

THE BIODYNAMIC MODEL OF OSTEOPATHY IN THE CRANIAL FIELD

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*“The Tao that can be completely explained is not the Tao itself.”—
Lao Tzu, Tao Te Ching*

INTRODUCTION

This chapter concerns the philosophy underlying the Biodynamic model of osteopathy in the cranial field (BOCF). To do this we employ a Hegelian dialectic, a weave of BOCF principles with BOCF science, presented within an historical context.

We will compare biomechanical OCF with Biodynamic OCF, or “left-brained versus right-brained cranial” as Fred Mitchell likes to quip. No treatment methods will be described here. Note that certain words in this article will be capitalized, indicating the usage of a defined BOCF meaning, not a standard dictionary sense.

BOCF’s legacy extends back to Hippocrates, as reflected in the Hippocratic Oath’s axiom “do no harm,” and its concern for our triune (body-mind-spirit) integrity. Threads of Paracelsus-style empiricism and Avicennian experimentalism colour the BOCF tapestry. The foundation of BOCF, however, is firmly grounded in the philosophy and practice of three osteopathic teacher-physicians, evolving from three lifetimes spent in general medical practice, working alongside the self-balancing, self-healing principles present in their patients.

The first of these teacher-physicians is Andrew Taylor Still (1828-1917), who founded osteopathy in 1874. Dr. Still sought “the Health” in his patients, which was always present no matter how sick his patients presented. This concept was fundamental to Still’s hands-on approach to care. “I love my patients,” he declared, “I see God in their faces and their form” (Still 1908). The physician’s task, Still always reminded his students, was to remove with gentleness all perceived mechanical obstructions to the free-flowing rivers of life (blood, lymph, and cerebro-spinal fluid). Nature would then do the rest. Still formulated innovative concepts regarding the cranium, the cranial nerves, and he famously proclaimed, “the cerebrospinal fluid [CSF] is the highest known element that is contained in the human body” (Still 1899). His treatment techniques included gentle pressure on cranial bones, for example in the treatment of pterygium (Still 1910).

The second of these teacher-physicians is William Garner Sutherland (1873-1954), who founded Osteopathy in the Cranial Field (OCF). Dr. Sutherland was a student of Still and became imbued with Still’s thinking, methods, and practice. Sutherland formulated his first cranial hypothesis as a student in 1899 while examining a temporal bone from a disarticulated skull. The thought struck him that its edges were bevelled like the gills of a fish, as if part of a respiratory system. Sutherland’s 1899 revelation initiated a life-long evolution of thought, described in subsequent sections of this chapter.

The third teacher-physician is James S. Jealous (1943-) whose Biodynamic Model of OCF (BOCF) has attracted great interest and controversy within the profession. Jealous adapted the term *Biodynamic* from his study of the German embryologist Erich Blechschmidt, and not from the Swiss philosopher Rudolf Steiner, although Steiner’s Biodynamic concepts resonate with BOCF principles. For over 30 years Dr. Jealous has compiled oral histories from Sutherland’s students, and he continues to research Sutherland’s writings (both published and unpublished). This “work with the elders” enabled Jealous to compile an authoritative chronology of Sutherland’s journey. Thus BOCF dedicates itself to the perceptual odyssey where Sutherland left off at the end of his life.

METAPHOR AND ARCHETYPE: THE KEEPERS OF THE KEYS

Still (1902) wrote, “. . .that life and matter can be united, and that the union cannot continue with any hindrance to free and absolute motion.” Still’s concepts, from the beginning, were already beyond the capabilities of double-blind trials. What Still saw and understood, and Sutherland came to refine in his later writings, was the universal principle that the natural world is constantly changing, and what is fixed (or without motion) becomes out of balance with its environment. Still considered osteopathy a science, but when Still’s osteopathy extended beyond known science and rational explanation, he imparted his lessons by using metaphorical language. A metaphor uses familiar information to describe an unfamiliar idea. Metaphor provides a verbal bridge to gap the space between the speaker’s intention and the listener’s interpretation (Artaud 1938). This transformational space, metaphorically speaking, characterizes the learning space between teacher and student, the theatre space between actor and audience, and the healing space between the practitioner and patient, where at a certain moment during an exchange something greater than the sum of the parts emerges.

Metaphors, despite being inherently nonrational, have long provided heuristic tools for approaching scientific problems (Chew & Laubichler 2003). Western culture, however, has difficulty grasping nonrational thought. The nonrational aspects of osteopathy (and other alternative medical systems) are the most

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difficult lessons to impart and the most difficult traditions to maintain. The man-as-triune truths that lay behind Still's osteopathy became the victims of medical reductionism, casualties of our Western way of emphasizing the intellectual and eschewing the intuitive and instinctual. Reductionism limits our view of reality and our faculty of awareness (sense of consciousness). Alternative forms of consciousness, as expressed through dreams, poetry, music, painting, or as found in cultures outside the West, such as meditation or trance states, have remained undeveloped in our society. Limiting our knowledge to what can be proven in a reductionist experiment has consistently succeeded in excluding the human spirit from the Western medical model.

This lack of spirit has been a concern of BOCF practitioners, who gained insight and inspiration from [Laurens van der Post \(1962\)](#), "Man's awareness since the Reformation has been so narrowed that it has become almost entirely a rational process, an intellectual process associated with the outside, the so-called physical, objective world. The invisible realities are no longer real. This narrowed awareness rejects all sorts of things that make up the totality of the human spirit: intuition, instincts and feelings, all the things to which natural man had access." Van der Post's anthropological concepts have played an important role in our understanding of health and disease in society.

Still no doubt acquired the skill of communicating symbolically-rich language from his father, a Methodist Minister. Sutherland, like Still, was a practiced wordsmith, having worked as a newspaper editor before training as an osteopath. Still's and Sutherland's language reflected the intimacy of their connection with the natural world. Still matured among the Shawnee and other Native American peoples—primal cultures, in anthropological terms. "In indigenous, oral cultures, nature itself is articulate; it speaks. . . There is no element of the landscape that is definitively void of expressive resonance and power. . ." ([Abram 1996](#)). Abram quotes a Native American healer, whose words resonate with the writing of Dr. Still, "In the act of perception, I enter into a sympathetic relation with the perceived, which is possible only because neither my body nor the sensible exists outside the flux of time, and so each has its own dynamism, its own pulsation and style. Perception, in this sense, is an attunement or synchronization between my own rhythms and the rhythms of the things themselves, their own tones and textures."

Still's landscape was peopled by individuals who saw things from a totally different cultural perspective. [Highwater \(1981\)](#) wrote, "Though the dominant societies usually presume that their vision represents the sole truth about the world, each society (and often individuals within the same society) sees reality uniquely." Still's and Sutherland's unique cultural perspectives have been revived by BOCF practitioners. BOCF initially evolved in New England, a land imbued with the spirit of Ralph Emerson and Henry Thoreau. These 19th century New England philosophers believed that the study of Nature, or being out-of-doors in the natural world, offered a cleansing of the mind and spirit, and enhanced the journey of self-discovery.

At the time [Sutherland \(1939\)](#) first published his insights, osteopathy was undergoing a period of reductionism. Most practitioners focused on the mechanistic aspects of osteopathic principles and practices. Sutherland's OCF represented a Renais-

sance of Still's osteopathy. But by the time of Sutherland's death in 1954, the OCF Renaissance itself entered a Reformational period, a reclaiming of the rational. Reformational OCF and its basic texts ([Magoun 1976](#), [Upledger & Vredevoogd 1983](#)) have been embraced by many osteopaths as well as massage therapists, physical therapists, and chiropractors. But Sutherland's original Renaissance has carried on, under the aegis of his osteopathic students including Paul Kimberly, Anne Wales, Ruby Day, Rollin Becker, and Robert Fulford ([Cardy 2004](#)).

As OCF has led to BOCF, the use of metaphor has led to the use of archetype. Whereas a metaphor is a figure of speech used to suggest a resemblance, an archetype is a term used to describe a universal symbol that evokes deep and sometimes unconscious responses in a reader or listener. Archetypes symbolically embody basic human experiences and their meaning is instinctually and intuitively understood. Jealous's concept of "the embryo" as *ever present in the living organism* is a key BOCF archetype. When studying the writings of the embryologist Blechschmidt (described below), Jealous was impressed by Blechschmidt's conclusion that embryonic function (fluid motion) creates form and precedes structure. [Jealous \(2001\)](#) intuited from Blechschmidt's reports that the embryologist must have witnessed the organizational forces of primary respiration at work, without the palpatory confirmation, given the reverence with which [Blechschmidt & Gasser \(1978\)](#) wrote, "The originality of embryonic human beings is discernible in many ways; for example, the early human conceptus is master of the whole geometry that it applies to itself. It is never mistaken about any angular sum, and it is never deceived in any surface to volume ration. It never sets an intersecting point on the wrong site and is master of every physical as well as chemical reaction."

The embryo, as an archetype of perfect form, serves as a blueprint for our body's ability to heal itself. The formative, resorbative, and regenerative fluid forces that organize embryological development are present throughout our life span, ready for our cooperation in harnessing their therapeutic potency. In other words, the forces of *embryogenesis* become the forces of *healing* after birth.

Among BOCF practitioners, every event within the therapeutic arena has a name. Nothing is referred to vaguely in terms of "energy." The importance of naming is shared by primal cultures worldwide, notably the Bushmen of the Kalahari ([van der Post 1961](#)). According to the Bushman, an individual's separation from that part of themselves that is connected to "everything else" leads to fear and a sense of aloneness, and this facilitates the disease process. Because treatment using the BOCF connects the patient to nature, the patient receives an immediate experience of "not-aloneness" or "belonging" in a deep way. Patients gain a physical sense of "community," possibly for the first time in their life. As [Wendell Berry \(1996\)](#) emphasized, "The community is the smallest unit of health."

In the next three sections of this article, we review OCF's and BOCF's evolution of thought, evolution of perceptual skills, and evolution of treatment approaches—from the *Bones* to the *Dura* to the *CSF* to the *Fluid Body*. See [Figure 1](#) for a summary.

1910s-1920s:

Sutherland studies the cranial bones and their sutures and foraminae

1930s, early:

Sutherland begins experimenting with the dura and its infoldings (falx, tent)

1930s, late:

Sutherland shifts his focus to the fluctuation of cerebrospinal fluid and elucidates the Primary Respiratory Mechanism

1943:

Sutherland describes the Breath of Life

1948:

Sutherland begins working with Tidal potency

1951:

Sutherland stops motion testing, all fulcra occur in still points

1960s:

Sutherland's writings are published, after editing by Ada Sutherland and Anne Wales

1970s:

Sutherland's students Rollin Becker and Robert Fulford expand his post-1943 work

1980s:

Bar Harbor: at a meeting of osteopaths from England and New England, James Jealous links Sutherland's insights to the works of Blechschmidt and van der Post

Figure 1. A chronology OCF and BOCF evolution.

EVOLUTION OF THOUGHT

“Bones”

From his student days until the late 1920s, Sutherland concentrated on cranial bones, their sutures, and foraminae. Sutherland proposed that cranial sutures remain mobile throughout a person's life. His hands-on insights predicted what is now known through histological studies—that most cranial sutures never completely ossify (Retzlaff & Mitchell 1987). Living sutures contain connective tissue, blood vessels, and nerves. They maintain articular function and serve as crossroads of metabolic motion and somatic information. Sutherland's deductive observations were confirmed by research completed by his osteopathic contemporary, Charlotte Weaver. She conducted fetal dissections that led her to regard the bones of the cranium as modified vertebrae (Weaver 1936a, 1936b). The sphenobasilar symphysis is embryologically homologous to an intervertebral disc, it is plastic and capable of motion (Weaver 1938). Thus Weaver proved true the insights Goethe had in 1790, that the bones of the cranium are metamorphized vertebrae (Rohen 2002).

“Dura”

In the early 1930s Sutherland shifted his emphasis to the dura and its bilaminar infoldings that form the falx and the tentorium, collectively known as the reciprocal tension membrane, which balances motion within the skull. Sutherland accessed the

dura by gently gripping the cranium. The external periosteum is contiguous with the internal dura. Sutherland visualized one continuous web of connective tissue, from the cranium down to the sacrum, which he characterized as the tadpole-shaped “core link.”

“CSF”

In the middle 1930s Sutherland shifted his focus to the fluctuation of CSF, driven by what he termed the *Primary Respiratory Mechanism* (PRM). He postulated that the PRM consists of five phenomenae (Magoun 1976):

- the inherent motility of the brain and the spinal cord;
- fluctuation of the CSF;
- motility of the intracranial and intraspinal membranes;
- articular mobility of the bones of the cranium; and
- involuntary mobility of the sacrum between the ilia.

Sutherland described CSF circulating down and around the spinal chord in a rhythmically pulsatile and spiral fashion. Science has again caught up with his hands-on insights, thanks to advances in radionuclide magnetic resonance imaging (Greitz et al 1997). Many practitioners call the pulsation the cranial rhythmic impulse (CRI), a term coined by Rachel and John Woods in 1961. Clinical studies report a palpable CRI rate of 6-12 cycles/min, independent of cardiac or diaphragmatic rhythms (Magoun 1976).

The CRI phenomenon is poorly understood and its origin remains unknown (acupuncturists face a similar situation when asked to describe *chi*). Many researchers have made hypotheses regarding its source. Initially, Sutherland (1939) proposed that pulsations arise from rhythmical motions of the brain, causing dilatation and contraction of cerebral ventricles, generating a pulse wave of CSF. Magoun (1976) elaborated on this proposal and also posed an alternative hypothesis—that the choroid plexus produces CSF in rhythmic cycles, and this oscillation generates brain motility. Upledger & Vredevoogd (1983) refined the choroid plexus hypothesis, calling it the “pressurestat model.” McPartland & Mein (1997) called the CRI a palpable *harmonic frequency*, a summation of several pulsations such as CSF oscillations, the cardiac pulse, diaphragmatic respiration, Traube-Hering modulations, rhythmically contractile lymphatic vessels, pulsating glial cells, and other polyrhythms. This “entrainment hypothesis” has been put forward independently (eg, Milne 1998) and recently supported by experimental data (Nelson et al 2001). Many of these biological oscillators are lesioned by imbalanced autonomic tone (Schleip 2002) making the CRI variable and ephemeral. Thus from a BOCF perspective the CRI is a lesion phenomenon.

“Fluid Body”

Many osteopaths today work within the CRI models proposed by Magoun or Upledger, but Sutherland moved on. In the final ten years of his life, Sutherland described the PRM being generated by *external* forces. He sensed his patients being moved by an external ubiquitous force, which he called the *Breath of Life* (BoL). Sutherland perceived the BoL to be an incarnate process, passing through the patient's body and the

Table 1. Polyrhythmic Cycles Described in OCF and BOCF

Cycle name	Cycle rate	Cycle source
Cranial rhythmic impulse	6-12 cycles/min	Unknown. Possibly entrained autonomic or pre-Neutral CNS activity
2½ CPM cycle	2.5 cycles/min	Primary Respiration
Long Tide	0.6 cycles/min	Breath of Life
300 second cycle	0.2 cycles/min	Unknown. Possibly a third-order wave

practitioner's hands, undiminished. With the BoL concept Sutherland's reverence for a self-correcting system had fully flowered. "Sutherland arrived at a conceptual transition, leaving those who followed with a bridge to the depth of osteopathic research and practice that places us upon a new and deeply challenging renewal of the ultimate truths of our profession" (Jealous 1997). Sutherland's bridge linked his students to Still's earlier insights, such as "Life is the highest known force in the universe" and "We are the children of a greater mind" (Still 1902).

In the final years of his life, Sutherland's perceptual language drew upon the natural world around his home in Pacific Grove, California. He spoke of his patients as if they were part of a sea, with *waves* that rhythmically move through the water, and a tide that moves deeper, through both water and waves (Sutherland 1967). Sutherland was describing a polyrhythmic system (see Table 1). As the BoL transubstantiates into the PRM, it generates various harmonic rhythms in the body, such as the "Long Tide," the "300 second cycle," the "2 to 3 cycle," and the CRI. Becker (1965) described the Long Tide as the basal rhythm, its rate directly correlating with that of the BoL, oscillating at a frequency of 6 cycles every 10 minutes. Around 1988 Jealous described the "2 to 3" (aka the 2½ CPM cycle) with a mean frequency of 2.5 cycles/min (Jealous 1997). The 2½ CPM is a harmonic of the Long Tide. It is not modulated by the central or autonomic nervous systems, making it a stable rhythm. Liem (2003) described the 300 second cycle, which has also been described by others. Polyrhythms may explain the poor agreement seen in some OCF inter-examiner reliability studies. For example, the inter-examiner study by Norton (1996), reported low reliability between OCF practitioners. This study was flawed because one practitioner recorded the CRI rate while the other practitioner recorded the 2½ CPM cycle (Jealous, personal communication, 1997).

Sutherland (1990) compared the BoL to the cyclic, sweeping beam of light emitted from a lighthouse, "lighting up the ocean but not touching it." The BoL sweeps through the patient, enlightening the healing forces already present in the patient. This allows the "Fluid Body" to emerge, where the whole body behaves as if it were a single unit of living substance. The Fluid Body represents the BOCF equivalent of a Bose-Einstein condensate, where individual molecules lose their identity and form a cloud that behaves as a single entity (Cornell & Wieman, 2002).

EVOLUTION OF PERCEPTUAL SKILLS

"Bones"

Sutherland's initial osseous approach to OCF requires a sound palpatory comprehension of all surface landmarks of the cranium, at all stages of human development. This includes the contours of the 22 cranial bones, their interlocking articulations, and many fissures and foraminae. Normal and abnormal levels of tonus in extracranial muscles must also be appreciated, as well as tissue texture changes in cutaneous tissues.

"Dura"

The dural model of OCF, like the osseous approach, requires a comprehensive grasp of anatomy. Perceptually, sensing the dura and the reciprocal tension mechanism requires the practitioner to palpate tissues beyond his or her fingertips. This seeming esoteric skill is familiar to anyone who has driven an automobile on wet roads—feeling a slippery road surface through the steering wheel, sensing the road surface indirectly, through a series of linkages from the road through the tires through the wheel axles through the steering wheel.

"CSF"

For practitioners working with the CSF and fluid fluctuations, anatomical knowledge is not sufficient. Rollin Becker admonished, "Studying the cadaver is like studying a telephone pole to find out how a tree works" (Speece et al 2001). The requisite education comes from a study of living tissues in one's patients. The practitioner visualizes "a state of rapport in the fluid continuity between the physician and the patient" (Magoun 1976) by "melding the hands with the head" (Upledger & Vredevoogd 1983). With training and practice the practitioner feels a subtle motion, much like the respiratory excursion of the chest, sensed as a broadening and narrowing of the head between the hands. This type of palpation represents a harmonic signal of several senses, including temperature receptors, mechanoreceptors, and proprioceptors (McPartland & Mein 1997). Other yet-unelucidated sensors may detect piezoelectricity or electrical fields as described by yogic practitioners (Green 1983). Milne (1998) achieved "visionary craniosacral perception" by entraining his diaphragmatic breath, empathy, and intent with those of his patient.

"Fluid Body"

Detecting polyrhythms and the Fluid Body requires practitioners to augment their "afferent" activity and reduce their "efferent" activity. In other words, practitioners must emphasize reception rather than transmission. This is the difference between listening to a radio and conversing on a cell phone. Even "melding the hands with the head" may be too efferent. Conveying efferent forces into a patient creates a jumbled sense of "I-thou." To detect the Long Tide and the 2½ CPM cycle requires defacilitation of the practitioner's central nervous system (Jealous 2001). Our consciousness, like our spinal cord, can become facilitated and noisy. According to Jealous, a quiet mind requires the cranial, thoracic, and pelvic diaphragms to function without inhibition. This is accomplished by allowing the breath to become slow and regular, and by softening the muscles above the

Table 2. Brief Comparison of Biomechanical and Biodynamic Models of OCF

Biomechanical	Biodynamic
Techniques led by practitioner's forces, directly or indirectly	Techniques follow movement within the system. Transmutative ability of the Tide is acknowledged. Tidal forces directly interface with pattern of disease. Practitioner follows closely.
Axial motion in bones	Motion is translational, transmutational, metabolic.
"Mechanism" used as a non distinct collective term	"Mechanism" defined through specific elements (ie, Breath of Life, Fluid Drive, Tidal Forces, different rates, and others) Words have sensory foundations that are clearly stated.
CRI is a primary expression of the BoL	CRI is not an expression of the BoL nor is it a therapeutic force.
CRI 8-14 cycles per minute. Slower rates not identified.	Basic rate is 2-3 cycles per minute; slower rates are specifically identified as primary to the system.
Perception is automatic. Skills not delineated	Perception is a conscious, skillful act, requiring training and moment-to-moment adjustment, not automatic.
Lesions are somatic and articular in nature	Lesions may occur at any level in the system. A lesion is seen as a unit of dysfunction in the Whole person.
SBS is a primary site of orientation for lesion activity. Lesions are diagnosed and reduced by conceptual sequences beginning at SBS	Primary site is variable. Lesions are not automatically corrected; sequences are not conceptual. Priorities are established by the Tide.

pubic bone. These actions reportedly serve to "synchronize the practitioner's attention." As attention synchronizes and has room to breath, the practitioner senses deeper rhythms, and the signal shifts from the CRI rate to the 2½ CPM cycle. With deeper defacilitation, perception of the 2½ CPM cycle disappears into the Long Tide (Jealous 2001).

With enhanced perceptual skills, the practitioner eventually perceives a sense of *Neutral*, which is experienced as a homogenization of tissue, fluid, and potency—the Fluid Body, where nothing under the fingertips can be discerned as a separate entity. This lysergic entity lies at the perceptual center of BOCF. The Neutral cannot be conceptualized; it can only be experienced. It is here that "holism" becomes more than a philosophical concept, it can be appreciated as an actual sensory perception. A summary of some of the differences between OCF and BOCF are presented in Table 2.

EVOLUTION OF TREATMENT APPROACHES

"Bones"

Directly adjusting sutures and foraminae affects the function of cranial nerves and vessels that traverse these apertures, as well as the function of muscles that originate or insert upon cranial bones. Some of Sutherland's students continue to focus on bones and sutures, such as the American chiropractor De-Johnette, who founded Sacral-Occipital Technique (Hesse 1991). Treatment of suboccipital muscles directly impacts the dura and may be helpful in patients with dural headaches and chronic pain syndromes (McPartland et al 1997).

"Dura"

Treating the reciprocal tension membrane with balanced membranous tension (BMT) is an indirect technique, performed by gently exaggerating the membrane's strain patterns, balancing

the tension in strained fibers with the tension present in normal fibers, effecting a release of the strain (Sutherland 1990). Many osteopaths work with this dural model and get good results. Lawrence Jones used his counterstrain technique to mould the falx and the tent. Beryl Arbuckle was an extraordinarily gifted practitioner of BMT.

"CSF"

Sutherland initially used direct hydraulic force, such as the CV4 technique for compressing CSF in the 4th ventricle (Magoun 1976, Upledger & Vredevoogd 1983). The CV4 induces therapeutic changes around the body, possibly via periaqueductal gray (PAG) tissue, which surrounds the 4th ventricle. The PAG is lined with neuroreceptors (opioid and cannabinoid receptors), and it responds to stimuli (such as hydraulic pressure) by activating these neuroreceptors, by releasing endorphins and endocannabinoids, and by propagating pain-inhibitory signals to the dorsal horn. The PAG is homuncular, like the somatosensory cortex, so the topography of the PAG corresponds to different parts of the body (J. Giodarno, personal communication, 2002).

Most practitioners who work with the rhythmic fluctuation of CSF focus upon the CRI rate, as exemplified by Magoun's and Upledger's models. The CRI rate is also the focus of the Sutherland Cranial Teaching Foundation (SCTF), although the SCTF now incorporates the 2½ CPM cycle and the Long Tide into their curriculum (A. Norrie, personal communication, 2002).

CRI-oriented practitioners may bring about therapeutic changes by inducing entrainment (McPartland & Mein 1997). Entrainment was first described in 1665 by Christiaan Huygens (Strogatz & Stewart 1993). He noted that collections of pendulum clocks began swinging in synchrony with each other. This coupling phenomenon also arises within organisms (eg, cardiac pacemaker cells) and between organisms (eg, simultaneously flashing fireflies, harmoniously chirping crickets, and women

whose menstrual phases cycle together). Huygens noted that “strongest” clocks (those with the heaviest pendulums) established the eventual, overall rhythm. (McPartland & Mein 1997) proposed that practitioners transferred their “strong clock” rhythms onto their patients, and enhanced this transfer by assuming a meditative state before treating patients. Meditative, centered states are known to produce strong entrainment (Tiller et al 1996). Centering to harness entrainment may be a widespread therapeutic technique, albeit unrecognized by practitioners of Feldenkrais, Network Chiropractic, Polarity therapy, Reiki, Therapeutic Touch, and Tragering. Chinese practitioners center on *tan tien*, the “one point,” about 5 cm above the pubic bone, whereas Tibetan practitioners meditate on an image of the Medicine Buddha centered at *sabar chakrā*, the crown of the head (McPartland 1989). The new “Freeze-Frame” technique focuses on the heart to achieve entrainment (Tiller et al 1996). All these techniques center attention on parts of the body rich in biological oscillators (intestines, brain, and heart).

Tiller et al (1996) stated that feelings of empathy and love lead to strong entrainment. Jahn (1996) described the *resonant bond* between practitioner and patient as a form of love, transmitting “beneficial information.” Wirkus (1992) emphasized that the healer “. . . must feel and be the heart chakra. . . It is not thinking the word ‘love,’ it is the real sensation of pure love which brings warmth, delicate vibrations in your heart area.” Fulford (1988) was precise: “You the [practitioner] stand neutral, acting as a conduit for the flow of divine love. As you learn to use love properly in healing work, your body vibrations increase and it becomes easier to handle the potency of the love energy.”

Entrainment has its limitations. It can only be employed by practitioners who work with the CRI. Practitioners working with slower rhythms avoid efferent activity, so no entrainment may be possible, or desired. We limit our therapeutic potential when we focus solely on the CNS—whether we work with the CSF like Sutherland’s early years, or the cellular vibrations of entrainment. We may also cause side effects and iatrogenesis (Greenman & McPartland 1995, McPartland 1996).

“Fluid Body”

According to a précis by Jealous (personal communication, 2004), “Cranial osteopathy is not about the cranium. It is about Primary Respiration.” Sutherland’s move from the CSF to the Fluid Body began with a technique he called “automatic shifting.” Paulsen (1953) described Sutherland’s sensation of a “motor” starting in the CSF and then carrying on of its own accord, generating a healing force that treated several lesions around the body. “The core of this work is perceptual,” wrote (Jealous 2001), “We learn to sense the Whole. When one meets a patient, one sees the Whole—a very rare event in our modern world.” When a patient achieves a *Neutral* as described previously, the CNS becomes quiet (the person often falls asleep). With the CNS “out of the way,” the whole person—the CNS, CSF, all other fluids, and all other tissues—merges into the Fluid Body. Within the protoplasmic Fluid Body, motion is purely metabolic, responding freely to the outside presence of the natural world and the BoL.

To harness the potency present in the BoL as expressed in the Tide requires ever-more subtle techniques. In the final years of

his career, Sutherland stopped all motion testing of the head, and applied no forces to osteopathic lesions. He worked with fulcrums in still points, and stated, “treat not with techniques but gentle contact” (Sutherland 1990). Working with the Health is a BOCF imperative, echoing Still (1899), “To find health should be the object of the doctor. Anyone can find disease.” Jealous (1997) described therapeutic changes requiring an “aboriginal and instinctual consciousness” on the part of the practitioner, not intellectual or even intuitive, “The moment is filled with the effort to be present with the Health in the patient and the story as it unfolds into its own answer.”

BOCF SCIENCE: QUANTUM CONSCIOUSNESS

Osteopaths base their science in *physics*, whereas Western medical practitioners practice *chemistry*—their pharmacodynamic tools treat chemical moieties known as genes and gene products. Osteopaths recognize the A-T-C-G chemistry of genes, but focus on the physics of the midline within the double helix itself. To wit, osteopaths focus on the double helix’s fourth dimension: Time. DNA converts time into space. Surprisingly, this transmutation can be explained within the mechanistic model of Newtonian physics (Pourquié 2003). Many new ideas proposed by New Age healers operate within a Newtonian paradigm. Pert (2000) hypothesized that energy therapists heal their patients by inducing a vibrational tone that shifts neuroreceptors into their constitutively-active state, or the vibrations trigger the release of endorphins that activate the neuroreceptors Oschman (2000) described crystalline materials within biological structures (eg, phospholipids within cell membranes, collagen in connective tissues) that generate electric fields when compressed or stretched (piezoelectricity). These energy fields may be the source of hands-on healing, a radical proposition, but safe within a mechanistic paradigm.

Newtonian physics has undergone a paradigm shift to Quantum physics, thanks to relativistic studies addressing subatomic phenomena and consciousness. Still’s writings suggest he had undergone a Quantum paradigm shift. He knew intuitively that the healing events in his patients happened at the subatomic level, but he did not have the words or the concepts of Quantum physics to draw upon, to express the transformation he was experiencing in his treatments. Instead, he ascribed the return to health to God or Divine Nature at work.

Sutherland’s BoL exhibits characteristics that can only be explained by Quantum theory (eg, the theory of implicate order by Bohm 1980). The BoL transubstantiates into primary respiration, a field force that generates a spatial orientation, so it shares characteristics with the “morphogenetic fields” described by Shel Drake (1981). Shel Drake’s concepts are very Quantum: Morphogenetic fields carry information only (no energy) and are available throughout time and space without any loss of intensity after they have been created. These nonphysical “blueprints” guide the formation of physical forms through three-dimensional patterns of vibration he called *morphic resonance*. The morphic resonance that generates form in the embryo is the same process that generates healing in the adult.

The role of consciousness in Quantum theory is a radical departure from classical physics. The outcome of any experi-

ment depends upon the consciousness of the observer. Indeed, the term *observer* should be replaced by the term *participator*. We cannot observe the universe, we are participants in it. Our individual consciousness is a small hologram of the universal consciousness shared by all living things. Capra (1996) named consciousness (“the process of knowing”) as a key feature of life, including life forms such as plants and protozoans that lack a central nervous system. The protoplasmic Fluid Body shares this consciousness, which explains its “sensitive” and “decision-making” attributes (Jealous 2001).

From a BOCF perspective, Jealous (2001) acknowledged that the practitioner’s consciousness has a primary role in the depth of therapeutic changes arising in the patient. Jealous discovered that his therapeutic results improved in proportion to the extent to which he could free himself from conscious rationalization. He discovered, as did Sutherland, that the practitioner’s effort “. . . is to let the Breath of Life move us, allow us vision. . . One’s effort must be from a ‘sense of the possibilities’” (Jealous 2001). The next couple sections of this article review new research “around the edges” of BOCF science.

BLECHSCHMIDT’S EMBRYOLOGY VIA À VIS THE BOL

Jealous (2001) characterized traditional osteopathy as a science based on anatomy, whereas BOCF is a science based on embryology. BoL practitioners have followed the work of Erich Blechschmidt (1902–1992), an unabashedly holistic embryologist. According to Blechschmidt (1977), each part of the embryo develops in motion, and each motion impacts the development of each subsequent motion. Early embryological development is largely *epigenetic*, guided by fluid dynamics. Blechschmidt’s concepts agree with BOCF practitioners, who postulate that the BoL, the external force described by Sutherland, generates a spatial orientation in the embryo. The spatial orientation becomes expressed in the material plane by fluid forces, perhaps by electromagnetic water hydrogen bonds (a concept that resonates with the “water imprint” theory of homeopathy), generating a matrix that governs the embryo’s development. This conceptual agreement between Blechschmidt and BOCF places them on one side of a great debate. For the past 50 years scientists have argued over two theories regarding embryonic development: is it *passive* and “*external*,” driven by fluid dynamics, or *active* and “*internal*,” driven by the molecular activity of genes?

Neural crest cells (NCCs) are a focus of this debate. Migratory NCCs appear in the fourth week of human embryogenesis. As the lateral edges of the neural plate fold up and fuse at midline to form the neural tube, NCCs surf the crest of the wave generated by this zipper-like action. NCCs follow highly replicated, stereotypical pathways. In our age of molecular medicine, advocates of *active* cell migration uphold the dominant paradigm. According to this view, migrating NCCs are directed by genes that express cell membrane receptors. NCC receptors sense molecular gradients in the extracellular fluid. Thus NCC migration has been described as *chemotaxic*, guided by molecules such as integrins, cadherins, and connexins (Maschhoff and Baldwin 2000). This molecular view is challenged, however, by phylogenetic inconsistencies—NCCs only appear in vertebrate embryos. Invertebrate embryos have no NCCs yet they express genes linked with

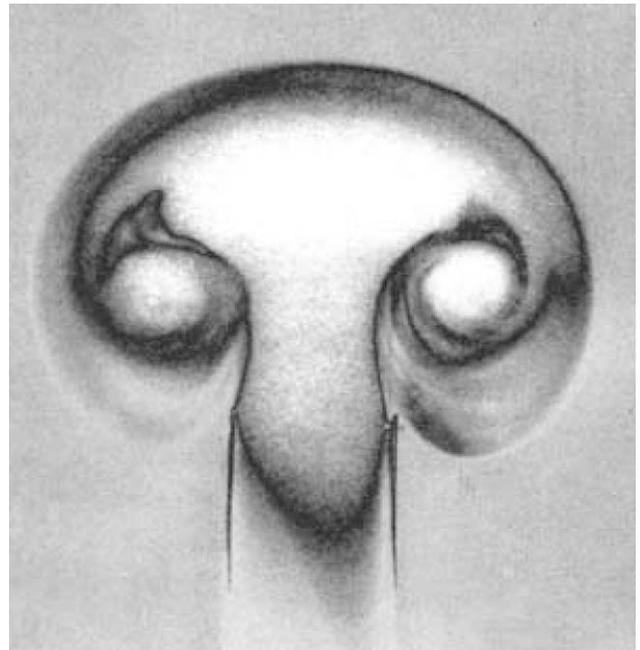


Figure 2. Photomicrograph of micropipette injecting a stream of fluid into water, forming a vortex. The boundary surface between the moving fluid and the still water creates organic forms. Illustration by Gerald Moonen, redrawn from Schwenk (1996).

NCC migration, such as *BMP2/4*, *Pax3/7*, *Msx*, *Dll* and *Snail* (Holland & Holland 2001). Vice versa, genes associated with vertebrate cell migration, such as *CNR1* (Song and Zhong 2000) are absent in invertebrates (McPartland et al 2001, McPartland & Glass 2001). Plants, which are devoid of a CNS, also express integrin receptors (Lynch et al 1998), which aid plant cells in the perception of gravity (a very subtle force in non-ferrous materials). Perhaps integrin receptors are not chemotaxic guides, but in fact respond to subtle electromagnetic forces such as the BoL.

Blechschmidt argued that fluid dynamics permit migrating cells to overcome the inertial, thixotropic (viscous) behavior of embryonic extracellular fluid. The tensile quality of the fluid matrix provides a scaffolding for the migration and movement of NCCs. BOCF practitioners correlate this concept with Sutherland’s description of the Tide acting as a fluid within a fluid, expressing a tensile quality, with the ability to direct force. Blechschmidt’s theory has been verified by researchers around the world (see a dozen citations in Jesuthasan 1997) who injected latex beads into living embryos. Latex beads are inert objects incapable of molecular chemotaxis and lack inherent motility. They nevertheless follow the migratory pathways of NCCs. The tensile fluid forces required for this kind of movement were demonstrated by Schwenk (1996), who used micropipettes to inject streams of fluids into water. Boundary surfaces arising between the moving fluid and the still water vortexed into organic forms (see Figure 2). Experimental changes in fluid density or injection speed created different forms. In some experiments, the tensile quality of the fluid matrix created shapes that resem-

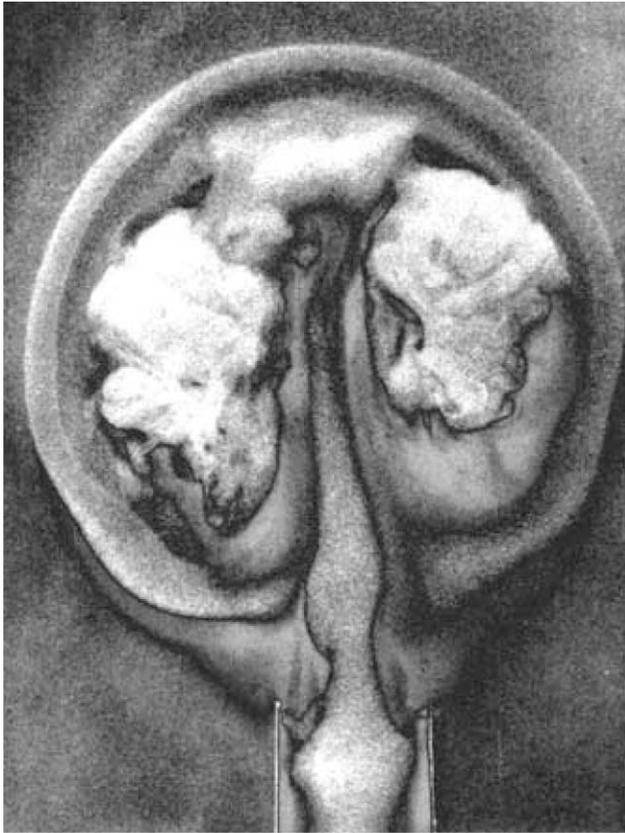


Figure 3. hotomicrograph of micropipette injecting a stream of fluid into water, an experimental variation from Figure 4, changing the density of the fluid. The spatial orientation of boundary surfaces suggests that of embryonic CNS formation. Illustration by Gerald Moonen, redrawn from Schwenk (1996).

bled the migratory path of neural crest cells. In other experiments the spatial orientations of fluid-in-a-fluid suggested CNS formation in the embryo, complete with dura and pia, cerebral hemispheres, and a corpus callosum connected the hemispheres (see Figure 3). Schwenk's experiments with fluid mechanics suggested that the geometric configuration of the embryo is present *before* the structure develops.

GENETIC CONTRIBUTIONS

After the fluids lay down a matrix or blueprint, genetic expression subsequently organizes the cells, and cell migration does indeed become active. For example, the initial wave of NCCs stops migrating and establishes a reticular lattice. This lattice provides a scaffolding for the active chemotaxic growth of neurons, presaging the mature organization of the autonomic nervous system (Conner et al 2003).

Similar phenomena govern the growth of neurons, via a sensory and motor apparatus in their tip termed the growth cone. Growth cone pathfinding is partially guided by fluid forces, a passive process again demonstrated by the translocation of inert

latex beads (Newman et al 1985). But genes also contribute to growth cone pathfinding, by expressing cell membrane receptors that are activated by extracellular "attractant" or "repellent" compounds. For example *UNC-40* and *Eph* receptors are activated by netrins and ephrins, proteins secreted into extracellular fluid. Activated *UNC-40* and *Eph* receptors begin a molecular cascade that directs the cell's actin cytoskeleton, thereby regulating growth cone motility (Dickson 2002). A veritable molecular soup guides neurons to their destinations. This complexity can be appreciated by the daunting task faced by commissural axons, which must grow towards the midline, cross it, and then continue on their path without turning back.

Nevertheless, Blechschmidt emphasized that genes do not act, they react to external forces. The reaction of genes to hydrostatic pressure during embryogenesis has recently been termed "the morphogenetic mechanism" (Van Essen 1997). Wal (1997) likened genes to the clay that forms a piece of pottery. Clay by itself cannot form into shape; it requires the hands of the artist. And the hands of the artist cannot act without the mind of the artist. From a BOCF perspective, clay represents the genes, the hands represents the fluid forces, and the artist's mind represents the BoL—the "deific plan" or the "master mechanic" often alluded to by A.T. Still. Anecdotally, we (J.M. and E.S.) attended a BOCF workshop the week that Venter et al (2001) published the human genome sequence. While scientists around the world pondered the paradox that an organism of our complexity could operate on only 30,000 genes (Claverie 2001), our workshop of BOCF practitioners confirmed the obvious necessity for epigenetic forces to make "decisions" that shape embryogenesis.

METABOLIC MOTION

Blechschmidt (1977) elaborated six different mechanisms by which fluids "behave internally," creating function out of which emerges structure: contusion, distension, dilatation, retension, detractation, and densation. Later he added corrosion, loosening, and suction mechanisms (Blechschmidt & Gasser 1978). These mechanisms are driven by the metabolism of cellular tissues. Cell metabolism potentiates or depletes various fluids, which Blechschmidt termed "metabolic fields." For example, the earliest bending of the embryonic disc (flexing into a "C" shape) is due to a decrease in pressure from the collapse of the yolk sac (Drews 1995). Cellular metabolism depletes nutrients in extracellular fluids, and causes a build-up of metabolic wastes. Sheets of cells adjacent to depleted fluids slow their growth, and become the concavity of tissue curvatures. Concentration gradients of nutrients and wastes create fluid movements between sources and sinks. When these fluid movements cannulize tissues they become embryonic blood vessels.

Sheets of cells, tissues, and organs grow at different rates. The epithelial linings of these assemblages become restraining structures, generating form. The embryonic face, for example, arises as folds and furrows between an expanding brain and a beating heart (Blechschmidt & Gasser 1978). Growth differentials within the embryonic cranium create fluid patterns that later condense into mechanical tension zones or mesenchymal restraining bands known as the dural girdles.

They guide the position, shape, and inner structure of the brain, “The resistances are not crude mechanical forces but delicate living developmental resistances” (Blechshmidt 1961). The midline dural girdle between the cerebral hemispheres serve as a strong restrainer against the pull of the descending viscera and the eccentric growth of the cerebrum. This midline dural girdle is retained into adulthood as the falx cerebri. It initially cleaves the frontal bone, which is why the frontal bone, a single midline structure in most adults, functionally behaves like a paired bone. In some individuals this midline function is retained as structure, the metopic suture (Magoun 1976). Several paired dural girdles arise in the embryo, and one of them is retained into adulthood as the tentorium cerebelli.

FUNCTIONAL MIDLINE

Another aspect of embryology that informs BOCF is the concept of a *functional midline*, around which our bodies and health must organize. The midline is the earliest expression of function within the embryo. A series of structures arises from the midline – first the primitive streak appears in the ectoderm, beginning at the caudal pole of the embryonic disc. Subsequently, the notochord develops within the endoderm, again growing from caudad to craniad. Days later, the neural groove forms along the midline, arising tail to head. During the fourth week of development, the neural tube closes at its two ends, and the movement of fluid is no longer a *circulation*, but a *fluctuation*. The amniotic fluid becomes the CSF. The lamina terminalis marks the closure of the cephalic end of the tube. This midline structure persists in the adult, at the roof of the third ventricle. It is the pivot point for all neural movement. During the inhalation phase of the PRM (ie, the “inspiration” phase), the entire central nervous system spirally converges upon lamina terminalis. During the exhalation phase, all tissues move away from lamina terminalis.

Jealous (1997) described the midline arising from the Stillness, generated by the BoL. The functional midline remains present throughout our life, and our structure and physiological motion remain oriented to the midline. The BoL comes into the body at the coccyx and ascends along the midline, radiating “like a fountain spray of life” (Sills 1999). The conveyance of a midline bioenergetic force from tail to head has been described by numerous workers, perhaps first by the medical polymath Wilhelm Reich. Reich and his students independently described the PRM, “. . .confirmation of brain movement can be obtained from individuals who are free of armoring. . . this movement is relatively slow and unrelated to arterial pulsations” (Konia 1980). Interestingly, genetic mechanisms tend to work in the opposite direction, in a cephalad to caudad progression. This is best exemplified by the activation of a dozen *Hox* transcription factor genes (the “*Hox* clock”) that direct the formation of embryonic somites from head to tail. The sequence of *Hox* gene expression is collinear with their gene order on the chromosome (Kmita & Duboule 2003).

The movement of the Tide can be palpated throughout the body, termed “Zone A” by BOCF practitioners (Jealous

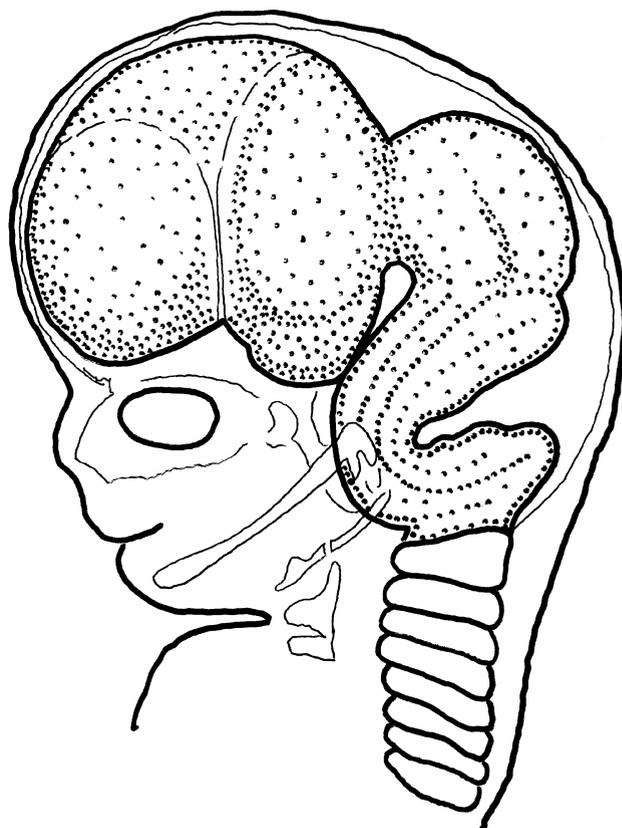


Figure 4. The anterior dural girdle forming in an 8 week old embryo, drawn as a thin double line between anterior and lateral telencephalic vesicles. Illustration by McPartland, redrawn from Blechschmidt & Gasser (1978).

2001). Asian practitioners conceptualize this energy moving in channels, such as Chinese *chi* and Ayurvedic *vata* and its subdosha *prana* (McPartland & Foster 2002). The movement of the Tide can also be palpated outside the body, in the “auric field” of various Eastern and Western energy workers, termed Zone B in BOCF lexicon. Osteopaths such as Randolph Stone and Robert Fulford primarily worked in Zone B. Rollin Becker worked in Zone C, a field diffusing from the midline to the edges of the room (personal communication, J. Jealous, 1999). Jealous (2001) emphasized that all these zones exist simultaneously, as do other domains, such as Zone D, which extends from the patient’s midline to the horizon. The zones are useful diagnostic tools, augmenting the practitioner’s perceptual fields.

EMBRYOLOGY LEARNS FROM BOCF

BOCF has learned from embryology, but the relationship is reciprocal—BOCF has informed the science of embryology. Take the anterior dural girdle (ADG) for an example. The ADG arises around the 8th week of pregnancy, as a condensate of strain patterns between the evaginating telencephalic vesicles (Figure 4). According to most embryologists, the

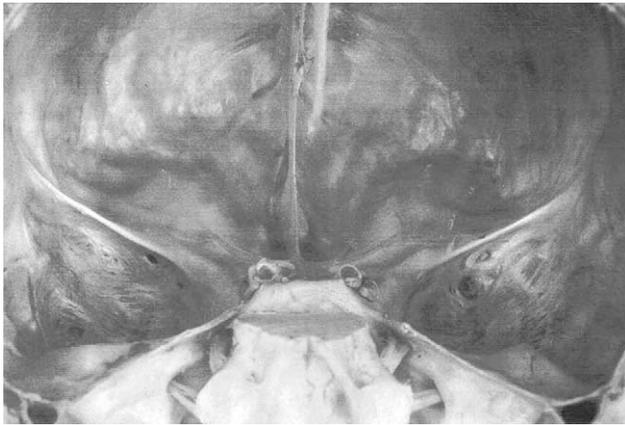


Figure 5. Neonate dissection of the anterior cranial fossa, looking from posterior to anterior, with the pons sliced and brain removed. Bilateral anterior transverse septae angle between the dissected midline falx and paired tentoria. Photograph courtesy F.O.R.T. Foundation, www.BioDO.com.

ADG regresses before birth. However, one of Jealous's colleagues alerted him to a cranial strain pattern that he detected in several of his adult patients. They started calling it "the hoop," describing its sensory feel. They organized perinatal dissections with Frank Willard, PhD, and discovered that the anterior dural girdle does not always involute before birth, but sometimes remains as an anterior transverse septum (Figure 5). In other cases the girdle regresses, although a strain pattern may remain in the fluids.

BOCF palpation also presaged the discovery of a dural bridge in the suboccipital region (Jealous, personal communication, 1999), and this structure is now known to persist in adults (McPartland & Brodeur 1999). The dural bridge attaches the dura to the posterior atlanto-occipital membrane (PAOM), a ligament that spans the OA joint.

CARE AND FEEDING OF THE ATTENTION FACULTY

BOCF is taught within a clinically based programme, where each step is designed as a journey to reawaken the intuitive and instinctual aspects of the practitioner's mind. Our intuitive and instinctual faculties were called "primary perceptions" by Pearce (1977), who described them as "part of nature's built-in system for communication and rapport with the earth." These abilities tend to disappear, like muscle atrophy, if they go unused. Thus intuition and instinct are present at birth, but wither due to lack of use given today's societal and educational burdens. Our intuition, instinct, and perceptual vitality are also dulled by the stress of urban living, and by the pressures of our professional life.

Great care is taken in the choice of where practitioners receive BOCF training. The natural world is a necessary participant and instructor. Through his own experiences in the wildernesses of New England and Canada, Jealous learned how the deeper self, the human spirit, emerges upon encoun-

tering the nature world. Nature's "spell of the sensuous" quiets a person's CNS, allowing boundaries to fall away between the individual and the whole. John Muir, a 19th century American naturalist, spoke like an osteopath, "In nature, when we try to pick out anything by itself, we find it hitched to everything else in the universe" (Muir 1911). The BOCF practitioner transports this natural-world phenomenon to the urban treatment room, incorporating an indigenous state of consciousness into everyday clinical practice.

It is important to recognise that what is observed during the course of treatment is not the result of mesmerism, coloured by a vaguely vitalistic theory, but evidence of a precisely organised natural system which requires discipline and dedication in order to develop the practitioner's perceptual faculty. Practitioners at this time in history are in a unique position. Given our training in medical science and hands-on manipulative techniques, combined with the principles of Still and Sutherland, we can consult with the blueprint for health, namely, embryological growth and development recapitulated as the forces of healing. But there is a caveat: without the proper preparation, this approach can be dangerous for the patient and an abuse of the practitioner's commitment to the Hippocratic Oath. This model does not work with "energy" but with the consciousness of the natural world.

REFERENCES

- Abram D. 1996. *The Spell of the Sensuous*. New York: Vintage Books.
- Artaud A. 1938. *The Theatre and its Double*. New York: Grove Press
- Becker RE. 1965. Be still and know. *Cranial Academy Newsletter*, Dec 1965:5-8.
- Berry W. 1996. *The Unsettling of America: Culture and Agriculture*. New York: Random House.
- Blechschild E. 1961. *The Stages of Human Development before Birth*. Philadelphia: Saunders.
- Blechschild E. 1977. *Beginnings of Human Life*. Berlin: Springer-Verlag.
- Blechschild E, Gasser RF. 1978. *Biokinetics and Biodynamics of Human Differentiation*. Springfield, Illinois: Charles Thomas Publishing.
- Bohm D. 1980. *Wholeness and Implicate Order*. London: Routledge and Kegan Paul.
- Capra F. 1996. *The Web of Life*. London: Harper Collins.
- Cardy I. 2004. *Experience in Stillness: a hermeneutic study of the Breath of Life in the Cranial Field of Osteopathy*. Masters dissertation, School of Osteopathy, UNITEC, Auckland, New Zealand. 103 pp.
- Chew MK, Laubichler MD. 2003. Natural enemies—metaphor or misconception? *Science* 301:52-53.
- Claverie JM. 2001. What if there are only 30,000 human genes? *Science* 291:1255-1257.
- Cornell EA, Wieman CE. 2002. Bose-Einstein condensation: the first 70 years and some recent experiments (Nobel Prize Lecture). *Chemphyschem*. 3(6):476-93.
- Conner PJ, Focke PJ, Noden DM, Epstein ML. 2003. Appearance of neurons and glia with respect to the wavefront during colonization of the avian gut by neural crest cells. *Developmental Dynamics* 226:91-98.
- Dickson BJ. 2002. Molecular mechanisms of axon guidance. *Science* 298:1959-1964.
- Draws U. 1995. *Color Atlas of Embryology*. New York: Thieme Medical Publishers.
- Fulford RC. 1988. Integration of love with the cranial concept. *The Cranial Letter* 41(4):2-3.

- Green E. 1983. 'Foreword,' pp. xi-xiv in *Craniosacral Therapy*. Upledger JE, Vredevoogd JD. Chicago: Eastland Press.
- Greenman PE, McPartland JM. 1995. Cranial findings and iatrogenesis from craniosacral manipulation in patients with traumatic brain syndrome. *J American Osteo Assoc* 95:182-192.
- Greitz D, Greitz T, Hindmarsh T. 1997. A new view on the CSF-circulation with the potential for pharmacological treatment of childhood hydrocephalus. *Acta Paediatrica* 86:125-132
- Hesse N. 1991. Major Betrand DeJarnette: six decades of sacro occipital research, 1924-1984. *Chiropractic History* 11(1):13-15.
- Highwater J. 1981. *The Primal Mind*. Harper and Row, New York
- Holland LZ, Holland ND. 2001. Evolution of neural crest and placodes: amphioxus as a model for the ancestral vertebrate? *J Anatomy* 199: 85-98.
- Jahn RG. 1996. Information, consciousness, and health. *Alternative Therapies in Health and Medicine* 2(3):32-38.
- Jealous J. 1997. Healing and the natural world. *Alternative Therapies in Health and Medicine*. 3(1):68-76.
- Jealous J. 2001. *Emergence of Originality*, 2nd Ed. Biodynamic/Sargent Publishing, Farmington ME, 145 pp.
- Jesuthasan S. 1997. Neural crest cell migration in the zebrafish can be mimicked by inert objects: mechanism and implications of latex bead movement in embryos. *J Experimental Zoology* 277:425-434.
- Kmita M, Duboule D. 2003. Organizing axes in time and space: 25 years of collinear tinkering. *Science* 301:331-333.
- Konia C. 1980. Brain pulsations, Part I: normal functioning. *J Orgonomy* 14:103-113.
- Liem, T. 2003. *Praxis der Kraniosakralen Osteopathie*. Stuttgart: Hippokrates Verlag GmbH.
- Lynch TM, Lintilhac PM, Domosych D. 1998. Mechanotransduction molecules in the plant gravisensory response. *Protoplasma* 201:92-100.
- Magoun HI. 1976. *Osteopathy in the Cranial Field*, 3rd Ed. Kirksville, MO: Journal Printing Co.
- Maschhoff KL, Baldwin HS. 2000. Molecular determinants of neural crest migration. *Amer J Med Genetics* 97:280-288.
- McPartland JM. 1989. Manual medicine at the Nepali interface. *J Manual Medicine* 4:25-27.
- McPartland JM. 1996. Side effects from cranial-sacral treatment: case reports and commentary. *J Bodywork & Movement Therapies* 1(1):2-5.
- McPartland JM, Brodeur RR. 1999. The rectus capitis posterior minor: a small but important suboccipital muscle. *J Bodywork & Movement Therapies* 3(1):30-35.
- McPartland JM, Foster F. 2002. "Ayurvedic Bodywork," pp. 155-164 in *Principles and Practices of Manual Medicine*, ed: P Coughlin, Edinburgh: Churchill Livingstone.
- McPartland JM, Glass M. 2001. The nematocidal effects of *Cannabis* may not be mediated by cannabinoid receptors. *New Zealand Journal Crop & Horticultural Science* 29:301-307.
- McPartland JM, Mein EA. 1997. Entrainment and the cranial rhythmic impulse. *Alternative Therapies in Health and Medicine* 3(1):40-44.
- McPartland JM, Brodeur R, Hallgren RH. 1997. Chronic neck pain, standing balance, and suboccipital muscle atrophy. *J Manipulative & Physiological Therapeutics* 21(1):24-29.
- McPartland JM, Di Marzo V, De Petrocellis L, Mercer A, Glass M. 2001. Cannabinoid receptors are absent in insects. *Journal of Comparative Neurology* 436:423-429.
- Milne H. 1998. *The Heart of Listening: A Visionary Approach to Craniosacral Work*. Berkeley: North Atlantic Books.
- Muir J. 1911. *My First Summer in the Sierra*. Cambridge: The Riverside Press.
- Nelson KE, Sergueef N, Lipinski CL, Chapman A, Glonek T. 2001. The cranial rhythmic impulse related to the Traube-Hering-Mayer oscillation: comparing laser-Doppler flowmetry and palpation. *J Am Osteopath Assoc* 101:163-173.
- Newman SA, Frenz DA, Tomasek JJ, Rabuzzi DD. 1985. Matrix-driven translocation of cells and nonliving particles. *Science* 228: 885-889.
- Norton JM. 1996. A challenge to the concept of craniosacral interactions. *J Am Acad Osteopathy* 6:15-21.
- Oschman JL. 2000. *Energy Medicine*. Edinburgh: Harcourt Publishers.
- Paulsen AR. 1953. Automatic shifting. *J Osteopathic Cranial Association* 1953:65-66.
- Pearce JC. 1977. *Magical Child*. New York: Penguin Books.
- Pert C. 2000. 'Foreword,' pp ix-xi in *Energy Medicine*, Oschman JL. Edinburgh: Churchill Livingstone.
- Pourquie O. 2003. The segmentation clock: converting embryonic time into spatial pattern. *Science* 301:328-330.
- Retzlaff EW, Mitchell FL. 1987. *The Cranium and its Sutures*. Berlin: Springer-Verlag.
- Rohen JW. 2002. *Morphologie des menschlichen Organismus*. Stuttgart: Verlag Freies Geistesleben.
- Schleip R. 2002. *Neurobiological aspects of the cranial rhythmic impulse*. Somatics Web Page, www.somatics.de/cranial.htm.
- Schwenk T. 1996. *Sensitive Chaos: The Creation of Flowing Forms in Water and Air (revised edition)*. London: Rudolf Steiner Press.
- Sheldrake R. 1981. *A New Science of Life*. Great Britain: Blond & Briggs, Limited.
- Sills F. 1999. The embryological ordering principle. *The Fulcrum* 14:1-8. <www.craniosacral.co.uk>.
- Song ZH, Zhong M. 2000. CB1 cannabinoid receptor-mediated cell migration. *J Pharmacology & Experimental Therapeutics* 294:204-209.
- Speece CA, Crow WT, Simmons SL. 2001. *Ligamentous Articular Strain*. Seattle: Eastland Press.
- Still AT. 1899. *Philosophy of Osteopathy*. Kirksville, Mo: The Journal Printing Company.
- Still A. 1902. *The Philosophy and Mechanical Principles of Osteopathy*. Kirksville, Mo: Co.Hudson-Kimberly Pub.
- Still AT. 1908. *Autobiography of Andrew T. Still, revised edition*. Kirksville, Mo: Published by the Author.
- Still A. 1910. *Osteopathy Research and Practice*. Kirksville, Mo: The Journal Printing Company.
- Strogatz SH, Stewart I. 1993. Coupled oscillators and biological synchronization. *Scientific American* 269(12):102-109.
- Sutherland WG. 1939. *The Cranial Bowl*. Mankato, MN: Free Press Co.
- Sutherland WG; Sutherland AS, Wales A, eds. 1967. *Contributions of Thought, the Collected Writings of William Garner Sutherland*. Kansas City, Mo: Sutherland Cranial Teaching Foundation.
- Sutherland WG; Sutherland AS, Wales A, eds. 1998. *Contributions of Thought*, 2nd Ed. Portland, Ore: Rudra Press.
- Sutherland WG; Wales A, ed. 1990. *Teachings in the Science of Osteopathy*. Portland, Ore: Rudra Press.
- Tiller WA, McCraty R, Atkinson M. 1996. Cardiac coherence: a new, noninvasive measure of autonomic nervous system order. *Alternative Therapies* 2:52-65.
- Upledger JE, Vredevoogd JD. 1983. *Craniosacral Therapy*. Chicago: Eastland Press.
- Van der Post L. 1961. *The Heart of the Hunter*. London: Hogarth Press.
- Van der Post L. 1962. *Patterns of Renewal*. Chester, Pa: John Spencer, Inc.
- Van Essen DC. 1997. A tension-based theory of morphogenesis and compact wiring in the central nervous system. *Nature* 385:313-318.
- Venter JC, Adams MD, Myers EW, Li PW, Muria RJ, Sutton GG, et al. 2001. The sequence of the human genome. *Science* 291:1304-1351.

-
- Wal, JC van der. 1997. 'De spraak van het embryo,' in Liber Amicorum Steven De Batselier. <www.home.uni-one.nl/walembryo/esve.htm>
- Weaver C. 1936a. Cranial Vertebrae. *J Amer Osteopathic Assoc* 35:328, 35:374-379, 35:421-424 [three parts].
- Weaver C. 1936b. Etiological importance of cranial intervertebral articulations. *J Amer Osteopathic Assoc* 35:515-525.
- Weaver C. 1938. Symposium on the plastic basicranium. *J Amer Osteopathic Assoc* 37:298-303.
- Wirkus M, Wirkus M. 1992. *Bioenergy—A Healing Art*. Bethesda, MD: Bio-Relax Press.
- Woods RH, Woods JM. 1961. A physical finding related to psychiatric disorders. *J Amer Osteopathic Assoc* 60:988-993. For more about BOCF, see: Jealous J. 2001 (with annual updates). *The Biodynamics of Osteopathy* (interactive audio CD series), www.bioDO.com.