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## Integration Nature and Nurture Through Developmental Systems: The Contributions of Gilbert Gottlieb

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## The Developmental Point of View: Anything Can Change Everything; Permission to Doubt Dogma, the Gilbert Gottlieb Legacy

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This article aims to illustrate some of the far-reaching theoretical impacts the research of Gilbert Gottlieb has made outside the fields of psychology, biology and sociology. Specifically, this theorist's "Developmental Point of View" has far reaching impacts as a potential model for investigating in the fields of health care. Epigenetic development cannot be adequately described or explored without considering a multitude of factors including, but not limited to; genetic, neural, behavioral and environmental "bi-directional influences." The goal of the present article is to acknowledge a great theorist, Gilbert Gottlieb and demonstrate how his ideas inspire other ideas and in fact may change one's own understanding of development.

*Keywords:* Development, bi-directional influence, nature and nurture, Chiropractic, Parkinson's Disease, joint dysfunction

Imagine living in a time when there was belief in a simplified explanation for individual development with a notion that organisms merely grew to a larger size from a tiny, totally pre-formed package. Today this idea so easily nullified it defies belief as to why the concept was ever written down as a lucid thought, much less popularized enough to become a part of "scientific history." Such is the power of dogma. Such was the view of the preformationists. One may not have even needed a magnifying glass to see such views would not hold up to macroscopic scrutiny.

Now imagine living in a time in which the popular press and sound-bite media perpetuate the idea that genes and genetic code are responsible for everything. This was the tenuous environment in which my father, Gilbert Gottlieb, was inspired to put forth novel concepts to explain epigenetic development. Albeit difficult to concisely describe, he has elegantly done so with illustration of "bi-directional influences," (See figure 14-3, a depiction of the completely bi-directional nature of genetic, neural, behavioral, and environmental influence over the course of individual development which appeared in Gottlieb, 2002, p.186).

Although after reading this entire special edition journal dedicated to Gilbert Gottlieb's scientific contributions over the course of a half-century, you may not agree that the before-mentioned concept is his most significant. However for me, his son, it has come to symbolize his life's work. Not for the concept itself, but for the path and the journey. What my father and his contemporary colleagues have had to overcome is a deeply embedded conventional wisdom that must be the developmental theorist's equivalent of living during a time when the world was thought to

be flat and you have evidence that it is round. In addition to his many theoretical contributions, my father had a special knack for illuminating the non-obvious with the true spirit of non-biased research.

I was "imprinted" on my father and at least one of his post-docs, David Miller, from an early age, in that our home was also the setting of a field station for performing naturalistic observations of multiple species including, but not limited to: jungle fowl, wood ducks, mallards, Peking ducks, and a variety of other geese and birds. First and foremost, I was left with the impression of the importance of being a careful observer; and that great meaning can be extrapolated from the smallest of details. In fact by age eleven I was a "field research assistant" monitoring the nests of wood ducks and collecting eggs for laboratory incubation to be carried out in a controlled setting. Inspired by these early childhood experiences, in 6th grade my father's work was the source of my own science project consisting of a slide essay of his scientific work. In high school for my senior paper, I interviewed him and quoted much of his work for a project entitled "Epigenesis and Preformation." I expanded on the topic for my first major paper, "Individual Development: Epigenesis and Preformation," written while a freshman at North Carolina State University, which my father approved of so much; he made it supplementary reading 1988-1994 for his Psychology 326 class at the University of North Carolina at Greensboro in the form of a library reserve. Despite this early accomplishment, I learned the hard lesson that if your English teacher is a "creationist" you will not get an "A" on a paper that explores the topic of evolution. While working on my Doctor of Chiropractic degree, I used the egg-opening techniques my father had learned from Zing Yang Kuo, for visualizing a developing chick in my embryology class. So basically, I rode his duck tails most of my academic career.

He inspired me to be an observer and researcher of sorts. Whereas he supplemented his research career with clinical training, I have supplemented my clinical career with research. Having witnessed my father's career involve battling conventional wisdom; I adopted many of the same characteristics. In a society enthralled with the idea that there is a drug or surgical treatment for every human ailment, I fought the cultural norms and matriculated to a Chiropractic college that fostered the exploration of health and wellness being achieved by means other than drugs or surgery.

As I observed with my father's career; it takes a great deal of energy to deal with the ever-persistent gravitational forces applied by conventional wisdom, much less to have the ability to overcome these issues in such a way as to make a substantial and lasting contribution to science. Embracing just some if not all of the concepts that amount to what is called Gilbert Gottlieb's "Developmental Point of View," creates an opportunity to expand one's knowledge across multiple disciplines. Although traditionally the collective works of Gilbert Gottlieb have been associated with the field of psychology, the concepts transcend interdisciplinary borders and additionally encompass biology, sociology, and most of the "-ology" sub-groups one can think of; as his career culminated with an influence in genetics.

For me this broad based applicability spilled over into health care. It seems within every old discipline there remains an attachment to central dogma, and old paradigms which remain intuitively appealing when merely superficially studied. However with Gottlieb's tenacity one can be open to exploring counter-intuitive concepts and, if really fortunate, can recognize the importance of non-obvious discoveries. The ability for me to think this way is perhaps a genetic expression turned on by my environmental exposures.

I developed an interest in human gestational issues, particularly relating to birth traumas in the prenatal and early-natal period. In "Neglected Spinal Cord, Brain Stem and Musculoskeletal Injuries Stemming from Birth Trauma;" I explored the mechanisms and concomitants associated with "environmental" complications as opposed to genetic heredity issues, (Gottlieb, 1993). In the simplest of terms stressing the anatomy of a fetus or new-born affects its physiology and therefore can be a causative factor of developing a myriad of health-challenging problems: from a general failure to thrive, to chronic ear problems, to general irritability, to musculoskeletal defects, to nervous system sequelae such as cerebral palsy. The exploration of such a topic leads to non-obvious correlations being discovered.

Rather than fall into the thinking, that for every action there is an equal and opposite reaction, consider openly all the possibilities. As an analogy, picture a still-framed photograph of a ball in mid-air. How many possibilities can you imagine? Has the ball been captured on the photograph while falling from gravitational force, is it accelerating or decelerating, is it going toward or away from the camera? That is the simplified essence of "bi-directional influences." At any given moment anything can change everything. There are enumerable examples of how nature and nurture integrate affecting development within the human organism.

The goal of the present article is to acknowledge a great theorist, Gilbert Gottlieb and demonstrate how his ideas inspire other ideas and in fact may change one's own understanding of development. In an amateurish way we often think of development as occurring primarily from conception through adult maturation. Humans change remarkably over the course of a life span. In true Gottlieb fashion the following discussion may raise more questions than answers, but illuminates the potential impact of thinking with "a developmental point of view."

Consider for a moment, without a preconceived bias, several fascinating examples. A layman's view of Parkinson's Disease would include in the very least there is a problem within the central nervous system that effects motor function. A slightly more sophisticated view may include explanations for etiology such as "bad genes," environmental exposure to aluminum, and/or a cellular level problem with Dopamine. Extrapolating with an open mind from research on "Supplementary and primary sensory motor area activity in Parkinson's Disease" (Rascol, 1992) one could theorize an entirely new potential etiology. "Akinesia represents the most characteristic motor deficit in Parkinson's Disease." Abnormal motor performance in Parkinson's Disease has been attributed to impaired function of the supplemental motor area of the brain, but usually no lesions are found in this area, and motor nerves which control muscle movements have normal electrophysiology

characteristics. In other words, there may not be a "sick brain or sick nerves," but an abnormality of motor programming caused by a "functional deafferentation of the brain."

For simple and complex movements, the nervous system is required at any given moment to process electrical impulses consisting of sensory feedback apprising the brain of "position sense" or proprioception through a complex of cellular mechanoreceptors and responding to this sensory input with appropriate efferent or outgoing motor signals instructing individual muscles to contract or relax, in an effort to coordinate a body movement with millisecond precision. A simplistic view of Parkinsonism would characterize the disease as a movement disorder thereby labeling it a motor problem. Using Gottlieb's "bi-directional influences" model or what the current author suggests modifying to "multidirectional influences" (see figure 1; as Gottlieb, G. likely intended), one may extrapolate an entirely different mechanism. For the sake of brevity in formulating a hypothesis: what if Parkinsonism is a sensory-motor problem, not just a motor problem? Looking at the most basic of influences; since movement occurs about joints by virtue of muscles contracting and relaxing to achieve body movements, there must be intact afferent or sensory circuits relaying messages from the body to the brain, and intact return circuits relaying efferent or motor messages causing a corresponding body movement. In a world consumed with finding a chemical cure for every ailment; what if there were a non-obvious cure within the body itself? In this example the author wishes to illustrate the idea that joints in effect are receptors and transmitters of neurological input to and from the brain. Therefore if a joint has abnormal function, it may send and receive abnormal information. In the simplest of terms a joint with decreased movement or function relays less sensory information to the brain, thereby decreasing stimulation to the brain, thereby decreasing or slowing motor response, producing a movement disorder. "Bradykinesia does not reflect an impairment of the final cortical motor neuron connection, and it is assumed that the motor cortex and its efferent pathways are intact in Parkinson's Disease," (Dick, et al., 1984).

#### Multidirectional influences, Forming Reactions to interactions

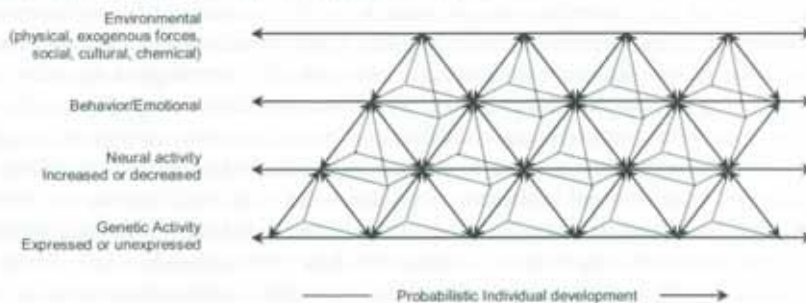


Figure 1. Depiction of the completely multidirectional nature of genetic, neural, behavioral, and environmental influences over the course of individual development (Modified from Gottlieb, 2002, p186).

Accordingly, one might assume that such a movement disorder is not due to a physical lesion in the brain, but rather some form of decreased brain activity or stimulation such as loss of sensory-neural input from a dysfunctioning joint. This is not to suggest an entirely different hypothesis without some rational basis. What if motor tremors observed in some patients are actually a mechanism for functionally enhancing sensory feedback to the brain? The more a body part wiggles, the more sensory feedback on positioning, and therefore the more stimulation relayed to the brain. Consider as an analogy the rock steady balance of a gymnast's foot on a balance beam compared to someone with poor balance while trying to maintain a single leg stance. The more the brain needs feedback about where a body part is positioned, the more the body part wiggles until sufficient feedback or training affect yields the desired balance point. The same may be true of Parkinson's patients, in that the stiffer the joints, the worse the motor movement due to a potential loss of feedback. Conversely patients in the early stages of Parkinson's find relief with movement related activities such as cycling, causing bombardment of the nervous system with sensory input with required subsequent motor output to maintain the activity. Additional clinical observations may support this contention as well.

Profoundly symptomatic Parkinson's patients with a shuffling gait can find themselves effectively stuck in the corner of a room. Without the ability to initiate head turning and trunk rotation one cannot get turned back out of the corner without assistance. From anecdotal reports, a patient with such symptoms may receive benefit from chiropractic spinal manipulation which enhances joint movement and neurological feedback at the joint level, allowing such a patient to get himself out of this predicament.

Chiropractic manipulation is known to cause supraspinal neurological stimulation. Likewise the author has noted while performing cervical spinal manipulation on a patient demonstrating classic upper extremity tremors, such as "pill rolling," that the abnormal movements will momentarily cease. This may be due to the stimulation of richly neuroreceptor-laden tissues, such as those surrounding and composing spinal joints. Presumably this is an intense sensory-neural bombardment of the brain caused by stimulating mechanoreceptors with physical motion. With loss of joint motion, a functional deafferentation occurs, and therefore restoration of joint function with movement related treatments, may be a key factor. Herein lies the spirit for considering the non-obvious in the development of a profound neurological disorder.

This is a potential example of "genetic activity or expression being influenced by supragenetic factors...cytoplasm can be influenced by external environment of the organism via the behavior of the organism, which gets the organism into and out of exposure to the different environmental influences..." (Gottlieb, 2003, p. 348). This type of theoretical thinking has prevented me from being narrowly channeled in my own conceptual thinking, and moreover helped me to 'connect the dots.' The previously quoted birth trauma research (Gottlieb, 1993) easily connected a cause-effect relationship regarding external influences affecting human development both in function and form.

Extrapolating how dysfunction may affect form, a correlation can be made between residual sequelae from birth trauma which affects head and neck movement

or function, and thereby causes abnormal movement patterns which lead to the development of abnormal bone shapes. Conversely abnormal bone development in-utero may lead to abnormal function in that, bone shape affects joint function.

After overcoming the paradigm of presumed symmetry within the human skeleton in anatomical texts and teachings; I performed an observational study of the human craniovertebral articulations, entitled: "Absence of Symmetry in Superior Articular Facets on the First Cervical Vertebra in Humans: Implications for Diagnosis and Treatment, (Gottlieb, 1994). The base of the skull has two round condyles that oppose concave bony elements on the receiving aspect of the atlas, or first cervical vertebra in humans. The study concludes there is remarkable variation within each individual atlas, comparing right and left sides, and even greater variation is exhibited between individuals. In a classical (which came first, the chicken or the egg) dilemma one must consider the possibility of in-utero pressures on the developing fetus may cause a respective change in the shape of the developing joint and/or forces exerted during labor and delivery may affect the shape of these malleable bones which are largely cartilaginous at this stage of development. This anatomy does not become fully ossified or turned to bone, with growth plates sealed for a number of years.

Inevitably "experience" may shape the bone and vice versa, the shape of the bone influences movement patterns of the individual. Furthermore, forces on bone cause reactive bone development, in an effort to counteract stress affects on the bone. This premise is demonstrated in other ways as well. Typically 5 lumbar vertebrae comprise the lower spine, but a developmental anomaly may cause the expression of either 6 moveable bones, (lumbarization of the sacrum) or 4 freely moveable bones, (sacralization of the 5<sup>th</sup> lumbar vertebra) in which case there is fusion of the fifth lumbar vertebra to the sacrum. Additionally, acquired bony changes are seen with osteoarthritis.

Central to Chiropractic treatment, is the restoration of joint motion, (Gottlieb, 1997). Much to my father's pleasure I connected the dots once again.

Motion is not only required for the ontogenetic development of tendons, but is also critical for the maintenance of their structure and function once they have developed, (Kieny & Chavallier, 1979) an important clinical point in osteoarthritis. Further elucidating the multidirectional influences premise; I once again threatened dogma with research entitled "Conservative management of spinal osteoarthritis with glucosamine sulfate and Chiropractic treatment," (Gottlieb, 1997).

"There are many synonyms or acronyms for osteoarthritis. The name used most commonly is degenerative joint disease (DJD). For more than semantic reasons, this name is actually misleading; the words do not accurately describe the path of physiological phenomena that are involved. The classification of arthritis as a disease has even been questioned by some authors, who prefer to redefine it as "an ancient Paleozoic mechanism of repair of dense tissues," (Bland & Cooper, 1984). The salient points of this tangent include: when joint movement is restricted, the normal joint physiology cannot be maintained, such that motion normally helps the distribution of nutrients to cells within a joint and when hindered, allows the joint cartilages to deteriorate, and thus joint

deterioration further affects movement and causes pain affecting movement of the individual, and furthermore exerting abnormal pressure on bone causes an aberrant healing response resulting in bone spurs and ultimately a change in the bone which provides the structural support for the cartilaginous joint surfaces. The deteriorating process can effectively be reversed down to the cellular level with influences such as functional treatments like manipulation and exercise to restore the natural nutrient pump mechanism for the joint and/or exogenous nutrients may be utilized to enhance the reversal of the osteoarthritis process. Conversely conventional medical treatment such as steroids and non-steroidal anti-inflammatory medication while temporarily relieving joint pain may actually remarkably accelerate the development of osteoarthritis, (Palmski & Brandt, 1993). Once again conventional wisdom is crushed. As it turns out, osteoarthritis is probably not caused by an aspirin deficiency. To the contrary, aspirin and similar remedies inhibit proteoglycan synthesis which reflects increased repair activity in osteoarthritic joints. In an effort to stop pain and inflammation, most common drug treatments also stop the healing process of the joint tissue.

Ultimately the aging process in humans, or in this instance, development, is the cause and effect of acquired functional deficits. For example exogenous forces on a developing fetus or infant may change the shape of a joint, causing a loss of function or range of motion. Abnormal joint forces affect joint lubrication, and therefore this limits nourishment of cells within the joint. Loss of nourishment leads to deterioration of the joint and further loss of function. Loss of function leads to a loss of mechanical stimulation of joint nerve receptors. Loss of nerve firing affects neurotransmitter production such as dopamine. Dopamine supplementation can treat the symptoms of Parkinsonism. So, where should one look for a cause and treatment? This theoretical exercise was not to claim once and for all a definitive cause for Parkinsonism, but more so to model an example of developmental thinking.

### Conclusions

Determining developmental influence is to chase a moving target. It is nearly impossible to acknowledge all of the potential interactions at any one given moment. Once an interaction has occurred, the organism has potentially changed in such a way as to be different than some other combination of interactions. In the example above, a congenital anomaly could ultimately progress to a neurological movement disorder resembling Parkinsonism and or be the source of abnormal mechanical movement and thus become the source of arthritis. One must recognize the multitude of factors that effect development whether the stimulus be that of expression or inhibition of a trait. In the spirit of Gottlieb's character, one must be willing and able to accept the answers may reside in the non-obvious, and just maybe you will discover something more meaningful than what you were looking for along the way. This is the essence of the "Developmental Point of View."



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