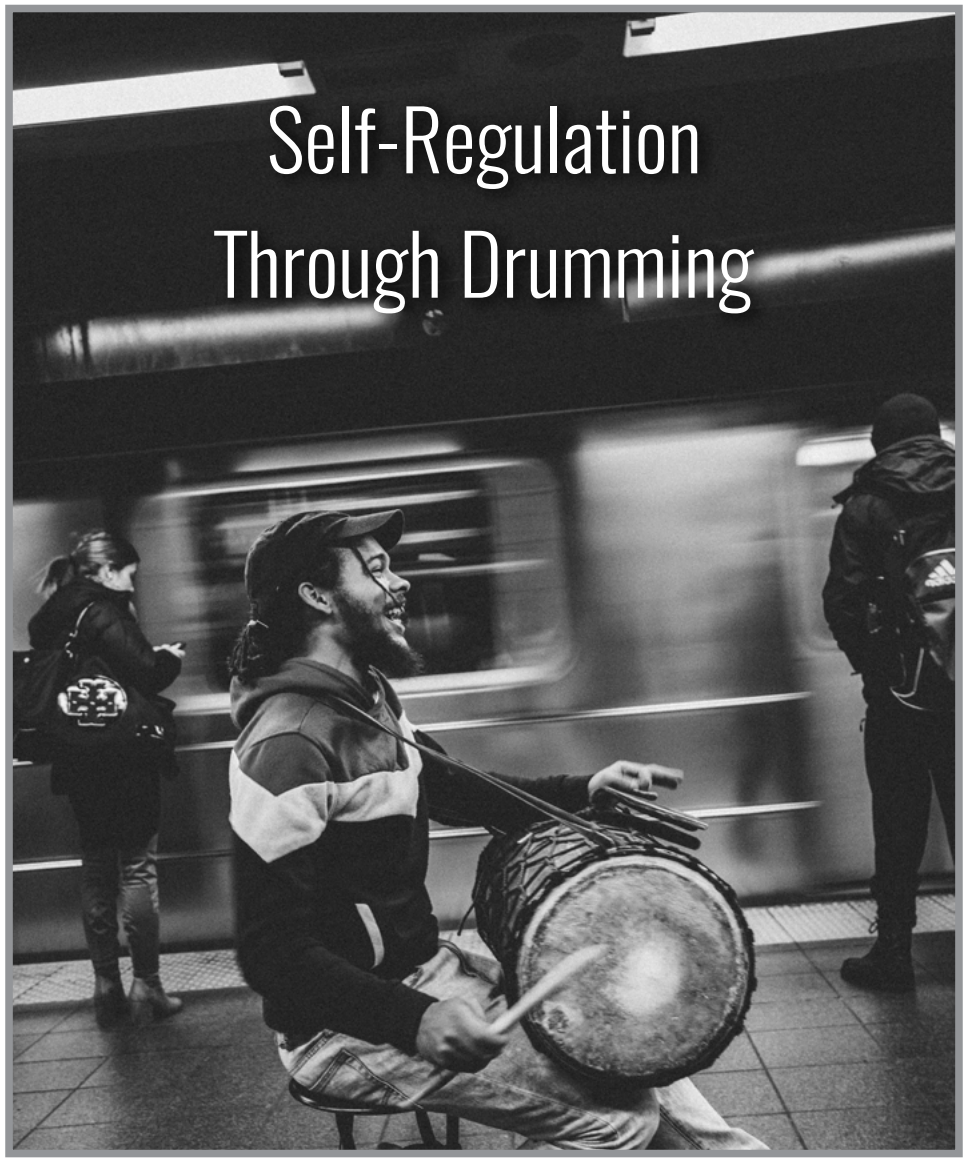

A Brain-Body Model for Optimizing Mental Health

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> Drumming offers a comprehensive, adaptive and widely accessible method of physical and mental training that assists with self-development

FEATURE

When it comes to staying healthy, both physically and mentally, current neuroscientific research suggests the health benefits of drumming are plentiful. Yet there is currently no overarching framework by which to understand drumming's potential beneficial effects for optimizing mental health and wellbeing. This article offers a theoretical framework and brain-body based model of drumming that focuses on integrating multiple approaches to brain change and self-regulation.

INTRODUCTION

Within the therapeutic context, the term "drumming" refers to a holistic mind-body discipline, part of which includes breath control, simple meditation, and an integrative system of coordinated body movements (Lynn-Seraphine, 2019). Drumming offers a comprehensive, adaptive and widely accessible method of physical and mental training that assists with self-development and, as I propose, improves self-regulation of an individual's cognition, emotions, and behaviors through top-down and bottom-up mech-

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anisms. In this article, I'll begin with a brief contextualization of the art of drumming as a mind-body discipline in historical and contemporary settings. From there, I'll present a sample of available evidence that highlights the beneficial effects of drumming. I'll also offer an explanation as to how specific components of a regular drumming practice may affect brain networks underlying self-regulatory processes associated with stress, attention, and emotion. The brain-body model I propose describes drumming practice as a comprehensive skill set of five synergistic processing components that facilitate bi-directional feedback and integration of brain networks that result in improved physical, emotional, and psychological health.

From a clinical perspective, I propose a paradigm shift towards empowering individuals with a rhythmic skillset that requires minimal effort at first, yet has the potential to easily expand in sophistication to assist in the treatment of clinical disorders. To support my proposed model, I will present available evidence involving therapeutic effects of rhythm integration affecting self-regulatory pathways by integrating existing constructs from polyvagal theory and cognitive neuroscience with emerging research on drumming and meditation. This article is intended to guide future research on therapeutic drumming, specifically as it relates to treating trauma and other stress-induced psychological disorders.

ORIGINS AND RESEARCH

Drums, also referred to as membranophones, are thought to originate from Western Asia over 7000 years ago (Dean, 2012; Hart & Lieberman, 1991; Redmond, 1997). They can be found in many different shapes and forms and are present in nearly every country and culture in the world. In Western contemporary settings, drumming tends to be synonymous with musical performances, drum circles, and some meditation practices. Historically, however, the practice of drumming was understood to be a far broader, more comprehensive and integral healing discipline widely practiced as a medium for communication, spiritual rituals, and exploring human consciousness. While there are many types of drums, no specific type is required in a clinical setting. Ethnic hand drums are often preferred, though, due to their portability and cost-effectiveness.

Over the last decade, the research involving the therapeutic effects of drumming has seen tremendous growth, and yet little has been written about the supporting evidence. In fact, several studies have shown drumming to offer beneficial effects on cognitive, psychological, and physical health, including support of behavioral and emotional regulation for improved symptoms of depression, anxiety, stress, post-traumatic stress disorder, and a myriad of benefits for other health conditions (Bensimon et al., 2008; Martin et al., 2017; Perkins et al., 2016; Smith et al., 2014).

For example, Fancourt (2016a) and his colleagues from London's Royal College of Music (RMC) investigated the positive mental health effects of group drumming. The research was carried out among 76 mental health users across two studies. Subjects took part in six- and ten-week programs of drumming workshops led by a professional drummer and supported by students from the RCM. Results showed reduced symptomology of depression

by 38%, while anxiety dropped by 20%, social resilience increased by 23%, and mental well-being improved by 16%. Not surprisingly, the benefits were still evident three months later. In addition, they noted a significant reduction of inflammation and improved immune systems, leading them to also suggest underlying biological effects could support drumming's therapeutic potential for mental health (Fancourt et al., 2016b).

In a similar way, Newman et al. (2015) investigated the psychological benefits of group drumming as a way to prevent staff burnout at a mental health care facility. The study population consisted of 30 staff members who participated in group drumming sessions. Their conclusion highlighted various mechanisms supporting enhanced wellbeing among participants, including improved mood, productivity, energy, relaxation, sense of accomplishment, and emotional expression.

Equally important, from a cognitive perspective, Professor Frederic Ullen, from the Karolinska Institutet in Stockholm, conducted a study that showed a link between intelligence, good timing, and the part of the brain used for problem-solving (Ullen et al., 2008). Professor Ullen and colleagues asked 34 right-handed men aged between 19 and 49 to tap a drumstick at a variety of different intervals. They were then given a psychometric test of 60 questions and problems. The results showed that participants with high general intelligence were more stable on a very simple timing task. They also discovered that these drummers had larger volumes of white matter, the type of tissue which connects different regions of the brain (Ullen et al., 2008). Professor Ullen's results suggest a bottom-up explanation of the link between temporal sta-

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bility and intellectual performance.

Additionally, from a psychosocial perspective, University of Oxford psychologist, Robin Dunbar, discovered that when drummers play together, both their happiness levels and pain tolerance increases (Dunbar, et al., 2012). More specifically, Dunbar and his colleagues reported that people who have been playing music have a higher tolerance for pain which is an indication that their bodies are producing endorphins, also referred to as natural opiates. The drummers also reported higher levels of positive emotions. Observing this natural opiate high led the researchers to hypothesize that drumming was an integral part of community bonding and that sharing rhythms was the sort of behavior necessary for the evolution of human society.

My proposed brain-body model of self-regulation through drumming is backed by the above case studies, as well as other available literature demonstrating the effects of drumming for acute and longer-term outcomes. Many different explanations regarding its positive effects have been proposed, but so far there is no overarching framework in which to understand them. A useful framework for investigating doing so is that of self-regulation.

THE ROLE OF SELF-REGULATION

Self-regulation is a vital skill that is generally thought of as the ability to have self-control over emotions and behaviors. Although self-regulation and self-control are similar, they have two distinct constructs. As psychologist Stuart Shanker puts it: "Self-control is about inhibiting strong impulses; self-regulation reduces the frequency and intensity of strong impulses by managing stress-load and recovery. In fact, self-regulation is what makes self-control possible, or, in many cases, unnecessary." (Shanker, 2016).

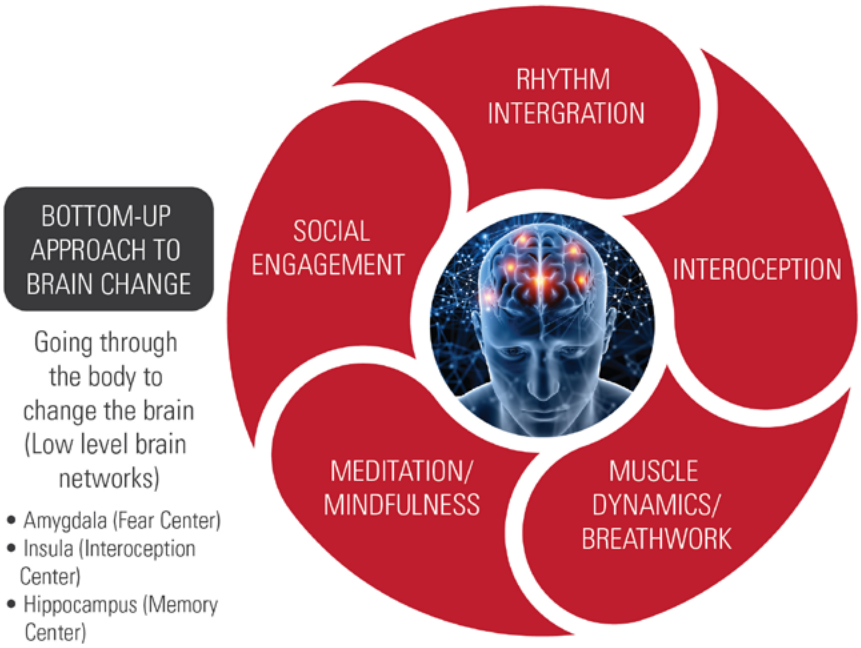
Self-regulation also plays a role in how we set long term goals to pursue, implement effective strategies, monitor our progress, and make adjustments that help us achieve long term goals. "Instead of acting impulsively, the self can delay gratification and suppress short-term temptations in order to pursue long-term goals that are larger and more motivating" (Reeve, 2018, p. 258). More formally, self-regulation involves a process of metacognitive planning, implementing, monitoring, and self-reflection. Those with high self-regulation are often better at managing their emotions, living with integrity, and practicing the self-discipline needed to achieve their goals.

Theories of self-regulation play a central role within numerous sub-disciplines such as psychotherapy, sport psychology, and cognitive neuroscience (Banfield et al., 2004; Baumeister et al., 2007; Grecucci et al., 2017; Kirschenbaum, 1984; Strauman et al., 2013). Generally speaking, the process of self-regulatory activity includes four interacting components: standards of desirable behavior, motivation to meet standards, monitoring factors that break standards, and the willpower of inner strength to control urges (Baumeister, 2007; Reeve, 2018). The goal for most contemporary psychotherapists is to help their clients develop self-regulation skills to reduce psychological stress and regain a sense of control over their lives.

For example, many psychotherapists use

SELF-REGULATION THROUGH DRUMMING

(A BRAIN-BASED MODEL)



BOTTOM-UP APPROACH TO BRAIN CHANGE

Going through the body to change the brain (Low level brain networks)

- Amygdala (Fear Center)
- Insula (Interoception Center)
- Hippocampus (Memory Center)

TOP-DOWN APPROACH TO BRAIN CHANGE

Going through the mind to change the brain (High level brain networks)

- Prefrontal Cortex (Thinking Center)
- Cingulate Cortex (Emotional Center)

Pro-Active Behavior
Social Engagement

Cardiovascular & Immunity Enhancement
Physical Self-Efficacy

Optimized Mental Health
Improved Brain Function

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cognitive-behavioral treatment methods that focus on top-down cognitive means of self-regulation such as cognitive reappraisal, goal-setting, and imaginal exposure or narrative writing. Additionally, "third-wave" cognitive behavioral therapists have embraced emerging approaches to psychotherapy such as dialectical behavioral therapy (DBT) (Carpenter, 2013), metacognitive therapy (MCT) (Nordahl & Adrian, 2018), psychological skill training (PST) (McCrory et al., 2013) and mindfulness-based skill development (Siegel, 2007). There is increasing support in the literature to suggest that mindfulness offers a combination of strategies involving top-down and bottom-up emotional mechanisms for self-regulation (Chiesa et al., 2012).

INTEGRATING BRAIN CHANGE APPROACHES

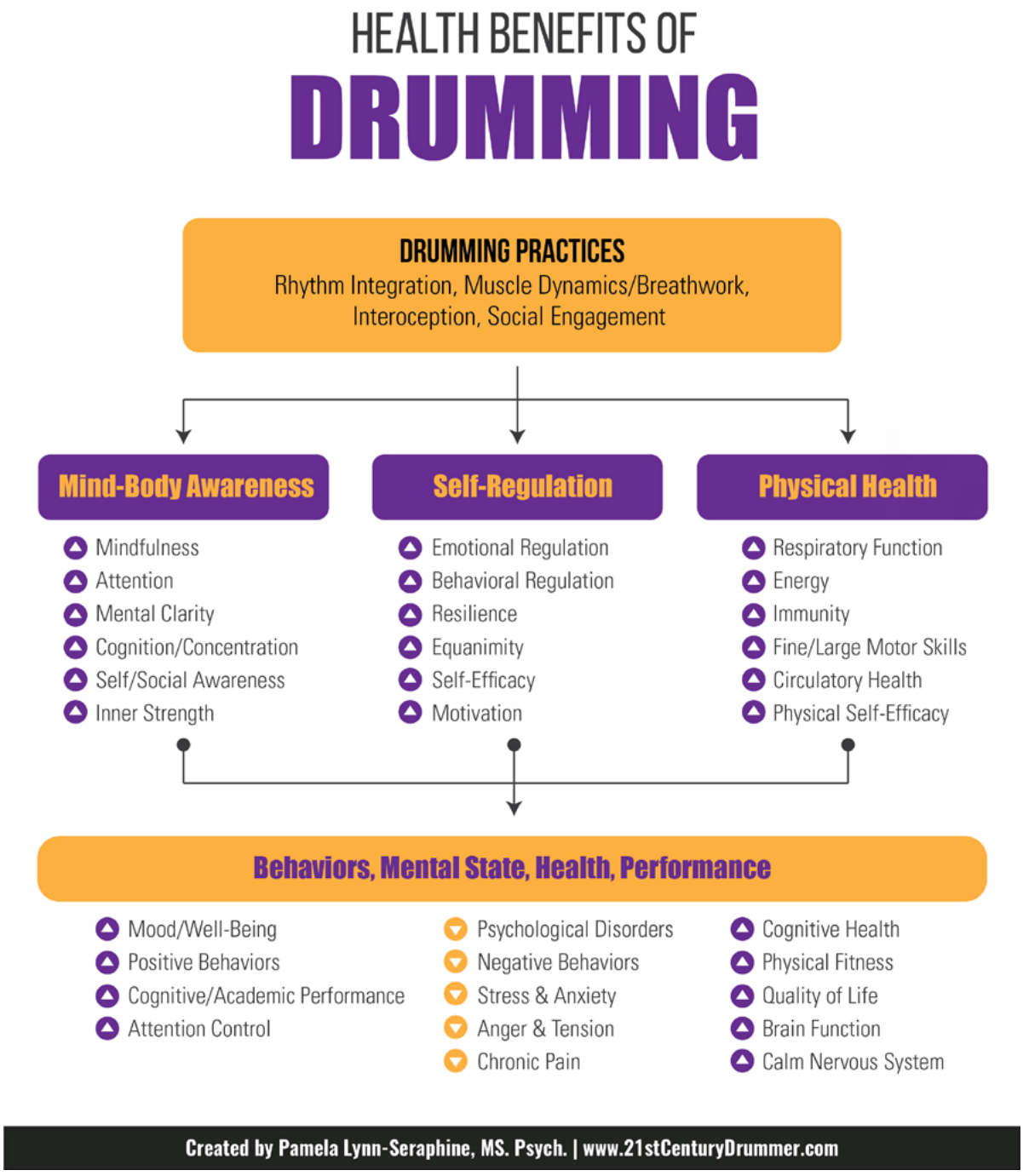
The art of drumming utilizes both top-down and bottom-up approaches to brain change and self-regulation. Top-down strategies occur when there is an emphasis on attentional control. In other words, when using top-down techniques, the mind is engaged to change the brain. When a drummer is specifically learning new material or they are intentionally practicing meditative drumming, they are harnessing top-down executive mechanisms. Top-down approaches can be used to strengthen higher cortical areas of the brain such as the prefrontal cortex (thinking center) and the cingulate (emotional regulation center) (McRae, 2012). Within a clinical context, various top-down alternatives can be added to drumming practice for greater impact such as closed trainspotting awareness, open awareness, closed concentration, and alternating open/closed meditation.

Conversely, bottom-up techniques utilize the body's ability to change the brain, especially in lower subcortical areas that are generally outside of conscious awareness and control (Ochsner, 2009). The nature of drumming itself, as a kinesthetic practice, has the ability to utilize bottom-up techniques as an effective way to leverage signals through the body to change brain structures such as the fear center (amygdala), introspection center (insula), and the memory center (hippocampus) (Ochsner et al., 2010). More specifically, bottom-up techniques change the brain in three key ways: deactivation of the amygdala, which reduces the stress response; regulating activation in the insula, which reduces anger, emotional outbursts, and dissociation; and enhancing activation in the hippocampus, which increases feelings of safety and aids in coping with negative memories (Sweeton, 2019).

As drumming practice deepens, the emphasis on enteroception can increase and modulation of emotional-generative brain regions (limbic) can be activated without increased use of higher brain regions responsible for cognitive forms of regulation. Both general and meditative drumming practices involve the influence of peripheral sensory, visceral, cardiovascular, immune, and autonomic input on neural processing and mental activities via regulatory pathways (Bittman et al., 2001; Geiser et al., 2014).

THE BRAIN-BODY MODEL

In my integrated brain-body model, I propose that specific aspects of drumming affect self-regulation through various feedback loops


HEALTH BENEFITS OF
DRUMMING
DRUMMING PRACTICES
Rhythm Integration, Muscle Dynamics/Breathwork,
Interoception, Social Engagement
Mind-Body Awareness
Mindfulness
Attention
Mental Clarity
Cognition/Concentration
Self/Social Awareness
Inner Strength
Self-Regulation
Emotional Regulation
Behavioral Regulation
Resilience
Equanimity
Self-Efficacy
Motivation
Physical Health
Respiratory Function
Energy
Immunity
Fine/Large Motor Skills
Circulatory Health
Physical Self-Efficacy
Behaviors, Mental State, Health, Performance
Mood/Well-Being
Positive Behaviors
Cognitive/Academic Performance
Attention Control
Psychological Disorders
Negative Behaviors
Stress & Anxiety
Anger & Tension
Chronic Pain
Cognitive Health
Physical Fitness
Quality of Life
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across multiple systems, which, in turn, promote brain changes that result in the promotion of psychological, physical, and emotional health. The integration of brain-mind-body healing through drumming involves a skillset of five tools for self-regulation:

- Rhythm Integration
- Interoception
- Muscle Dynamics/Breathwork
- Meditation/Mindfulness
- Social Engagement.

Each of these components potentially offers positive attributes that affect cognitive, emotional, and behavioral systems under stress; and they have the potential to improve one's physical and psychological functioning during drumming practice as well as everyday life. A brief description of the five skillset tools of drumming for self-regulation follows.

Rhythm Integration. The foundation of the drummer's path towards self-regulation is rhythm integration. The central concepts of rhythm integration include movement, time, rhythmic attunement, and applied rhythmic entrainment. For example, applied rhythmic entrainment refers to the physiological synchronization that occurs between the brain patterns of the drummer and the sound patterns being played on the drums (Lynn-Seraphine, 2016). Sound vibrations permeate through the entire body and induce a deep sense of awareness. The opportunity to mindfully focus on the rhythmic patterns allows for the vibrations to sink deeper into one's body and consciousness. Research shows that auditory-motor coupling can affect one's hormones, cognition, behavior, and psychological wellbeing (Moumdjian, 2018). Each element of rhythm integration includes its own set of valuable assets that help reduce physical and emotional stress. Rhythm and movement-based techniques are generally used as bottom-up processes that reduce the stress response and amygdala activation.

Interoception. The ability to "feel inside" one's own body and be aware of internal states is an essential component of self-regulation (Reeves, 2018). The insula is the brain structure primarily responsible for interoception, and a strongly regulated insula helps identify physical and emotional sensations (Gasquoine, 2014). The practice of drumming facilitates interoception by means of touch and the need for anchoring into the present through sensory sensitization. Drummers can learn to improve interoception abilities and feel into their bodies, which in turn allows them to better understand how they feel physically and emotionally.

Muscle Dynamics/Breathwork. Everything about drumming involves muscle dynamics and breathwork. Muscle dynamics are essential to understanding how we feel while playing, and what we can interocept. Similarly, focused breathing can be used as a powerful way to create change in the brain and body. Breathing techniques can be used as both bottom-up and top-down approaches to brain change. When drummers focus on a rhythmic pattern, sensation or image, their cognitive control activates cortical regions, thus changing the brain top-down. Equally important, focused diaphragmatic breathing facilitates the activation of the ventral vagus nerve, which deactivates subcortical brain regions and reverses the stress response (Porges, 2003).

Meditation/Mindfulness. For the purpose of our brain-body model, meditation is defined as a set of practices that train the mind to focus on a set of elements such as sensations, emotions, thoughts, or external stimuli. In traditional drumming practices, concentrative (closed) meditative techniques have been primarily used to induce altered states of consciousness and spiritual enlightenment (Remond, 1997). A nonsectarian approach to the practice of meditative drumming merely involves the process of being able to direct undivided attention towards a single focus, whether it's a word, prayer, or sound (Lynn-Seraphine, 2019). Sustained attention on a focal point during meditation not only lowers activity in the default mode network but also facilitates the physiological benefits of tapping into the body's parasympathetic nervous system (Benson, 1974; Lynn-Seraphine, 2019). Additionally, building awareness through kinesthetic-tactile learning involves bottom-up processing, which stimulates physiological and neurochemical changes that can influence positive emotions without the need for conscious cognitive input.

Equally important is the facilitation of mindfulness meditation (open awareness) involved with any drumming practice. The beneficial effects of mindfulness practices are related to both top-down and bottom-up emotional regulation (Chiesa, Serretti, & Jakobsen, 2012).

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Although the practice of drumming contains both bottom-up and top-down components, special attention can be given to intensify cognitive monitoring, awareness, and attention. For example, while kinesthetic-tactile learning can involve bottom-up processes, mindfulness meditation allows for open awareness of domains including one's body, emotions, thoughts, or the external environment. Drummers often drift between both domains of meditation. For example, when learning something new, drummers may set their intention to attend to their movements and allow their attention to drift wherever their body needs to move in order to achieve their musical goals. However, once integrated into their motor memory, their time can be spent moving freely between concentrative (closed) exercises and allowing their mind to drift (open awareness) on a selected thought or allowing themselves to be lost in random thoughts.

Current neuroscientific research shows that meditation changes the brain in various ways: there is less activation in the amygdala (fear center); more activation in the hippocampus (memory center), cingulate (self-regulation center) and prefrontal cortex (thinking center); and improvement in connectivity and overall functioning (Lazar et al., 2000). However, different practices lead to different results, and a lot depends on the individual and the techniques being applied.

Social Engagement. Current neuroscientific investigations have led to important insights into the neural substrate of social behavior from a biological perspective. The proposed brain-body model of self-regulation through drumming relies on new conceptualizations within polyvagal theory. Specifically, the brain-body model relies on the important link between phylogenetic changes in the autonomic nervous system via social engagement. Researchers have proposed that dysfunctional mental states are interictally related to an excessive vagal outflow and an imbalance between sympathetic and parasympathetic branches in the autonomic nervous system - all of which is consistent with polyvagal theory (Porges, 1976; Porges, 2003; Wenger, 1941).

The proposed brain-based model provides a theoretical platform to interpret the benefits of social engagement within a neurophysiological context of drumming for self-regulation. From a polyvagal perspective, the interaction between the drummer and other individuals present during the applied practice results in various phylogenetic changes in the autonomic nervous system and social behavior.

FUTURE DIRECTIONS

As discussed above, drumming can be broken down into a skillset of five tools for self-regulation: Rhythm Integration; Interoception; Muscle Dynamics/Breathwork; Meditation/Mindfulness; and Social Engagement. In my proposed brain-body model (Figure 1), I describe how this skillset may facilitate self-regulation and result in optimized mental health and wellbeing. In this model, I've proposed how drumming skills facilitate bi-directional feedback and improve integration and efficiency of high-level brain networks (e.g., central executive network, frontal-parietal control network, etc.) and low-level ones (e.g., autonomic systems, vagal complex, etc.) along with cardiac, respiratory, and peripheral sensory informa-

tion. The model proposes that a regular practice of drumming provides motivation for realistic goals and positive intentions to approach social engagement as a supportive framework to develop and further future aspirations.

From a clinical perspective, the proposed brain-body model of drumming can be used to further our understanding of the growing body of research linking drumming with improved mental health and wellbeing. Although drumming research is complex due to the various process tools involved, future research should systematically test the proposed framework. Through the practice of drumming, the proposed mechanisms are likely to give individuals a means to enhance adaptive autonomic nervous system functioning and cognitive-emotional-behavioral processes that will help them better deal with the stressors of daily life. A paradigm shift towards empowering individuals with a rhythmic skillset to begin the process of positive brain change has the potential to transform lives for the better. The brain-body model for self-regulation through drumming can advance our understanding of human functioning as well as promote more effective interventions for improving human health and wellbeing.

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REFERENCES

Banfield, J. F., Wyland, C. L., Macrae, C. N., Münte, T. F., & Heatherton, T. F. (2004). The cognitive neuroscience of self-regulation. In R. F. Baumeister & K. D. Vohs (Eds.), *Handbook of self-regulation: Research, theory, and applications* (pp. 62-83). New York, NY: Guilford Press.

Baumeister, R. F., & Vohs, K. D. (2007). Self-regulation, ego depletion and motivation. *Social and Personality Psychology Compass, 1. doi:10.1111/j.1751-9004.2007.00001.x*

Bensimon, M., Amir, D., & Wolf., Y. (2008). Drumming through trauma: Music therapy with post-traumatic soldiers. *The Arts in Psychotherapy, 35, 34-48.*

Benson, H., Beary, J.F., & Carol, M.P. (1974). The relaxation response. *Psychiatry, 37* (1), 37-46. doi:10.1080/00332747.1974.11023785

Bittman B., Berk., Felten, D., Westergard, J., Simonton, C., Pappas, J., & Ninehouser, M. (2001). Composite effects of group drumming music therapy on modulation of neuroendocrine-immune parameters in normal subjects. Alternative Therapies, 7(1): 38-37.

Burnard, P., & Dragovic T. (2014). Collaborative creativity in instrumental group music learning as a site for enhancing pupil well-being. *Cambridge Journal of Education*, *45,* 1–22. Carpenter, R. W., & Trull, T. J. (2013). Components of emotional dysregulation in borderline personality disorder: A Review. *Current Psychiatry Reports, 15*, 335.

Chiesa, A., Serretti, A., & Jakobsen, J. C. (2012). Mindfulness: Top-down or bottom-up emotion regulation strategy? *Clinical Psychology Review, 33,* 82-96.

Dean, M. (2012). The Drum: A History. Plymouth, UK: Scarecrow Press, Inc.

Fancourt, D., Perkins, R., Ascenso, S., Carvalho, L.A., Steptoe, A., & Williamon, A. (2016a). Effects of group drumming interventions on anxiety, depression, social resilience and inflammatory immune response among mental health service users. *PLoS ONE, 11*(3).

Fancourt, D., Perkins, R., Ascenso, S., Atkins, L., Kilfeather, S., Carvalho, L.A., Steptoe, A., & Williamon, A. (2016b). Group drumming modulates cytokine response in mental health service users: a preliminary study. *Psychotherapy Psychosomatic, 85, 53–55.*

Faulkner, S., Wood, L., Ivery, P., & Donovan, R. (2012). It is not just music and rhythm…Evaluation of drumming-based interventions to improve social wellbeing of alienated youth. *Children Australia*, *37*(1), 31-39.

Gasquoine, P.G. (2014). Contributions of the insula to cognition and emotion. *Neuropsychology Review*, *24*(2), 77-87.

Geiser, E., Walker, K.M., & Bendor, D. (2014). Global timing: A conceptual framework to investigate the neuronal basis of rhythm perception in humans and non-humans. *Frontiers in Psychology*, *5*, 159.

Grecucci, A., Frederickson, J., Remo, J. (2017). Advances in emotion regulation: From neuroscience to psychotherapy. *Frontiers in Psychology, 8.*

Kischenbaum, D. S. (1984). Self-regulation and sport psychology: Nurturing an emerging symbiosis. *Human Kinetics Journals*, *6*(2), 159-183.

Martin, K., & Wood, L. (2017). Drumming to a new beat: A group therapeutic drumming and talking intervention to improve mental health and behaviour of disadvantaged adolescent boys. *Children Australia:42* (40, 268-276.

McCrory, P., Cobley, S., & Marchant, P. (2013). The effect of psychological skills training (PST) on self-regulation behavior, self-efficacy, and psychological skill use in military pilot-trainees. *Military Psychology*, *25*(2), 136-147.

McRae, K., Misra, S., Prasad, A. K., Pereira, S. C., & Gross, J. J. (2012). Bottom-up and top-down emotion generation: implications for emotion regulation. *Social Cognitive and Affective Neuroscience,* 7(3), 253–262.

Lazar, S. W., Bush, G., Gollub, R. L., Friccione, G. L., Gurucharan, K., & Benson, H. (2000). Functional brain mapping of the relaxation response and meditation. *NeuroReport*, *11*(7), 1581-1585.

Lynn-Seraphine, P. (2016). *Neurodrumming:*

Towards an Integral Mental Fitness Training for Healthy Aging (Maters dissertation). *doi:10.13140/RG.2.2.28555.28966*

Lynn-Seraphine, P. (2019a). Drumming Redefined. *21st Century Drummer Magazine, 1*.

Lynn-Seraphine, P. (2019b). The Science behind rhythmic mantras. *21st Century Drummer Magazine, 2*.

Moumdjian, L., Buhmann, J., Willems, I., Feys, P., & Leman, M. (2018). Entrainment and synchronization to auditory stimuli during walking in healthy and neurological populations: A Methodological systematic review. *Frontiers in Human Neuroscience, 12, 263.*

National Collaborating Centre for Mental Health. (2005). Post-traumatic stress disorder: The management of PTSD in adults and children in primary and secondary care. *NICE Clinical Guidelines, 26*(5).

Newman, G. F., Maggott, C., & Alexander, D.G. Group drumming as a burnout prevention initiative among staff members at a child and adolescent mental health care facility. *South African Journal of Psychology*, *45*(4), 439–451.

Nordahl, H., & Wells, A. (2018). Metacognitive therapy for social anxiety disorder: An A–B Replication series across social anxiety subtypes. *Frontiers in Psychology*, *9*.

Ochsner, K. N., Ray, R. R., Hughes, B., McRae, K., Copper, J. C., Weber, J., Gabrieli, J. D., & Gross, J. J. (2009). Bottom-up and top-down processes in emotion generation: common and distinct neural mechanisms. *Psychology Science, 11*, 1322-1331.

Perkins, R., Ascenso, S., Atkins, L., Fancourt, D., & Williamon, A. (2016*).* Making music for mental health: How group drumming mediates recovery. *Psychology of Well-Being Theory, Research and Practice, 6*(11).

Porges, S.W. (1997). Peripheral and neurochemical parallels of psychopathology: A psychophysiological model relating autonomic imbalance to hyperactivity, psychopathy, and autism. In H.W. Reese (Ed.), *Advances in child development and behavior (pp. 35-65).* New York, NY: Academic Press.

Porges, S. (2003). The Polyvagal theory: Phylogenetic contribution to social behavior. *Physiology and Behavior, 79*, 503–513.

Redmond, L. (2018). *When the drummers were women. A Spiritual history of rhythm.* Reprint ed. New York, NY: Crown Publishers, Inc.

Shanker, S. (2016). Self-regulation vs. self-control. *Psychology Today.* Retrieved from https://www.psychologytoday.com/us/blog/self-reg/201607

Siegel, D. J. (2007). *The Mindful Brain: Reflection and Attunement in the Cultivation of Well Being*. New York, NY: W. W. Norton and Company.

Smith, C., Viljoen, J.T., & Geachie, L., (2014). African drumming: A holistic approach to reducing stress and improving health? *Journal of Cardiovascular Medicine*, *15*(6), 441-446.

Strauman, T. J., Goetz, E. L., Detloff, A. M., MacDuffie, K. E., Zaunmüller, L., & Lutz, W. (2013). Self-regulation and mechanisms of action in psychotherapy: a theory-based translational perspective. *Journal of Personality, 81*(6), 542–553.

Hart, M., Lieberman, F., & Sonneborn, D. A. (1998). *Planet drum. A Celebration of percussion and rhythm.* Pennsylvania State University: Harper Collins.

Wenger, M. A. (1941). The measurement of individual differences in autonomic balance. *Psychosomatic Medicine, 3, 427–34.*

Winkelman, M. (2003). Complementary therapy for addiction: "drumming out drugs". *American Journal of Public Health, 93*, 647–51.

Wood, L., Ivery, P., Donovan, R., & Lambin, E. (2013). "To the beat of a different drum": Improving the social and mental wellbeing of at risk young people through drumming. *Journal of Public Mental Health, 12*(2), 70-79.

Yap, A. F., Kwan, Y. H., & Ang, S. B. (2017). A systematic review on the effects of active participation in rhythm-centred music making on different aspects of health. *European Journal of Integrative Medicine, 9, 44-49.*

Yuhi, T., Kyuta, H., Mori, H. A., Murakami, C., Furuhara, K., Okuno, M., ... Higashida, H. (2017). Salivary oxytocin concentration changes during a group drumming intervention for maltreated school children. *Brain Sciences, 7*(11), 152.