in immediate space as this is where the distressing imagery and thoughts of their problems are spatially situated. In the images shown, these problems may include social problems at home, problems paying bills, or keeping up with a vehicle. When one elicits nighttime-sky imagery in them or imagine what heavenly bodies lie beyond it in the vastness of space. Their spatial attention gets shifted to the vastness or potentially infinite spatial expanse of outer space in which no stressful problems are spatially situated. We propose this will dissociate one from these problems and promote positive emotions of wonder and awe which counteract the distressing and arousing emotions which promote a vicious cycle of insomnia and distress (Original image by Michael Jensen).

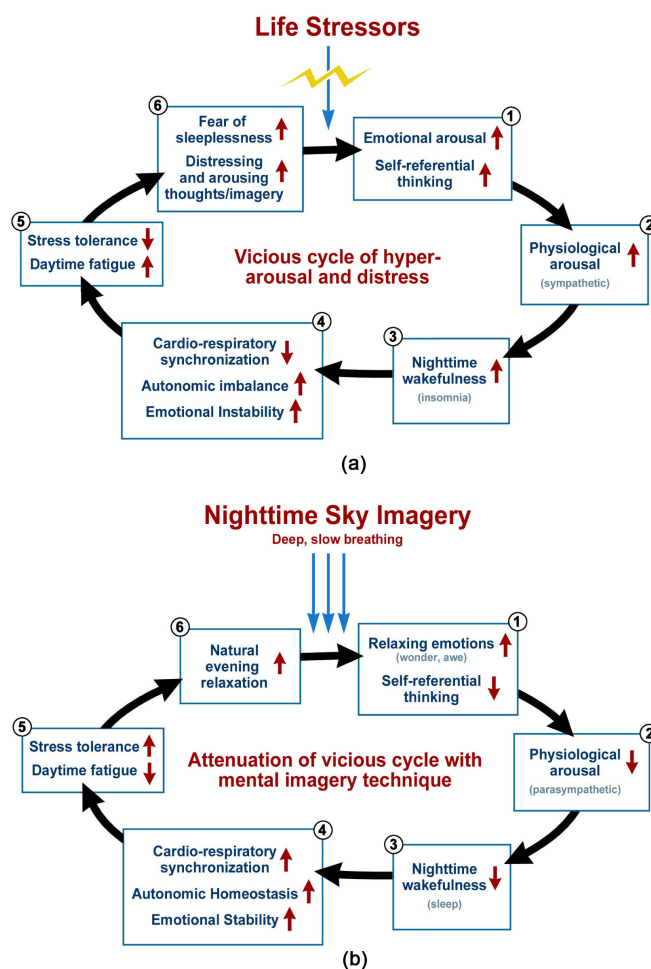


Figure 2. A viscous cycle and its attenuation with a mind/body technique. This image illustrates the phases of a vicious cycle of the intimately associated conditions of chronic distress and insomnia which feed upon one another. The top cycle (a) illustrates the pathology discussed of such a viscous cycle and the bottom one (b) shows its attenuation. Cycle A begins with a significant life stressor which sparks intense emotional (or cognitive) arousal and self-referential thoughts. This in turn causes physiological arousal of the mind and body which causes one to not be able to sleep. This arousal of the body is mediated by the sympathetic branch of the autonomic nervous system and includes increased respiration and heart rates. The lack of sleep leads to problems during the day, some of which are associated with decreased cardio-respiratory synchronization. Daytime emotional instability and hyperarousal of the sympathetic nervous system due to sleep loss in part lead to the lack of ability to handle common stressors. Personal problems brought about by daytime Fatigue (differentiated from wakefulness) and increased stress brought about by sleep loss lead one to fear sleep. In addition, this stress lasts into the evening and the distressing thoughts/images they experience restart the cycle with nighttime arousal and thus further sleep loss. In image (a), the jagged cutoff from the “Life Stressors” initiator indicates that at the point the cycle comes full circle, the significant life stressors are no longer needed and the cycle can maintain itself. Cycle (b) essentially shows the “deceleration” of cycle A. By reducing emotional arousal via essentially dissociating one from their stressors, physiological arousal is reduced (with the assistance of deep-slow breathing), allowing one to relax and achieve sleep. Good sleep then promotes healthy emotional reactivity and stress tolerance, eliminating the fear of sleeplessness and promoting normal evening relaxation (Original image by Michael Jensen).

Considering that the mind not only affects the body, but the body affects the mind [129] [130], these temporary breaks in arousal via imagery may reduce physiological arousal thus further decelerating the vicious cycle. By including deep-slow breathing in combination with imagery such deceleration may be synergistically magnified through promoting a more parasympathetic state of the autonomic nervous system. Good sleep may thus be acquired which then further promotes parasympathetic tone during the day [131]. The brain recognizes the state of the body and responds appropriately. When we are stressed or aroused, the brain produces quick, irregular respiration via the sympathetic system while simultaneously recognizing this somatic state causing further arousal. Along with other mechanisms, by voluntarily slowing and making our respiration more regular, the brain may recognize this as a calm state thus calming arousal. This follows the somatic marker hypothesis and other theories which describe a major source of emotion as feedback from reflexively activated bodily activity [129] [132] [133] [134].

6. Conclusion

Mind/body stress reduction programs that include a combination of deep breathing, meditation, and mental imagery have been shown to be the most effective non-pharmacological interventions to reduce stress, and so we promote such imagery discussed here to be used alongside other mind/body techniques as they appear to work synergistically. We have provided a perspective on the neuropsychological role of a specific type of mental imagery, nighttime sky imagery, in this synergistic therapy. We have discussed the nature of a vicious cycle of distress and/or insomnia and how mental imagery may assist in breaking this cycle. The synergistic mind/body treatments may be more effective at diminishing hyperarousal as they target not only the brain but the body likely via the autonomic nervous system and somatic recognition by the brain. By providing neuropsychological backing for treatment with a specific type of imagery (night-time-sky) to be used in conjunction with deep-slow breathing and/or meditation, we hope to inspire research into traditionally neglected mental imagery and promote the use of mind/body techniques over pharmacological interventions.

Author Contributions Statement

Theory Developed by RJ with some writing and background research. The Majority of the Manuscript and background research was done by CB. The Images were made originally by MJ. A minority of background research and the manuscript was done by RP.

Conflicts of Interest

The authors declare no conflict of interest.

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