

PARADIGMS

Challenges Inherent to *T'ai Chi* Research: Part I—*T'ai Chi* as a Complex Multicomponent Intervention

PETER M. WAYNE, Ph.D., and TED J. KAPTCHUK

ABSTRACT

In this, the first of 2 companion papers, we present a framework for viewing *t'ai chi* as a complex, multicomponent intervention that integrates numerous physical, cognitive, and ritualistic components. We discuss how the richness and complexity of *t'ai chi* poses challenges related to the traditional distinction between specific versus nonspecific effects, the development and interpretation of valid sham controls, and more generally, to the reductionist causal approach of attributing observed outcomes to single, independent component factors. We also discuss parallels between *t'ai chi* research and the emerging field of whole systems research, and how *t'ai chi* research may benefit from the use of an ecologic framework. In a second, companion paper, we discuss additional challenges inherent in defining the *t'ai chi* intervention itself, and more comprehensively outline the benefits and limitations of commonly used clinical research designs to evaluate the efficacy and safety of *t'ai chi*.

INTRODUCTION

T'*ai chi*, also referred to as *Taiji*, *T'ai Chi Chuan*, or *Taijiquan*, is a mind–body exercise that originated in China, and that is growing in popularity in the West. Recent surveys suggest that approximately 5 million Americans have practiced *t'ai chi*, and this number is increasing.^{1,2} Because *t'ai chi* is purported to be safe and effective, even for the elderly and frail, it has the potential to be widely integrated into health care. However, the extent of its integration and adoption by the health care community will depend to a large degree on research-based evidence regarding its efficacy and safety for different populations and for specific medical conditions.

A growing body of clinical research has begun to evaluate the efficacy and safety of *t'ai chi* as a preventative and rehabilitative therapeutic tool for a variety of health issues including: balance and postural stability,^{3–12} musculoskeletal strength and flexibility,^{6,13–15} cardiorespiratory fit-

ness^{14–21} immune function,^{22,23} and general stress management.^{24–26} This research has been summarized and critically evaluated in recent reviews.^{12–32} However, little attention has been devoted to evaluating “how” *t'ai chi* is scientifically studied, and the advantages or limitations of different methodological approaches. Understanding the strength and weakness of each approach will increase the likelihood of a complete and unbiased understanding of the potential value of *t'ai chi* in health care.

We begin this paper with a brief overview of the history and principles of *t'ai chi* and present a framework for viewing *t'ai chi* as a complex, multicomponent intervention that integrates numerous physical, cognitive, and ritualistic components. We discuss how the richness and complexity of *t'ai chi* poses challenges related to the traditional distinction between specific versus nonspecific effects, the development of valid (inert) sham controls, and more generally, to the reductionistic (causal) approach of attributing observed outcomes to single, independent, component factors. We con-

clude with a discussion of the potential of whole systems (ecologic) approaches to studying *t'ai chi*. In a companion paper,³³ we will discuss additional challenges inherent to the study of *t'ai chi* including *t'ai chi*'s pluralism, the concept of *t'ai chi* dosage, and long-term versus short-term evaluations of *t'ai chi*'s efficacy and safety, and outline the benefits and limitations of commonly employed clinical research methods.

T'AI CHI: GENERAL BACKGROUND

Definition and history

T'ai Chi Chuan is commonly translated as "Supreme (Grand) Ultimate Fist or Boxing," with "Supreme Ultimate" referring to the all-encompassing Taoist dialectical principle of *Yin* and *Yang* on which it is based.^{34,35} *T'ai chi* is variously described as a meditative or internal martial art or a moving mind-body exercise. In this paper, we define *t'ai chi* as an exercise based on slow intentional movements, often coordinated with breathing and imagery, which aims to strengthen and relax the physical body and mind, enhance the natural flow of what the Chinese call *qi* (a nontranslatable word that describes the interpenetration and connection of phenomenon, or life energy), and improve health, personal development, and self-defense.

The history of *t'ai chi* is not well understood. China has a long history of health-enhancement exercises that mimic animal movements, however, how these earlier exercises link to what we now call *t'ai chi* is unclear.³⁵ The first written mention of *T'ai Chi Chuan* is in a 17th-century text authored by the martial artist Chen Wangting where it is described as a new style of *kung fu*.³⁵ Despite this explicit origin in the martial arts, *t'ai chi* as currently taught and practiced commonly integrates Traditional Chinese Medicine principles of health and longevity, meditative and spiritual principles, and Taoist philosophy into its training regimen.³⁶⁻⁴⁰

T'AI CHI IS A MULTICOMPONENT COMPLEX INTERVENTION

Regardless of specific style, form, or teaching approach, *t'ai chi* itself is inherently a complex intervention, composed of multiple components each of which have potentially independent and synergistic therapeutic value. As such, the study of *t'ai chi* may best be viewed as a form of whole-systems research^{41,42} rather than the study of a single active ingredient. *T'ai chi* is readily described as being composed of 2 (mind-body) or 3 components (mind-body-spirit, mind-body-breath); however, even these hyphenated categorizations are too broad and are themselves composed of multiple components. A more whole-systems or ecologic

characterization of the complexity of *t'ai chi* intervention and the potential therapeutic effects on its practitioners is presented in Figure 1. This diagram summarizes *t'ai chi*'s therapeutic components into 8 broad classes. Below we briefly review the relevance of each of these components, citing, when available, evidence of its potential therapeutic value. This deconstruction of *t'ai chi* into separate components will help illustrate that *t'ai chi* is a complex intervention, and provide a framework for both better evaluating the advantages and disadvantages of various research methodologies and for interpreting results of studies to date.

Musculoskeletal strength, flexibility and efficiency

Perhaps the most obvious component of *t'ai chi* training is its emphasis of the musculoskeletal system. Phrases from historical *t'ai chi* classics such as "suspend the spine like a string of pearls from heaven," and "stand like a balance and move like a cartwheel,"³⁵ reflect inherent, sophisticated insight regarding human balance and movement. A large body of sound research supports that *t'ai chi* training can improve musculoskeletal strength and flexibility.^{6,12-15} Research using sophisticated motion analysis has also demonstrated that *t'ai chi* alters a number of neuromuscular components associated with quiet standing and gait,^{9,43,44} and along with improved strength and flexibility, markedly improves balance and reduces the probability of falling among the elderly.^{4,45,46}

Breathing

Efficient breathing is a central focus of many *t'ai chi* training systems, and breath is often directly associated with the concept of cultivation of *qi*: "The inhalation and exhalation are long and deep and the *qi* sinks to the *dan tian*" (*dan tian* means "cinnabar fields" and is located slightly beneath and behind the navel). Many modern *t'ai chi* books devote entire sections to breathing techniques.^{40,47} While *t'ai chi* studies to date have not specifically evaluated the therapeutic effects of 1 form of breathing versus another, there is some evidence that suggests that patterns of breathing, in and of themselves, can make a significant impact on numerous health-related outcomes including metabolic rate, heart rate variability, blood pressure, immunity, and mood.⁴⁸⁻⁵¹ Not surprisingly, *t'ai chi* has been shown to increase oxygen uptake and exercise capacity,³² and to improve functional status in conditions with impaired cardiorespiratory physiology including chronic heart disease.⁵²

Concentration, attention, and mindfulness

The "mind" component of *t'ai chi* includes a number of interrelated aspects that may each confer therapeutic value. One central concept of *t'ai chi* is concentration or focus, whereby the mind becomes unified in its purpose for an extended period of time.⁴⁷ This focused attention can be di-

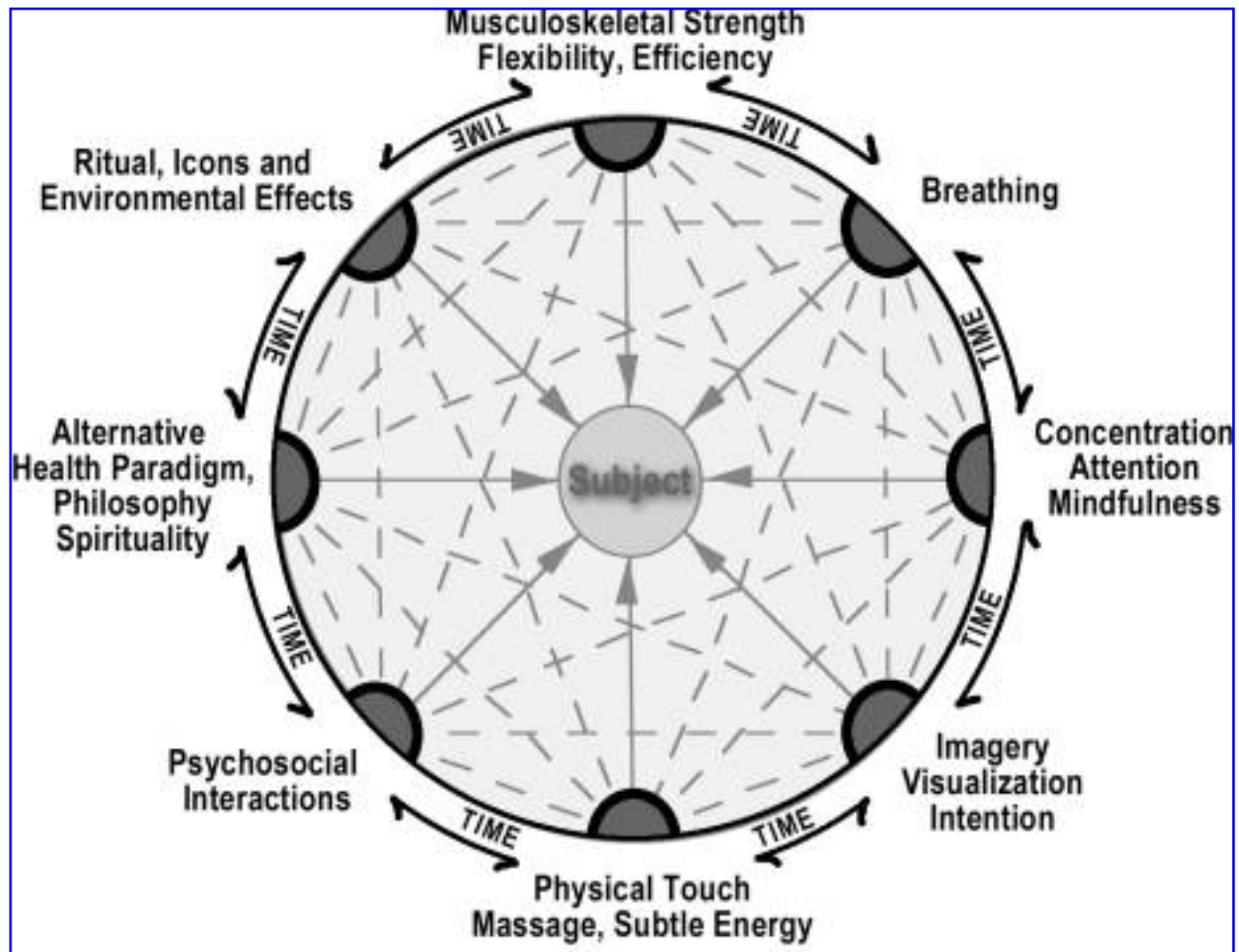


FIG. 1. A whole-systems or ecologic characterization of the complexity of *t'ai chi* interventions and their purported therapeutic components.

rected to one's own body as well as to the external environment. A typical *t'ai chi* phrase that exemplifies this principle is: "Cleanse your mind and concentrate on the slowness and evenness of your movements." Experimentally, quantifying the relative therapeutic contribution of concentration/attention versus other components of *t'ai chi* may not be feasible, as teaching *Tai Chi* without concentration/attention would mean it was not "true" *t'ai chi*. However, recent studies have demonstrated that concentration and mindfulness meditation in and of itself (i.e., without overt exercise) has significant neurophysiologic effects, which, in turn may modulate multiple aspects of health including immune function, mood, and pain.⁵³⁻⁵⁷ Additionally, studies have shown that long-term *t'ai chi* practitioners have greater body awareness (e.g., a kinesthetic sense) compared to non-practitioners and other athletes.^{6,58,59}

Imagery, visualization, and intention

Another set of mind-related components of *t'ai chi* includes imagery, visualization, and intention. Imagery is a

thought process that invokes and uses the senses to serve as a form of communication between perception, emotion, and bodily change.⁶⁰ Research from fields as diverse as medical placebo and shamanism have demonstrated that our images and beliefs/expectations directly influence our physiology and health.⁶⁰⁻⁶³ Modern cognitive neuroscience has learned that imagining certain movements activates many of the same brain regions that are engaged during the actual movement.^{64,65} This observation adds support to a common *t'ai chi* saying, "imagination becomes reality."⁶⁶ *T'ai chi* training is typically rich in images or metaphors drawn from the *t'ai chi* classics such as: "move like a river" and "stand rooted like a tree," and the names of many *t'ai chi* movements themselves (e.g., "Cloud Hands," "Crane Spreads its Wings") include images that guide students toward certain kinesthetic, emotional, and energetic states. Even more fundamentally, the *t'ai chi* classics often emphasize notions derived from the earliest layers of Chinese thought that all movement begins with thought or intention: "The mind (*yi*, intention) leads the *qi*, and the *qi* moves the body."³⁵ As with attention and breathing, the therapeutic roles of im-

agery and intention per se have not been decoupled from other components in *t'ai chi* research, and again, removing these elements would invalidate the training as well as attempts to assess *t'ai chi*'s benefit in clinical trials. However, a growing body of research has clearly demonstrated that the use of active imagery and expectancy has multiple therapeutic effects,^{62,67} and recent studies have even demonstrated that simply visualizing movements without physically practicing them can improve recovery of motor function following impairment as well as the learning of new complex movements.^{68,69}

Physical touch and subtle energy

Different forms of physical stimulation are often integrated into *t'ai chi* training. Self-massage before and/or after a *t'ai chi* training session is commonly practiced.^{39,47,70} In the process of form correction, teachers will commonly touch and physically adjust students' postures. Even greater physical interactions take place during a 2-person contact exercise such as sensing and pushing hands. In some cases it is believed that interactions, especially those implemented by experienced teachers, include an energetic or healing component. The relative importance of massage and touch in *t'ai chi* has not been specifically evaluated, however, a significant body of research suggests that equivalent forms of self- and interpersonal tactile stimulation can have marked physiological and psychological effects.^{71–74} Additionally, the impact of more subtle, energy- or *qi*-based healing transmission in *t'ai chi* is also poorly understood, although some studies are beginning to explore this independently.⁷⁵ Anthropologists have pointed out that touch in ritual "changes how a body feels by altering what it feels."⁷⁶

Psychosocial interactions

Training in *t'ai chi* includes significant psychosocial interactions resulting from student interactions with instructors as well as with other students. In some cases, as in many churches, synagogues, and senior centers, *t'ai chi* schools can provide a significant source of community-based social support. While we are not aware of studies evaluating the benefits of *t'ai chi* learned with (e.g., classes) versus without social support (e.g., videos), social support and identifying oneself as being part of a group has been demonstrated to have therapeutic value for patients with a variety of medical conditions.^{77–79}

Some unique characteristics of the teacher–student relationship in *t'ai chi* are worth distinguishing from other therapeutic encounters. One role of the *t'ai chi* teacher is to evaluate students' exercise performance, and prescribe modifications and new material to facilitate progression. In this capacity, they are similar to physicians and health care providers who diagnose patients, and then prescribe medications or therapies. However, *t'ai chi* instructors also commonly play the roles of motivators, coaches, and therapists.

Current models of biomedicine, especially in controlled research settings, consider providers as relatively inert vehicles for the transmission of information, despite significant evidence suggesting that variation in health care practitioner's attitudes and expectations regarding the effectiveness of an intervention makes an impact on outcomes.^{63,80} An even greater distinction between *t'ai chi* instructors and other health care providers is that *t'ai chi* instructors are expected to embody the principles of their art, and it is largely through this embodiment that they transmit the principles (i.e., via visual demonstration of movements, during interactive exercises or form corrections), and more generally, by their overall demeanor. As such, the teacher is far from an inert carrier of information. This richness of the teacher–student relationship in *t'ai chi* challenges the commonly used distinction between specific and nonspecific effects emphasized in placebo-controlled trials.^{80,81}

Alternative health paradigm and philosophy

As has been described in other complementary and alternative medicine modalities,⁸² some people are attracted to *t'ai chi* because of its holistic health paradigm, philosophy, and spiritual principles.⁴⁷ Disease and medical conditions viewed through *t'ai chi*'s Traditional Chinese Medicine perspective offer an alternative framework with which to view health and medical conditions. It has been suggested that being provided an alternative medical diagnosis, in and of itself, may result in significant therapeutic effects.^{83,84} Exposure and adherence to the philosophical and spiritual principles of *t'ai chi*, which draw heavily from many Asian traditions including Taoism and Buddhism,^{40,85} may thus have therapeutic and remoralizing value independent of physical practices. Studies have not compared the effects of *t'ai chi* taught with and without an emphasis on philosophy and spirituality, however, medical research has shown that patients with strong spiritual beliefs and faith may live longer and have better health outcomes than people who lack such beliefs.^{78,86}

Rituals, icons, and environment

Some aspects of *t'ai chi*, like other exercises or activities performed in a repetitive manner, take on the characteristics of a ritual (i.e., "the performance of more or less invariant sequences of formal acts . . . not entirely encoded by the performers."⁸⁷ Long-term regular practice of the same *t'ai chi* forms becomes a daily, almost liturgical act and can represent a journey to a sacred presence. Certain *t'ai chi* programs also encourage regular practice regimens and environments (e.g., daily morning practice in nature). Some schools have mandatory "rituals" such as removing street shoes before entering the training space or saluting to the teacher. For some practitioners, even putting on *t'ai chi* "slippers" has ritualistic qualities. Many training spaces also commonly contain *t'ai chi*-related art and symbolic icons,

and play meditative music during classes. Collectively, these rituals, icons, and environmental factors have the potential to create a culturally rich context for meaning, remembering, and perhaps even amplifying certain therapeutic experiences during *t'ai chi* practice. Psychosocial factors are underscored as “participants accept, and indicate to themselves and to others that they accept the philosophy and symbols . . . encoded in the canon” of the entire system.⁸⁷ The very repetition of a ritual may have a “performative” efficacy that has a rhetorical, persuasive, or “illocutionary” effect that “works” as Klienman and colleagues suggest, “even in the absence of significant improvement of physical symptoms.”^{88,89} Through its “sensory, polyvalent, presentational, and participatory [envelopment],”⁹⁰ ritual “creates a diffusion of self”⁹¹ that can alter a person’s relationship to discomfort and disability.

Finally, independent of ritual effects, physical components of many *t'ai chi* environments may impact practitioners’ experiences. While we do not know of studies that have compared the effects of learning *t'ai chi* in traditional schools versus other environments (e.g., hospital settings), some health care research indicates that certain environmental characteristic may have therapeutic effects. For example, patients in hospital rooms with unobstructed views of nature or nature art have shorter postoperative stays, use less pain medication, and express higher satisfaction with nursing care than patients with obstructed views.^{92,93}

In summary, *t'ai chi* is a multicomponent complex intervention integrating physical, cognitive, social, and environmental factors, all of which may confer some therapeutic effect. Moreover, many of these factors are inseparable and synergistic. This complexity poses a number of challenges to the design and interpretation of clinical trials, which we discuss below and in a companion paper.³³

IMPLICATION OF T'AI CHI'S COMPLEXITY TO ITS EVIDENCE-BASED ASSESSMENT

Limitations of placebo-controlled trials and the distinction between specific versus nonspecific effects

One conclusion emerging from the above discussion is that the randomized, placebo-controlled research design in which the efficacy of single, specific active ingredients is studied, while all other co-occurring or contextual factors are (in theory) controlled for and/or considered nonspecific, may not provide a completely valid or practical design for studying *t'ai chi*. First, *t'ai chi* has multiple potential “active ingredients,” each with evidence supporting potential therapeutic effects. Second, the traditional concept of a placebo control (i.e., a relatively inert or nonspecific intervention component that can be clearly distinguished from specific components) is challenged by *t'ai chi*'s inherent characteristics. Some factors traditionally viewed as non-

specific (e.g., therapist–patient interaction, attention, belief) are integral to *t'ai chi* and removing them invalidates the intervention. In this way, *t'ai chi* is fraught with the theoretical and practical problems of psychotherapy randomized clinical trial where what are nonspecific effects in drug trials may be characteristic and essential components of the active intervention.^{94,95} Third, as in other complex systems,^{81,96,97} components considered specific versus nonspecific may be highly interdependent, and some cannot be independently isolated. For example, if one wished to do a reductionist-type study to evaluate the effects of breathing mechanics on oxygen uptake, even if one believed attention and concentration were not essential to improving breathing, it would be practically impossible to independently evaluate these factors; one cannot ask patients to modify neuromuscular aspects of breathing without them simultaneously shifting more attention and concentration to their breathing. For these reasons, we believe it would be practically impossible to construct a credible, dummy control that mimics the array of active components of *t'ai chi*, eliminating the placebo-controlled design as a research tool for *t'ai chi*.³³

Potential biases associated with randomization

The importance of intention, belief, and expectancy in *t'ai chi*, and the implications of these behavioral characteristics to the randomization process also warrant highlighting. As discussed above, one cannot perform valid *t'ai chi* without the intention or belief that there will be a positive outcome. In this context, the whole process of randomization, during which patients not interested or invested in “doing” *t'ai chi* might be assigned to a *t'ai chi* intervention, could compromise study validity and create bias.⁴² Randomization should be employed in most controlled studies, because its advantages for minimizing bias for factors other than expectancy and belief are important. When it is used, however, the potential for bias should be acknowledged and measures should be taken to assess expectancy- and belief-related characteristics in all study arms. Some supplementary approaches to the randomized controlled research model, including preference designs, are discussed in our companion paper.³³

A whole-system ecologic framework for studying t'ai chi

T'ai chi's complexity poses more general challenges to simple, single-factor, cause-and-effect reductionist models. For example, the commonly reported reduction in falls following *t'ai chi* training probably results from multiple mechanisms including increased leg strength and flexibility, changes in neuromuscular patterning/control, reduced fear of falling, improved body awareness and concentration, and a number of cognitive strategies (e.g., imagining being rooted like a tree).³¹ Moreover, these factors are likely to interact with one another, change in relative importance over

time, and differ for different practitioners. In this sense, *t'ai chi* faces many of the challenges encountered in whose systems research, which also (1) emphasizes understanding the therapeutic effects of multicomponent interventions; (2) assumes complex interactions between components, including the effects of patient's beliefs and patient-practitioner interactions; and (3) allows for potentially unique responses of individual patients, and patient-specific changes over time in the therapeutic relevance of intervention components.^{41,42} Consequently, research attempting to understand the mechanisms underlying *t'ai chi*'s therapeutic effects may need to draw on the tools used in disciplines such as epidemiology, sociology, and ecology, which commonly deal with complex, multivariate phenomena.⁹⁸⁻¹⁰⁰ Some promising multivariate analytical tools suggested by whole-systems researchers include path analyses, structural equation modeling, and confirmatory factor analysis.¹⁰¹

CONCLUSIONS

We conclude that *t'ai chi* is best viewed as a complex, multicomponent intervention. The richness and complexity of *t'ai chi*, including its integration of physical, cognitive, and ritualistic components, poses challenges to the reductionist (causal) approach of attributing observed outcomes to single, independent, component factors. Moreover, because belief, ritual, and psychosocial interactions are integral components of *t'ai chi*, traditional distinctions between specific and nonspecific effects, and reliance on the placebo-controlled design may not be feasible. The study of *t'ai chi* shares a number of similarities with the emerging field of whole systems research, and may benefit from the use of its ecologic framework and multivariate analytic tools.

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Address reprint requests to:

Peter M. Wayne, Ph.D.

T'ai Chi Research Programs

Division for Research and Education in Complementary

and Integrative Medical Therapies

Harvard Medical School

401 Park Drive, Suite 22A

Boston, MA 02215

E-mail: peter_wayne@hms.harvard.edu