

PERSPECTIVES

Emerging Paradigms in Mind–Body Medicine

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ABSTRACT

The emerging paradigms in medicine can be seen through mind–body interactions. Observations in many meditative traditions suggest a series of objective indicators of health beyond absence of disease. Several of the physical signs have been confirmed by research or are consistent with modern science. Further correlation with long term health outcome is needed. Integration of meditation with conventional therapy has enriched psychotherapy with parallels drawn between the Nine Step Qigong and Freudian developmental psychology. A unified theory of the chakra system and the meridian system widely used in traditional mind–body interventions and acupuncture is presented in terms of modern science based on the *morphogenetic singularity theory*. Acupuncture points originate from the organizing centers in morphogenesis. Meridians and chakras are related to the underdifferentiated, interconnected cellular network that regulates growth and physiology. This theory explains the distribution and nonspecific activation of organizing centers and acupuncture points; the high electric conductance of the meridian system; the polarity effect of electroacupuncture; the side-effect profile of acupuncture; and the ontogeny, phylogeny, and physiologic function of the meridian system and chakra system. It also successfully predicted several findings in conventional biomedical science. These advances have implications in many disciplines of medicine.

INTRODUCTION

Research has shown that subtle mental stress that does not meet the criteria of disease can have major impact on health: A pessimistic attitude is associated with increased mortality (Maruta et al., 2000). Common negative emotions such as frustration, tension, and sadness are associated with a twofold greater risk of myocardial ischemia during activities of daily living in patients with stable coronary artery disease (Gullette et al., 1997). Hostility can increase the risk of atherosclerosis and all-cause mortality (Iribarren et al., 2000). Signifi-

cant impairment can be found in individuals with subthreshold forms of anxiety disorders (Mendlowicz and Stein, 2000).

Most assessments of stress or emotional well-being in conventional medicine have been made through subjective ratings. Observations in certain meditative traditions suggest the existence of objective physical signs associated with stress reduction and health improvement. Meditation has also been successfully incorporated in psychotherapy with parallels drawn between the two techniques. Qigong and yoga are two major popular meditative traditions. The meridian system and the chakra system

evolved from these two traditions, respectively. Understanding these systems in modern science has been a major challenge in mind-body medicine. Recent advances in these areas are reviewed here.

HEALTH INDICATORS BEYOND THE ABSENCE OF DISEASE?

According to the World Health Organization (WHO): "Health is a state of complete physical, mental, and social well-being and is not merely the absence of disease or infirmity" (World Health Organization, 1948). What is the state of complete physical, mental, and social well-being? What are the intermediate states leading to this state? What are the efficient methods to achieve this state? Modern scientific knowledge in this area is relatively deficient. The observations in many meditative traditions suggest a series of indicators of health beyond absence of disease up to complete physical and mental well-being (Murphy, 1993). Many of the indicators are relatively objective, such as increase in attention span, temperature tolerance, decrease in habituation, food intake, sleep, respiratory rate, heart rate, bodily secretions, change in body odor, and blood color. Some have been confirmed by research or are consistent with modern science and other traditions (Benson, 1993). One interesting claim is that body odor is related to mental stress. According to modern science, body odor arises mostly from the action of cutaneous microorganisms on the axillary apocrine secretions that respond to emotional stimuli, often mediated through stress hormones such as epinephrine and norepinephrine. In mammals, the functional roles of body odor include territorial markers, warning signals, and sexual attractants (Goldsmith, 1999). Many meditation practitioners have experienced a change of body odor—decrease of an unpleasant, animal-like odor and/or change to a sweet, herb-like odor. This change seems to accompany stress reduction (Shang, 1995). These sweet odors have been called "odors of sanctity" (Murphy, 1993), "fragrance of morality," and "fragrance of virtue" in different cultures. The change in emotions causes a change in secretion, which

may in turn affect cutaneous bacterial flora and metabolism. It is also noteworthy that many organic substances that generate sweet odors at low concentrations become unpleasant at high concentrations. Stress is likely to increase apocrine secretion and cause unpleasant odors. Body odor as a physical sign has been used in the diagnosis of diabetic ketoacidosis, liver failure, renal failure, and various amino acid metabolic disorders. It is also influenced by personal hygiene and food intake (Senol and Fireman, 1999). It is conceivable that body odor can be used for monitoring emotional stress with control of individual hygiene and dietary factors.

With the growing aging population and pressure for health care cost containment, the correlation of these physical signs with long-term health outcomes deserves further study. They can be used in primary prevention and other sociomedical practices.

INTEGRATION OF TRADITIONAL MIND-BODY INTERVENTIONS AND MODERN PSYCHOLOGY

The parallels between meditation and psychotherapy have been reviewed before (Delmonte, 1989; Berke, 1996; Smith, 1998). In psychiatry, mindfulness meditation has been incorporated in cognitive-behavioral therapy to treat some difficult problems such as borderline personality, with superior results over conventional therapy in randomized controlled trials (Linehan et al., 1994). In addition to concentration, relaxation, and mindfulness, there can be also active transformation of emotional drive, which is consistent with modern psychology. In the Nine Step Qigong (Yan, 1997) males practice self-visualization as healthy 7-year-old boys and females practice self-visualization as 6-year-old girls. The technique also includes visualization of parents. The visualization of the opposite-sex parent precedes the visualization of the same-sex parent. This has interesting correlation with developmental psychology. Children between the ages of 6 and 12 years have relatively few physical or mental problems (Gundy, 1978) and tend to be industrious and proactive in learning and group activities (Erikson, 1963). In Freudian

psychology, this is called the latency period, when sexual drive is naturally channeled into learning and peer relations (Freud, 1905). On average, girls mature about 18 months earlier than boys in reaching puberty (Litt and Martin, 1999). Therefore, 6-year-old girls and 7-year-old boys generally are at the same stage of development, in the beginning of transformation of sexual drive into learning. In the Nine Step Qigong, the visualization of parents follows the same temporal order as the resolution of Oedipus complex and Electra complex, in which the preoccupation with the opposite-sex parent precedes the identification with the same-sex parent. According to Freudian psychology, this resolution usually happens between ages 3 and 6, temporally in contiguity with the latency period. More research is needed on the efficacy and side effects (Lee, 2000) of these techniques that can potentially enrich and extend modern psychotherapy.

UNIFIED THEORY OF THE MERIDIAN SYSTEM, CHAKRA SYSTEM, AND MODERN SCIENCES

Qigong and yoga are two popular mind-body intervention techniques. The description and use of the meridian system (McGee et al., 1996) and the chakra system as pathways of energy or signal flow evolved respectively from these two traditions. In the past decade, a unified, multidisciplinary theory of the meridian system and chakra system has been developed that has not only explained the observations in qigong and yoga, as well as acupuncture, but also successfully predicted the research results in conventional biomedical science (Shang, 1999).

The meridian system

According to the Standard Acupuncture Nomenclature proposed by the WHO (World Health Organization, 1991), the meridian system consists of about 400 acupuncture points and 20 meridians connecting most of the points. Since the 1950s, it has been discovered and confirmed by researchers in several countries with refined techniques (Pomeranz, 1997)

that most acupuncture points and meridians correspond to the high electrical conductance points on the body surface (Bergsman and Wooley-Hart, 1973; Nakatani and Yamashita, 1977; Wensel, 1980; Reichmanis, 1988; Comunetti et al., 1995) and *vice versa* (Eory, 1984). The high skin conductance of the meridian system is further supported by the finding of more than a dozen-fold higher density of gap junctions at the acupuncture points and meridians (Mashansky et al., 1983; Cui, 1988; Fan, 1990; Zheng et al., 1996). Gap junctions are hexagonal protein complexes that form channels between adjacent cells. It is well established in cell biology that gap junctions facilitate intercellular communication and increase electric conductivity. The high density of gap junctions at the epithelia can increase both cell-to-cell conductance and the cross-sectional area of the conducting tissue involved in the skin conductance measurement. Gap junctional communication has been shown to play a crucial role in morphogenesis (Ewart et al., 1997). The gap junction genes can also behave as classic tumor suppressor genes, both in cell culture and in animal tests in restoring growth control of metastatic cancer cells (Hirschi et al., 1996). Other studies suggested twofold higher density of dermal papillae, capillary vessels, and nerve endings at acupuncture points (Croley and Carlson, 1991).

Organizing centers, acupuncture points, and singular points

Bioelectric field effects are important in growth control and morphogenesis (Erickson, 1985). There is usually enhanced cell growth toward the cathode and reduced cell growth toward the anode in electric fields of physiologic strength (Nuccitelli, 1984; McCaig, 1987). Fast-growing cells tend to have relative negative polarity due to the increased negative membrane potential generated by the mitochondria at a high rate of energy metabolism (Chen, 1989). Imposed electric fields can affect anterior-posterior polarity (Marsh and Beams, 1952) and dorsal-ventral polarity (Kolega, 1985) in animal morphogenesis. In development, the fate of a larger region is frequently controlled by a small group of cells, termed an organizing center

(Meinhardt, 1982). Organizing centers have high electric conductance (Shang, 1989; Hotary and Robinson, 1994) and a high density of gap junctions (Coelho and Kosher, 1991; Laird et al., 1992; Yancey et al., 1992; Meyer et al., 1997).

Change of electric activity at the organizing centers correlates with signal transduction and can precede morphologic change (Shang, 1993). The electric field can serve as cues in growth control. The electric potential gradient and chemical signals can enhance each other (Fang et al., 1998). Disruption of electric field at an organizing center can cause malformation (Hotary and Robinson, 1994). The high electric conductance persists at the organizing centers after early embryogenesis (Shi and Borgens, 1996). The similarities between acupuncture points and organizing centers suggests that acupuncture points originate from organizing centers (Shang, 1989). Both acupuncture points and organizing centers have high electric conductance, current density, and density of gap junctions. These points of high electric conductance are also points of convergence and abrupt change of local electric current. They are the singular points of the electric field. A singular point is a point of discontinuity as defined in mathematics. It indicates a point of abrupt transition from one state to another. Small perturbations around singular points can have decisive effects on a system. As James Maxwell observed: "Every existence above certain rank has its singular points . . . At these points, influence whose physical magnitude is too small to be taken account of by a finite being, may produce results of the greatest importance" (Winfree, 1980).

Consistent with the nature of singular points, both organizing centers and acupuncture points can be activated by nonspecific stimuli (Shang, 1989). The therapeutic effect of acupuncture can be achieved by a variety of stimuli (Altman, 1992), including electricity, needling, temperature variation, laser (Hornstein, 1997; Schlager et al., 1998), and mechanical pressure. Similarly, morphogenesis of organizing centers can be induced by various stimuli such as mechanical injury and injection of nonspecific chemicals (Meinhardt, 1982). The distribution of acupuncture points and orga-

nizing centers is closely related to the morphology of the organism. Based on the phase gradient model in developmental biology (Winfree, 1984; Shang, 1989), many organizing centers are at the extreme points of curvature on the body surface, including blastopore, zone of polarizing activity, and various growth tips. Similarly, almost all the extreme points of the body surface curvature are acupuncture points. The auricle, which has the most complex surface morphology, also has the highest density of acupuncture points. According to the WHO, 43 auricular points have proven therapeutic value (World Health Organization, 1991); these points comprise 10% of the acupuncture points of the whole body.

Boundaries, separatrices, and meridians

At early stages of embryogenesis, gap junction-mediated intercellular communication is usually diffusely distributed, which results in the entire embryo's becoming linked as a syncytium. As development progresses, gap junctions become restricted at discrete boundaries, leading to the subdivision of the embryo into communication compartment domains (Lo, 1996). These high-conductance boundaries or separatrices are also major pathways of bioelectric currents and are likely to be the precursors of meridians. A separatrix is a trajectory or boundary between different spatial domains (Vinogradov et al., 1992) and often connects singular points together. Separatrices can be folds on the surface or boundaries between different structures (Shang, 1989; Lee and Malpeli, 1994). The morphogenetic singularity theory suggests that the cells in the meridian system remain interconnected and underdifferentiated, maintaining its regulatory function in a partial embryonic state (Cui, 1988; Shang, 1989). In consistency with the proposed underdifferentiation of the meridians, it has been observed that the most apical parts of folds remain undifferentiated in morphogenesis (Toivonen, 1978), just as organizing centers such as zone of polarizing activity (Ros et al., 1997) and apical ectodermal ridge (Carlson et al., 1998) do. The attributes of the separatrix are consistent with the observation in the *Inner*

Classic (Nei Jing; Veith, 1992) that meridians distribute along the boundaries between different muscles.

Role of the meridian system in evolution and physiology

In embryogenesis, the development of organizing centers of the growth control system precedes the development of the other physiologic systems such as the nervous system. The formation and maintenance of all the physiologic systems are directly dependent on the activity of the growth control system. As the individual embryonic development recapitulates the evolution of the species (ontogeny recapitulates phylogeny), the evolutionary origin of the meridian system as an intercellular signal transduction system of growth control is likely to have preceded that of all the other function-based physiologic systems. Its genetic blueprint was likely to have served as a template from which the newer systems evolved. Consequently, it overlaps and interacts with other systems but is not simply part of the nervous system. The regulation of many neural, circulatory, and immune processes is through growth control mechanisms such as hypertrophy, hyperplasia, atrophy, and apoptosis, with shared messenger molecules and common signal transduction pathways involving growth control genes such as proto-oncogenes (Bailey et al., 1996; Berczi, 1994; Tonaka and Samuel, 1994; Baldwin, 1996; Miano et al., 1996). Many "nonexcitable" cells have shown electrochemical oscillation, coupling, and long-range intercellular communication (Rink and Jacob, 1989; Shang, 1989; Nedergaard, 1994) and can participate in the meridian signal transduction.

Unified basis of meridian system and chakra system

Based on the morphogenetic singularity theory, the distribution of the meridian system is related to both internal and external structures and not solely determined by nerves, muscles, or blood vessels. The distribution is a result of morphogenesis. Acupuncture points that are not at obvious extreme points of surface curvature or meridians that are not at obvious boundaries

may be vestigial or more related to internal structures. The underdifferentiated, interconnected cellular network is not limited to the body surface or epithelia. The primary tumor distribution pattern of a certain cell type reflects the distribution of its normal counterpart. For example, the distribution of primary pheochromocytoma reflects the distribution of normal sympathetic ganglion cells. One type of the least differentiated cells is the germ cell. The germ cell tumors (Kountakis et al., 1994; Azizkhan and Caty, 1996) have a midline and para-axial distribution pattern that appears to concentrate at seven locations: sacrococcygeal region, gonads, retroperitoneum, thymus (Dehner, 1990), thyroid (Gonzalez-Crussi, 1982), suprasellar region, and pineal gland (Kretschmar, 1997). The pattern resembles the major chakra system used in yoga and acupuncture (Stux, 1997), suggesting the existence of underdifferentiated cells that may be highly interconnected in a normal state as part of the "inner meridian system" and provide important regulatory functions (Nichols et al., 1997). A hierarchy is likely to exist in the degree of cell differentiation and function in the meridian system with the germ cell system (major chakra system) as the least differentiated, constituting the central core of the regulatory system. The more peripheral meridians and acupuncture points are more differentiated and further down in the hierarchy.

Mechanism of meridian system based diagnosis and therapy

The electrical conductance of organizing centers varies with morphogenesis, the conductance of acupuncture points also varies and correlates with physiologic change (Comunetti et al., 1995) and pathogenesis (Oleson et al., 1980; Saku et al., 1993). The facts that the change in electric field precedes morphologic change (Shang, 1993) and that manipulation of the electric field can affect the change (Smith, 1988) may shed light on the diagnosis (Oleson et al., 1980; Ishchenko et al., 1991) and treatment of many diseases. According to the morphogenetic singularity theory (Shang, 1989), the network of organizing centers retains its regulatory function through high levels of intercel-

lular communication correlated with relatively low levels of cell differentiation after embryonic development. This prediction is consistent with the finding that high electric conductance persists at the organizing centers after early embryogenesis (Shi and Borgens, 1996). The organizing centers with high density of gap junctions can communicate with other parts of the body to maintain proper forms and functions. An anomaly of the organizing center network may be detected and treated by manipulation of the interconnected organizing centers at the early signal transduction stage.

The activation of organizing centers is likely to be involved in the restoration of proper form and function in wound healing and stress response. Acupuncture can speed up the wound healing process (King et al., 1989) and can cause an exaggerated systemic wound healing and stress response (Lin et al., 1980; Wong and Brayton, 1982). The response can include excessive release of endorphin, which stimulates epithelial cell growth (Kishi et al., 1996) as well as analgesia. Other neurohumoral factors induced by acupuncture, such as serotonin (Cheng and Pomeranz, 1979) and corticotropin (Malizia et al., 1979) also have growth-control effects (Pakala and Benedict, 1998).

A principle in electroacupuncture is that positive (anode) pulse stimulation of an acupuncture point inhibits its corresponding function and negative (cathode) pulse stimulation enhances the function (Kenyon, 1983). This polarity effect is similar to the finding that cell growth is enhanced toward the cathode and reduced toward the anode (Nuccitelli, 1984; McCaig, 1987), consistent with the theory that the mechanism underlying acupuncture overlaps with that of growth control. The nonspecific perturbation at certain acupuncture points may not directly antagonize a pathologic process but may indirectly adjust the process and restore normal function by activating the network of organizing centers in the organism. For example, the same type of acupuncture at ST36 suppresses hyperfunction and stimulates hypofunction of the gut motility (Li et al., 1992). The activation of the self-organizing activity can avoid the side effects that result from directly antagonizing pathologic processes, which often overlap with other normal and

beneficial physiologic processes. Therefore, proper use of these meridian system-based techniques frequently causes few side effects (Holden, 1994; Carneiro and Li, 1995; Shiraishi et al., 1995; Marwick, 1997).

PROSPECTS ON MIND-BODY MEDICINE

The advances reviewed here have broad implications in medicine. With more rigorous studies, some advanced health indicators observed in meditative traditions can be used in health promotion and self-care. The scope and potential of qigong, yoga, and other mind-body intervention techniques need further exploration (Lu, 1997). The morphogenetic singularity theory suggests a unified foundation of conventional biomedical science, mind-body medicine, and acupuncture research. The theory is compatible with the neurohumoral findings of acupuncture. It also explains the distribution and nonspecific stimulation of acupuncture points and organizing centers, the high electric conductance of acupuncture points, the polarity effect of electroacupuncture, and the side effect profile of acupuncture, as well as the ontogeny, phylogeny, and physiologic function of the meridian system and chakra system. Most of these have not been explained by any neurohumoral theory. In several "prospective blind trials," biomedical researchers who were unaware of the theory confirmed its corollary on the role of singularity and separatrix in morphogenesis (Lee and Malpeli, 1994) and its predictions of high electrical conductance and high density of gap junctions at the organizing centers (e.g., blastopore, zone of polarizing activity).

Techniques involving the manipulation of the meridian system, such as acupuncture, yoga, and qigong, may activate the self-organizing system of an organism and improve its structure and function at a more fundamental level than symptomatic relief. Development of these techniques may enable the diagnosis and treatment of a pathologic process at the early signal transduction stage, before the anatomic or morphologic change appears, and improve health beyond mere absence of disease.

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