

Biobehavioral utility of mindfulness-based art therapy: Neurobiological underpinnings and mental health impacts

Megan E Beerse¹, Theresa Van Lith¹, Scott M Pickett² and Gregg D Stanwood^{3,4} 

¹Department of Art Education, Florida State University College of Fine Arts, Tallahassee, FL 32306, USA; ²Department of Behavioral Sciences and Social Medicine, Florida State University College of Medicine, Tallahassee, FL 32306, USA; ³Department of Biomedical Sciences, Florida State University College of Medicine, Tallahassee, FL 32306, USA; ⁴Center for Brain Repair, Florida State University College of Medicine, Tallahassee, FL 32306, USA

Corresponding author: Gregg D Stanwood. Email: gregg.stanwood@med.fsu.edu

Impact statement

Recent studies demonstrate the therapeutic potential of intensive MBAT and other mindfulness-based interventions for severe health conditions including cancer, heart disease, and anxiety, with effectiveness that rivals and sometimes even exceeds cognitive behavior therapy. MBAT-based approaches appear to be poised to mature into large-scale, cost-effective therapies for mental health disorders and symptoms comorbid with other serious health issues. However, the field currently suffers from inconsistent deployment protocols and needs additional validation data—at the behavioral, neuroendocrine, and neural levels—in order to establish best practices.

Abstract

Mindfulness-based art therapy (MBAT) combines mindfulness practices with art therapy to promote health, wellness, and adaptive responses to stress. Mindfulness-based stress reduction programs have been demonstrated to reduce anxiety symptoms in people with generalized anxiety disorder and serious medical conditions such as cancer. However, the benefits of MBAT specifically—not just in clinical anxiety disorders, but also for routine day-to-day anxiousness—have received little attention until recently. In this mini-review, we summarize how several established mindfulness-based interventions affect mental health with a specific focus on MBAT. We also describe and evaluate data indicating involvement of specific neural circuits and neuroendocrine markers of stress and/or anxiety. Lastly, we suggest areas of focus for future rigorous research on MBAT interventions and propose multiple biobehavioral and physiological mechanisms through which therapeutic benefits may be achieved.

Keywords: Biomarkers, brain, mindfulness, neuroendocrinology, neuroscience, stress

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Anxiety and stress

Anxiety disorders constitute the largest group of mental disorders in most parts of the world and are a leading cause of disability. In the United States, anxiety disorders and mood disorders are the most common mental health disorders with 12-month prevalence rates of approximately 18.1% and 9.5%, respectively.¹ Of note, although anxiety disorders and major depression are often comorbid with one another and can present with common symptoms, these disorders are distinct clinically and involve dysfunctions in distinct brain circuits and molecules. Nevertheless, both anxiety disorders and mood disorders are related to poor physical health outcomes,^{2–4} in addition to diminished quality of life, impairments in daily functioning, and lost occupational/academic productivity.^{5–7}

Specifically, both anxiety disorders and mood disorders are associated with cardiovascular disease, metabolic disorders, cancer, sleep disorders, and decreased longevity. Links between poor physical health and anxiety or mood disorders are distinct, reciprocal, and complicated, but it is also appreciated that there are shared neural and endocrine mechanisms. Interestingly, research suggests that the etiological pathways are similar between poor physical health outcomes and chronic daily stress, a common risk factor in the onset of both anxiety disorders and mood disorders.^{8,9}

Beyond clinically diagnosed anxiety disorders, approximately 7 out of 10 adults in the United States report moderately impairing levels of stress or anxiety on a daily basis.¹⁰ Poorly managed anxiety and/or stress can contribute to economic and global burdens, including student loan

debt,¹¹ work productivity loss,¹² and healthcare costs.¹³ In terms of years lived in less than ideal health, anxiety disorders are the sixth leading cause of disability throughout the world¹⁴ and account for 390 disability-adjusted life years per 100,000 individuals. Chronic daily stress and anxiety increase the risk of physical pathology like sleep quality, weight gain, decreased cognitive functioning, cardiovascular disease, autoimmune diseases, and gastrointestinal problems.^{9,15,16} Similar to anxiety and mood disorders, the association between chronic daily stress and anxiety and poor physical health are due to the effects that chronic daily stress and anxiety have on biological systems essential for optimal health. Stress induces neuro-immune and neuro-endocrine responses, and individual differences in these effects contribute to vulnerability and resilience.¹⁷ At a mechanistic level, stress can even transform signals in the brain that are typically related to reward into punishment signals and thus bias individuals towards negative expectations, anxiety symptoms, and depression-related behaviors.¹⁸

Chronic stress and anxiety disorders have both been previously associated with dysregulation of stress hormones, neuro-inflammatory markers, and neural circuit activation.^{15,19–25} These maladaptations are in turn correlated with negative health consequences including metabolic syndrome,^{26,27} cardiovascular disease risk,^{9,16,28} and chronic pain.^{29–32} Circulating cytokines, including tumor necrosis factor alpha (TNF- α) and interleukin-6 (IL-6), help interconnect signals between the central nervous system and peripheral immune system.³³ Moreover, they can amplify the production of other secreted molecules and intensify immune responses. Cytokines play a variety of roles within the nervous system, including the initiation of immune processes, the promotion of repair after cell injury, and regulation of endocrine signals and feedback.^{17,34} Several studies support altered cytokines and other inflammatory markers in anxiety disorders.^{19–22}

Approaches to mindfulness and established effects of mindfulness interventions on mental health and neural systems

Mindfulness refers to the psychological process of attending to experiences happening in the present moment; it is originally derived from ancient Eastern roots, especially Buddhist traditions and yogic practices. It focuses on progressively orienting a person to an awareness of connections and interaction between body and mind. Recently, such practices have been adopted and adapted by Western cultures for wellness management and clinical interventions. Research demonstrates a strong relationship between mindfulness practices and quality mental health. The most common method of mindfulness-based intervention for reducing stress is mindfulness-based stress reduction (MBSR).^{35,36} A standard MBSR curriculum is eight weeks long and structured in a group therapy format, with each session typically lasting between 1 and 2 h in length. Mindfulness-based interventions exert positive impacts on an individual's mental health in addition to physical health.^{37–44} Effectiveness has been established

not only for clinically diagnosed anxiety disorders but also for subclinical levels of anxiety and stress. Two meta-analyses have established that mindfulness-based interventions are at least as efficacious as cognitive behavioral therapy (CBT).^{38,45} Possible biological mediators of positive effects include improved sleep quality,^{23,46} brain structure changes,⁴⁷ and enhanced cortisol regulation.^{23,48} A mindfulness intervention also reduced stress and improved mental well-being in caregivers for family members with dementia,⁴⁹ suggesting that a wide array of stress-related burdens might be responsive to these therapies. However, studies in this area are not always well controlled, and randomized control trials of behavioral therapies are more difficult to design and interpret than are pharmaceutical interventions.⁵⁰ For example, effectiveness in a behavioral intervention is dependent on not only characteristics of the intervention provider but also factors relating to the recipient and how they engage with the intervention. A therapist providing a behavioral intervention is equipped with a unique combination of training and clinical experience, meaning subtle variations may exist between therapists and how they adhere to and facilitate a behavioral intervention protocol. Consequently, this will have an impact on how a recipient responds to the intervention. Moreover, regardless of the background, skill, and decisions of the provider, a recipient independently decides their level of engagement with the intervention, while their cultural background and personal experience can impact how they interpret and respond to it. This differs greatly from a medication trial where dosage and provision of services can be strictly controlled.

Hoge *et al.*⁵¹ recently defined changes in blood levels of cortisol, ACTH, IL-6, and TNF- α following mindfulness meditation in adults with generalized anxiety disorder (GAD). The most sensitive indicators appeared to be ACTH and IL-6, after use of the Trier Social Stress Test to induce an acute stress response. This study provided direct evidence that biological substrates of stress responses may be altered in response to a mindfulness-based therapy intervention. MBSR attenuated stress hormone and inflammatory marker responses to stress in patients with GAD. An additional study from the same group suggested that mindfulness-induced improvements in anxiety may be mediated primarily through a practice called decentering.⁵² Decentering is an ability to recognize that thoughts, feelings, and urges are transient internal events and not inherent, permanent aspects of the self or accurate depictions of reality. Investigation of underlying neural mechanisms of an MBSR-intervention in patients with GAD using functional magnetic resonance imaging (fMRI)⁵³ revealed that at baseline, GAD patients exhibited enhanced amygdala activation than did controls in response to neutral faces; thus, ambiguous stimuli produced stronger reactions in patients with the anxiety disorder. In GAD patients, amygdala activation to neutral faces decreased following MBSR and activation in the prefrontal cortex increased. Changes in amygdala-to-prefrontal functional connectivity were correlated with changes in self-reported anxiety, and interestingly, amygdala-to-prefrontal connectivity changed from negative coupling (typically seen as part of emotional

down-regulation), to positive coupling. These data suggest a potential neuronal mechanism by which mindfulness can regulate brain circuit activation and processing.

A more specific approach is termed mindfulness-based cognitive therapy (MBCT).^{54,55} MBCT follows the same eight-week group therapy structure as MBSR and is made up of similar content. It employs the tenets of mindfulness and CBT to address specific symptoms and patterns of negative thinking associated with major depressive disorder (MDD).⁵⁶ In systematic reviews of MBCT for MDD and associated depressive outcomes,⁵⁷ and MBSR compared to MBCT,⁵⁸ there is strong evidence that ameliorations in emotional reactivity and cognitive augmentation contribute to the underlying mechanisms of these mindfulness-based interventions. There are also indications that they may have predicting or mediating roles in things like rumination, worry, mindfulness, compassion, and meta-awareness. However, as with most research of psychological interventions, there are some inconsistencies in the theoretical frameworks between researchers, and strong conclusions regarding the mechanisms at play are still elusive.

Yet another variant of a mindfulness intervention is termed integrative body-mind training (IBMT), and this approach focuses on integrative central and autonomic nervous system training through body relaxation, mental imagery, mindfulness training, and music. Studies suggest that IBMT can improve emotion regulation,^{59,60} improve cognitive control,^{59,60} reduce salivary cortisol,⁶¹ and alter brain structure and function.^{59,62–64} In one particularly interesting study, investigators found improved emotion regulation, self-control, and stress reduction after IBMT training; these improvements correlated with augmented activity in the prefrontal and anterior cingulate cortices following training.⁵⁹ People who smoke exhibited diminished prefrontal cortical activity in the network ahead of training (as compared to nonsmoking participants), and training ameliorated these deficits, demonstrating that this approach may be useful in the treatment and prevention of drug addiction.

MBAT

Art therapy is a mental health service that integrates creative processes with traditional talk therapy.⁶⁵ It has been used in a variety of settings, with individual, family, and group therapies, to address multiple mental health challenges.^{66,67} One of the advantages of art therapy is that it provides a mode of communication that can be less intimidating than traditional verbal communication. Additionally, the creative process and art materials may contain intrinsic therapeutic properties that may be a valuable asset to mental health services. As with the mindfulness interventions described above, with brain imaging technologies and unobtrusive tests of biological markers, there are emerging data that support art playing an active and effective role in stress management and addressing symptoms of anxiety.

For example, Kaimal *et al.*⁶⁸ gave 39 healthy individuals the choice of collage materials, modeling clay, and/or markers for a brief art-making session. Most participants

had a small but significant decrease in salivary cortisol levels after art making. Although the extent of the changes were widely varied between individuals—the source of this likely complex heterogeneity in responses was unclear, despite the authors fairly detailed analysis of prior experience with art, art materials used, gender, ethnicity, and age. In a more recent study, the same research group⁶⁹ looked at blood flow in the medial prefrontal cortex. Participants were asked to complete three visual self-expression tasks including coloring a pre-drawn mandala, personalized doodling, and free drawing on a blank sheet of paper. Data on cerebral blood flow in the brain were collected for each task, in addition to resting periods in between. All of the tasks produced activation of prefrontal cortical regions, with no statistically significant difference among tasks. They also included a self-report measure regarding self-perception of creativity, which increased for all participants at the end of the session. Building healthy habits typically requires practice and positive reinforcement. The activation of this pathway during art making suggests that practicing art making can have lasting benefits in healthy habit building that combats stress.

Another intriguing study compared clay work to drawing.⁷⁰ Electroencephalograms were used to monitor brain activity patterns in healthy female participants engaged in the two different art tasks; the study found that both drawing and clay sculpting increased gamma power, which is associated with information-rich task processing, but only clay sculpting resulted in increased theta power. Theta waves are associated with deep meditative states, imagination, and internal focus.⁷¹ These findings suggest that clay carries intrinsic therapeutic properties that may complement mindfulness, as the act of clay sculpting alone appears to be able to induce relaxation and even a meditative state. We note, however, that the study of Kaimal did not observe any effects of art media choice on cortisol levels.⁶⁸

Art therapy and mindfulness practices have complementary effects on neurological and biological processes as well as mental health. MBSR protocols are integrated with art therapy prompts and art making in order to perform MBAT; in other words, MBAT typically combines the MBSR protocol with complementary art therapy directives.⁷² MBAT has been examined using randomized controlled trials, typically for severe illness management like cancer^{73–78} and coronary artery disease.⁷⁹ Monti *et al.*⁷³ used fMRI and successfully correlated brain activation responses to stress and anxiety measures with engagement in their MBAT regimen. MBAT-receiving participants showed increases in blood flow in several limbic brain regions, including the insular cortex, amygdala, hippocampus, and the striatum. These changes occurred both at rest and during meditation. Moreover, reactions to a stressor involved decreased activation of the cingulate cortex in MBAT-receiving participants, demonstrating regulation of a specific neural circuit—one that is already known to be involved in stress responses and anxiety regulation^{25,80}—by MBAT.

Our group recently demonstrated significant decreases in anxiety symptoms and salivary cortisol in anxious but

healthy college students receiving MBAT.⁸¹ The most typical MBAT protocol consists of 2-h sessions weekly for eight-weeks⁷²—this is more time- and cost-intensive than even CBT. Validation of more abbreviated and efficient MBAT approaches is crucial in determining whether this therapeutic approach can be effective in large-scale deployments. Thus, rather than following the standardized eight-week protocol, ours utilizes one initial in-person facilitated session, eight 15-min easily reproducible, clay-based MBAT directives, administered through an online platform, and then one final in person session (Figure 1). Although our initial proof-of-concept study was small, a follow-up study of 77 participants demonstrated positive effects on both anxiety and perceived stress (Beerse, Van Lith and Stanwood, unpublished data). Therefore, it appears that MBAT has the capacity to improve mind and body outcomes by concurrently activating and reorganizing behavioral, neurobiological, and neuroendocrine processes while supporting the healthy development of social and emotional processes. The fundamental science underlying MBAT—and a mechanistic understanding of its endocrine and neural mechanisms—will potentially lead to a novel biobehavioral approach to help reduce the burden of anxiety symptoms, anxiety disorders, and protect against chronic daily stress. Our utilization of a web-based application offers a feasible strategy for increasing access to mental health services while circumnavigating the issue of stigma that still surrounds mental health. This may be especially true for those who are wary of traditional services and for those who feel their symptoms are distressing but

not yet dysfunctional. Mental health apps are increasing in popularity, but few have been rigorously studied,^{82–84} and most rely on self-report measures,⁸⁵ failing to investigate the biobehavioral implications. Ours appears to represent the first project adapting a systemized MBAT intervention to an electronic delivery system that can be up-scaled quickly and efficiently.

Future directions

The neural basis of the nature and benefits of mindfulness, and especially MBAT specifically, is still in its early days. Nonetheless, a good deal of data have been already generated, and published work in this area is growing very rapidly. It is important to assess what has been learned to date and to further improve experimental designs and approaches. There is a need for more rigorous and transparent studies, delineation of subpopulations of individuals showing differing responsiveness to the interventions, and a more complete understanding of the host of neuroendocrine, behavioral, and neural changes that mediate therapeutic success. These behavioral approaches have great promise in the treatment of complex mental health conditions, but additional science is needed to discern how to best deploy them. As described in a recent meta-analysis,⁴⁴ there is a lack of consistency across studies in type of mindfulness intervention and control conditions used in studies. Furthermore, few studies include subgroup analyses and the field needs to do better. With regard to MBAT specifically, to our knowledge, only one study has examined changes in neural activation

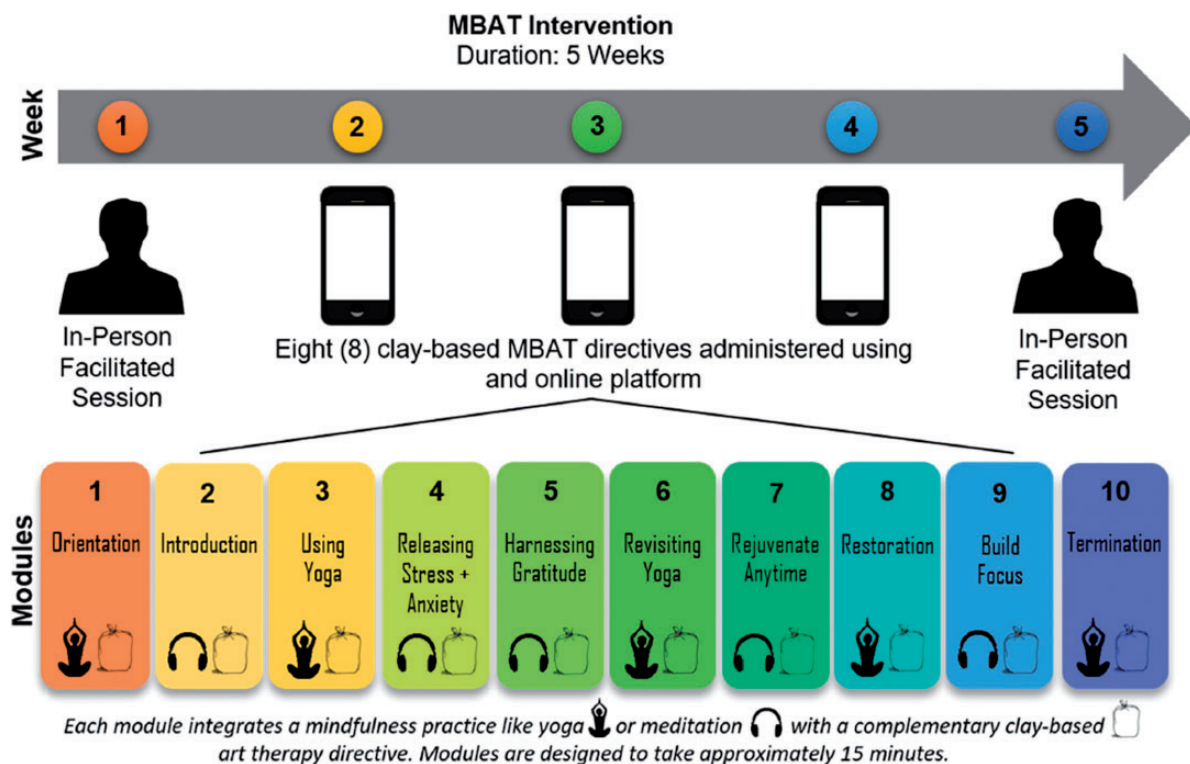


Figure 1. Structure of MBAT intervention designed to maximize user accessibility and implemented by our group. (A color version of this figure is available in the online journal.)
MBAT: mindfulness-based art therapy.

patterns,⁷³ and that was in only 18 patients with brain cancer (of course, many others—some cited above in this article—have used functional neuroimaging to better understand meditation and mindfulness themselves). Comprehensive identification of the neuroprotective circuits recruited by MBAT interventions and resultant modifications of stress hormone and metabolic signaling pathways are sorely needed. In Figure 2, we present a

potential conceptual framework that may be of utility in this effort.

Cognitive and emotion regulation mechanisms in the brain are often discussed as being based in “top-down” or “bottom-up” in nature. Quite simply, top down processing refers to processing based on what is already in the mind or highest levels of the brain. In contrast, bottom up processing refers to processing based on what is in the

Possible Mediating or Moderating Variables of MBAT

MBAT Delivery

- MBAT Facilitator
(*training, clinical experience, characteristics, and approach*)
- Delivery Strategy
(*in-person vs. online, individual vs. group*)

MBAT Protocol

- Mindfulness Practice
(*meditation, guided visualization, yoga, breathing*)
- Art Material- Clay (kinesthetic and sensory experiences)
- Art Directive/Prompt
(*sequential steps or broadly defined*)
- Dosage
(*duration of each session, frequency, duration of intervention, participant engagement*)
- Art work
(*type of connection*)

Recipient Characteristics

- Demographic Characteristics
(*age, gender, race, marital status, occupation, annual income, education level, geographical location*)
- Experience with Mindfulness and/or Art-Making
- Subgroup Identifier
(*pre-existing diagnosis, somatic symptoms, sleep quality and quantity, pre-natal/postpartum, student, etc.*)

Potential Outcomes

Behavioral

- Changes in self-reported symptoms
(*quality of life, anxiety symptoms, stress symptoms, somatic symptoms*)
- Sleep quality and quantity
- Performance in resilience testing
(*Trier Social Stress Test*)
- Academic or occupational performance

Physiological

- Systolic and diastolic blood pressure
- Heart rate variability
- Heart rate
- Muscle tension

Neuroendocrine

- Inflammatory markers
- Stress hormones
- Metabolic signaling pathways

Neural

- Changes in neurobiological circuit activation
- Changes in brain wave activity

Figure 2. Proposed methodologies, experimental design considerations, and analyses to improve our understanding of the therapeutic benefits of MBAT and biobehavioral mechanisms through which these benefits are achieved. (A color version of this figure is available in the online journal.)
MBAT: mindfulness-based art therapy.

stimulus array reaching sensory organs. Some authors have suggested that mindfulness is a top-down strategy to regulate emotion, while other groups propose that mindfulness is, instead, bottom-up.⁸⁶⁻⁸⁹ Discrepancies are produced in part from the distinct definitions, descriptions, and uses of mindfulness. One suggestion is that mindfulness training produces top-down emotional regulation in the beginning, but with practice and time, recruits bottom-up neural mechanisms in longer-term, expert practitioners/users.⁸⁶ However, this has yet to be fully tested or established. The particularly effectiveness of MBAT might also be based on a more unified joint processing from both directions, given the direct engagement of art materials and art-making with one's sensory organs. Directed study of these possibilities is warranted.

The reciprocal relationship between anxiety, stress, and sleep disruption should be addressed in future treatment research designs of MBAT. It is commonly known that anxiety and stress, characterized by cognitive difficulty and emotional reactivity, are also associated with sleep disruption and the development of insomnia.⁹⁰⁻⁹⁷ Several etiological models have highlighted shared mechanisms between anxiety, stress, and sleep disruption that may explain the reciprocal risk and high comorbidity.^{91,98-100} Specifically, cognitive and emotional arousal, sleep-stress reactivity, and emotion regulation mechanisms, including mindfulness, may all play an important role.¹⁰¹⁻¹⁰⁶ Mindfulness-based treatments, as discussed previously, are effective for the reduction of stress and anxiety symptoms and, interestingly, are effective for improvements in sleep disruption and insomnia.¹⁰⁷⁻¹⁰⁹ However, improvements in sleep disruption as a result of MBAT have not been examined. Therefore, the assessment of sleep characteristics in MBAT treatment research designs for anxiety and stress would add to the growing evidence concluding that mindfulness-based treatments are effective for promoting healthy sleep, and potentially confirm that targeting shared mechanisms in treatment can improve anxiety, stress, and sleep difficulties simultaneously (Figure 2).

Even though the American Psychiatric Association reorganized the 5th edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM) away from a multi-axial system, there has since been an appeal for a symptom-based approach to mental health research rather than based on diagnosis.¹¹⁰ A symptom-based approach acknowledges that most mental disorder diagnoses are not rooted in neurobiological evidence, but rather supported by neurobiological research *ex post facto*. In this approach, research cohorts are organized by their predominant symptoms and complaints. With MBAT research still in its infancy, there is an opportunity to collect data in a symptom-based approach that withstands the evolution of diagnostic criteria relating to anxiety disorders as well as mood disorders. Instead, researchers can determine how MBAT interventions interact with a variety of somatic symptoms that are often associated with anxiety and stress, such as migraines, gastrointestinal problems, muscle pain or spasms, fatigue, and sleep disruptions. Additionally, research cohorts could be organized by group characteristics. For instance, a recent review has

summarized emerging literature suggesting that mindfulness-based programs can decrease psychological stress during pregnancy and improve maternal mental health.¹¹¹ Similarly, cohorts could be organized by other characteristics like unique cultural groups or individuals within a set geographical location which could all provide insight into the more nuanced variables that interact with mental health research.

While variables on the receiving end can be strategically organized, so, too, can the intervention strategy be manipulated to better understand the mechanisms at play. The MBAT protocol and delivery strategy could be altered to determine whether a face-to-face intervention would elicit stronger positive outcomes than an electronically delivered intervention. Recipients of MBAT could also be divided into individual or group therapy structures, since MBSR emphasizes the importance of using a group therapy format. Lastly, MBAT is fundamentally unique in the realm of mental health approaches due to the valuable role art materials and the creative process hold. Even subtle manipulations in art-making instruction and material can further breakdown the mechanisms underlying this intervention.

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ORCID iD

Gregg D Stanwood  <https://orcid.org/0000-0001-6005-1203>

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