CHAPTER 9

# Rethinking Future Directions of the Mindfulness Field

**Abstract** This chapter discusses future directions of the field of mindfulness, such as the from state to trait mindfulness, large-scale brain network dynamics in mindfulness, different stages of mindfulness and different states of practice, individual differences, the effects of combining mindfulness with other training regimens, and how to translate mindfulness into clinical practice.

**Keywords** Large-scale brain network · Individual differences · Physical exercise

## Clarifying "Mindfulness"

In Chap. 1, I have clarified that, mindfulness is a mental state and direct experience rather than a concept. Therefore, the name of a mindfulness meditation or intervention with or without the term "mindfulness" should not define the nature of the program. Instead, the exact components and instructions of mindfulness practice are the key to define the program. Mindfulness methods always include several components, and there is no pure "mindfulness" with only one component of mindfulness. This chapter will discuss several aspects related to future directions of mindfulness field. With open minded and equanimous attitude and action, we believe scientific exploration and direct experience can help human beings achieve happiness, peace, compassion, wisdom, and self-growth.



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## Large-Scale Brain Network Dynamics

Although it has long been assumed that brain functions are attributable to the isolated operations of single brain areas, more neuroimaging evidence now supports that idea that information processing results from the dynamic interactions of distributed brain areas operating in large-scale networks (Tang et al. 2015, 2017). The examination of interactions among large-scale brain networks has become a priority for cognitive and computational neuroscience research, as well as for the field of mindfulness research. The science of large-scale brain networks also offers a powerful paradigm for investigating learning performance and cognitive, affective, and social dysfunction in neuropsychiatric disorders. In my laboratory, we are using these systems approaches (resting and functional connectivity, small world topology, dynamic causal modeling, multi-voxel pattern analysis, Bayesian networks, machine learning, and neuroinformatics) to study multiple levels of brain processing such as effortless attention, implicit learning, working memory, learning habit formation and change, and cognitive and social development (Tang 2017). These new tools will allow us to understand neural coding (information representation patterns) and dynamics (how neural circuits manipulate, modify, and store information), and decode people's internal mental states related to performance and behavior. These tools could help us understand how large-scale brain networks support different stages of mindfulness practice and how these networks interact to establish, maintain and switch among different mental states. This research may also point the way to new interventions for strengthening self-control in healthy individuals and restoring it where it is impaired, as in mental disorders in the whole brain level. In addition, it allows us to explore and develop new in vivo body-brain coupling imaging technologies on the nervous system using both animal and human models.

## Different Mindfulness Techniques and Different Stages of Practice

Different types of mindfulness practice may involve or emphasize different components. Within any technique of training, the stage of practice may involve differences in behavior, physiology, and brain activity. Two styles of training most commonly studied are: (1) focused attention meditation, which entails the voluntary focusing of attention on a chosen object; and (2) open-monitoring meditation, which involves nonreactive,

moment-to-moment monitoring of the content of experience. Previous studies showed that portions of the ACC, PFC, and parietal cortex are involved at some stage in both of these mindfulness techniques, but results are not always consistent. One reason for inconsistent findings is that most studies average measures from different stages of meditation (early, intermediate, and advanced) to determine mechanisms or effects, or compare them without identifying the stage involved. Therefore, future research should separate the process of mindfulness meditation into different stages and then analyze data and draw conclusions (Tang and Posner 2013).

In general, mindfulness meditation can be roughly divided into three different stages of practice—early, intermediate, and advanced—each of which involves a different amount of effort during the meditation practice. The early and intermediate stages involve more control with effort, which differs from an advanced stage that occurs with more effortless practice. The early stage appears to involve the use of attentional control and often involves the lateral PFC and parietal areas. In the intermediate stage, participants learn to exert appropriate effort to deal with distractions and the wandering mind. This process involves diverse brain networks depending on the strategies used. In the advanced stage, little or no effort is needed, and meditation is maintained by activity in the ventral ACC, left insula, and striatum, accompanied by high parasympathetic activity. In this stage, there is a reduction of activity in the lateral PFC and parietal cortex (Tang et al. 2015).

## From State To Trait Mindfulness

In Chap. 4, we discussed the trait and state mindfulness and pointed out that recent research has shown that our beliefs and attitudes are learned and shaped by our own experience and expectation, and that these personality traits are not fixed and can be changed. However, it remains unknown when mindfulness state will develop and transfer to trait following training. One idea is to follow a long-term practice (e.g., 10,000 hours in total) to develop certain traits and we hope to change traits or characteristics, but in reality, it does not seem always true because many people still keep the previous behavior, characters and habits. Moreover, studies have also shown that a short-term mindfulness training could induce state and trait changes. If so, what are the key factors involved? We propose a hypothesis that changes of brain structure might be a precursor of trait changes that drive new behavior and habit.

Research has shown that brain function and especially brain structure correlates with and support certain traits of temperament and personality (Whittle et al. 2006, 2014). In the same vein, mental disorders significantly affect certain traits of personality (Tang et al. 2016a). In a series of RCT studies, using IBMT vs. relaxation control, we found few hours of IBMT changes brain activity and cognitive and emotional performance (Tang et al. 2007, 2009). In the studies of diffusion tensor imaging (Tang et al. 2010, 2012), 2–4 weeks of IBMT (not the relaxation training) showed significant brain structural changes in the ACC and associated areas. Most important, after a 2-week IBMT, correlation between total mood disturbance change (an index of emotion regulation) and AD decrease in the left posterior corona radiata was significant, indicating that the training-induced change in emotion was correlated with the ACC structural changes, the self-regulation network in the brain. Furthermore, we found some trends in the changes of temperament and personality following IBMT, suggesting the possibility of state and trait changes following short-term mindfulness (Tang 2017). Although our results showed that short-term IBMT induces brain structure changes and correlates with trait-related changes such as emotion regulation, this warrants further investigation in other domains of characteristics in temperament and personality (Tang and Tang 2015a; Tang et al. 2016b).

## Personalized Mindfulness Training

Individual differences of self-control and learning ability exist, and people respond to training and learning experience differently. Previous research indicated that gene × environment × behavior interactions shape the brain networks and drive behavioral changes such as cognitive, emotional, and social domains (Posner et al. 2013). Clearly, people respond to mindfulness meditation differently. These differences may derive from temperament, personality, or genetic differences. Studies in other fields have suggested that genetic polymorphisms may interact with experience to influence the success of training. For example, carriers of dopamine receptor D4 gene (DRD4) 7-repeat allele are more sensitive to environmental change, and this type of meditators may benefit more from practice compared to participants without DRD4 7-repeat allele; thus, it might be helpful to examine these polymorphisms to determine their possible influence on the success of mindfulness practice. Moreover, individual differences in personality, lifestyle, life events, and trainer–trainee dynamics

are likely to have substantial influence on training effects, although little is known about these influences (Tang 2017). Our studies have shown that mood and personality can be used to predict individual variation in the improvement of creative performance following mindfulness meditation. Capturing temperament and personality differences may serve to predict success in mindfulness training because different temperament and personality traits are reported to be associated with different EEG patterns and HRV in meditators (see Chap. 6).

Since some human networks, including attention, are also common to nonhuman animals, by examining these networks and behaviors in animals using diverse methods of molecular biology and optogenetics, it should be possible to understand the role of genes in shaping attention and self-control networks and social behaviors following mindfulness training. We had reported cognition and emotion results related to stress, memory, learning, and social behavior using animal models and will integrate these results to further explore how gene × environment × behavior interactions shape the brain networks associated with cognitive and social behavioral changes. This research direction will eventually help design brain-based personalized training that can optimize our cognitive, emotional, and social capacity, as well as improve health and well-being and prevent diseases. Ultimately, these efforts will lead to personalized training, therapies, and medicine.

## Combining Mindfulness With Other Training Regimens

In Chap. 7, we discussed a longitudinal comparison study of the training effects and mechanisms using mindfulness IBMT and physical exercise (PE) which have shown the positive effects on increasing physical and mental health. We found both IBMT and PE improve cognitive functioning, immune function and quality of life, but IBMT involves greater connectivity in a circuit including ACC, striatum and the parasympathetic branch of the autonomic nervous system, whereas PE induces lower basal heart rate and greater chest respiratory amplitude, congruent with PE's effects on training mainly the cardiovascular system. Since the mechanisms of PE and IBMT are distinct but complementary, our findings suggest combining physical and mental training in order to achieve better health, performance and quality of life (Tang 2009).

Some people feel the difficulty of meditation practice because it requiring many hours of dedicated training. Therefore people try to meditate for its health benefits, but often quit after the initial training due to the steep learning curve. Given that meditation state in part involves transient hypofrontality and reduced DMN activity, this raises one possibility to use other devices to facilitate this brain changes. One option is to apply a non-invasive brain stimulation technique such as Transcranial Direct Current Stimulation (tDCS) or Transcranial Magnetic Stimulation (TMS) to adjust brain excitability and inhibition to help meditator enter the state. Future research should examine whether the combination of tDCS or TMS with meditation could achieve better outcomes. If so, what the best stimulation protocols would be, such as target brain areas, frequency, length and dose.

## Clinical Application

Some clinical trials have explored the effects of mindfulness meditation on depression, generalized anxiety, addictions, ADHD and other disorders, and the results suggested the efficiency of mindfulness practice for these conditions (Hofmann et al. 2010; van Tol et al. 2010; Tang et al. 2015). However, only a few recent studies have investigated the brain changes underlying these beneficial effects of mindfulness in clinical populations (Tang et al. 2015). One of the reasons might be the theoretical challenge. In other words, there have been less effort to integrate the existing basic and clinical literature into a comprehensive theoretical framework from a psychological, neuroscientific and clinical perspective although the number of empirical publications in the field has been growing very fast in the last decade (Tang et al. 2015).

Self-regulation deficits are associated with diverse behavioral problems and mental disorders, such as increased risk of ADHD, anxiety, depression, schizophrenia and drug abuse. Convergent findings indicate that mindfulness meditation could ameliorate negative outcomes resulting from deficits in self-regulation and could consequently help patients suffering from diseases and behavioral abnormalities. Therefore we first propose an integrative framework of mindfulness meditation which includes at least three components that interact closely to constitute a process of enhanced self-regulation: enhanced attention control, emotion regulation, and self-awareness (Tang et al. 2015). Then we adapt this basic framework to an integrated translational framework (as an common framework for

mental disorders) to illustrate the neurobiological and behavioral mechanisms whereby mindfulness meditation could affect self-regulation outcomes including diverse mental disorders with deficits of self-regulation (Tang et al. 2012; Tang and Leve 2016).

Although the clinical studies in the field are promising, to best translate mindfulness into clinical practice, future work needs to follow the basic and translational framework and replicate and expand the emerging findings to optimally tailor interventions and treatments for clinical application.

## A Balanced View of Mindfulness

Research over the past two decades indicate that mindfulness meditation—practiced widely for the reduction of stress and promotion of health—exerts beneficial effects on cognitive performance, physical and mental health, well-being, and brain plasticity. However, everything has two sides. For instance, although participants report relaxation and experience calmness in mindfulness practice, some also report various unpleasant feelings and reactions such as discomfort, anxiety, or agitation. Mindfulness is just one form of training or intervention techniques, but it is NOT everything. It is an attitude and a new skill, but it is not the only way to achieve the goals of health and well-being. In this current world of information overload, we propose that combining mindfulness practice with other training methods such as physical exercise may be more effective for diverse populations. Moreover, some studies have also shown that practitioners in long-term residential retreats who try very hard to control mind and practice mindfulness intensively every day often have high levels of the stress hormone cortisol, which can harm brain functioning and health. Therefore, appropriate effort and an optimal dose of mindfulness training is crucial in practice. As we discussed in this book, a balanced state is most important in learning and practice mindfulness. With regard to different ages of populations such as children, adolescents, adults, and elders who practice mindfulness, it is important to develop or find a proper method or technique that can fit different groups. Regarding patient populations with PTSD, schizophrenia, and epilepsy, or individuals who are at risk for psychosis or seizures, some concerns have been raised that mindfulness practice might put these individuals at elevated risk for exacerbation of these symptoms, or trigger adverse events or experiences such as a trauma or depressive episodes. However, there are few empirical studies on this topic thus far, so additional research is warranted.

In sum, mindfulness practice aims to increase mental flexibility and decreases psychological rigidity, which gives practitioners more choice and freedom, rather than restricting or limiting human capacity. Mindfulness facilitates a more open, centered, and engaged approach to living, rather than attachment of excessive reliance on a problem-solving mode of mind that may be the root cause of mental disorders and suffering. The only limit in one's life is the limit in one's mind.

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