The Resonance Principle of the Brain

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By rejecting the worst kind of reductionism that today regards the human brain as nothing more than a complex, biomechanical computer, we need not thereby relegate all thought to some purely "philosophical" realm. Man is unique because he is cognitive; understanding the material substrate of cognition only requires that we avoid the modern epistemological fallacy that for knowledge to be scientific, it must be indifferent, or even hostile, to the unique properties of the mind itself.

Forget the crude Behaviorism of psuedo-sciences like neuroeconomics, where the measured brain activity of banal consumer-related decisions is exploited to supposedly prove man's inherent irrationality. A true neuroscience—itself a subsumed study within the science of physical economy—begins with the inherent creativity of the human individual as the empirically given cause, for which the structural and material properties of the brain must account.

That mankind's creative will constitutes an empirical fact of science was proved by Vladimir Vernadsky, who defined the nosphere as a distinct domain of experimentally verifiable "geological" effects, effects qualitatively superior in their transformative power to those of the biosphere. Lyndon LaRouche's definition of the social reproduction of the human species as the characteristic expression of this creative will, and the rate of increase of potential relative population density beyond any biologically-determined "ecological" potential as its measurable effect, further situates to what extent we are free—and in what respect we are limited—in examining man in his most significant biological aspect: that of the structure and function of the human brain.

In taking up this investigation, we can only begin to indicate where certain questions can be more clearly formulated. For example, Vernadsky's work on the material-energetic distinction of living from non-living processes, and his related hypothesis of the existence of unique, Riemannian *states of space* in living organisms remains a virtually unplowed field of inquiry. It is also evident that Bernhard Riemann's own studies of singularities and boundary conditions in higher transcendental functions stem explicitly from his efforts to understand the generation and interaction of thought-objects ("Geistesmassen"), as outlined most explicitly in his posthumously published "philosophical fragments". It is the task of a new generation of scientists to advance these avenues of frontier investigation.

Mechanism vs. Vitalism

Brain science began with the study of brain damage. Specifically, correlating damage to particular areas of the brain with particular changes in perception and behavior. The first known such case was documented by the French neurologist Paul Broca in 1861, in which he discovered an impairment of motor speech, which he termed aphasia, caused by a lesion in a specific part of the left hemisphere of the brain. Brain research was subsequently preoccupied with localization of sensory and other functions in sharply differentiated areas of neural tissue, a trend which can be seen in the various phrenological charts popular through the turn of the century, in which everything from "Secretivenes" to "Parental Love" was assigned a particular location in the brain.

Many of those who rejected this "Mechanistic" reduction of mental activity to strictly localized areas of the brain, instead adopted the view that the brain was an undifferentiated mass which acted only as a whole, but whose specific activity could in no way account for higher mental processes. These could only be explained by a "Spiritual" or "Vital" force, for the comprehension of which the instruments of science were useless.

It was against the background of this divide between the Mechanists and Vitalists in psychology and biology more broadly, that Gestalt Psychology was born. Philosophically, it was an extension of the aesthetical and pedagogical thought of Friedrich Schiller and Johann Friedrich Herbart, whose ideas on the nature of the generation of concepts influenced many 19th century German thinkers, including Riemann. Gestalt Psychology as such was established by Max Wertheimer, Kurt Koffka, and Wolfgang Köhler, after Wertheimer's 1912 experiment disproving the prevailing dogma that every sense perception is the result of a sum of individual, local stimuli—no more, and no less, than the sum of its parts.

The experiment was simple: the shadows of two rods separated by a certain distance were projected in rapid succession against a screen, so as to produce the perception of motion of one shadow moving continuously across the given distance. This stroboscopic, or *perceived* motion, was found to be indistinguishable from "real" motion. It therefore had to be recognized as a real fact of perception, rather than simply dismissed as an "illusion". Since this *perceptually real motion* could not have been produced by the individual stimuli of the two static images of the rods themselves, Wertheimer hypothesized that some kind of "short-circuit" in the brain was responsible for this gestalt phenomenon.

Thus, from its very beginning, Gestalt Psychology was more than merely "descriptive" (as it has often been criticized) in refuting the mechanistic psychology of Behaviorism and Associationism, by proving that human psychology is characterized by the creation of functional whole unities (gestalten) in perception and thought. Rather, with Köhler's work in particular, this new school of psychology represented a fundamental breakthrough in the domain of *psychophysics*, the study of the underlying physiology of mental processes.

The existence of gestalts in nature can be easily proven. Even many simple systems in inorganic physics, such as the steady distribution of electric charge over a conductor, represent such "physical gestalts". That is, they create self-organized, functional whole structures, sometimes called "field" phenomena, through their own "free dynamics" of active forces-whether these forces be gravitational, electromagnetic, chemical, e.t.c. If this is true in the abiotic world, it is even more so in the highly organized systems of the biological world, such as those central nervous processes involving electrochemical interactions. Since organization in perception arises from an intrinsic organization of the physical processes underlying perception, therefore, a *psychophysical isomorphism* must exist between the "subjective" world of our experience, and the external, "objective" world, which happens to include our brain. In other words, "*actual consciousness resembles in each case the real structural properties of the corresponding psychophysiological process.*"[1]

It may be difficult to appreciate the profundity of this insight today, given our habituation to the belief that any agreement between our inner perceptions and the outer world is merely coincidental, a happy outcome of chance, or an anthropomorphic misinterpretation of indifferent facts. But this statement by Köhler simply put in psychological terms a general truth that had long been held by the best minds of physics, who saw in the lawful ordering of nature the guidance of the same universal Reason expressed in man. He himself was part of the core of a broad intellectual movement in the early decades of the 20th century seeking to forge a "third way" beyond the false dichotomy between Mechanism and Vitalism, and bridge the chasm separating the "two cultures" of art and science at a time of increasing cultural pessimism and existentialism. This largely German-based movement, which was self-consciously rooted in the outlook of Gottfried Leibniz, and which virtually died out following World War II, included the physicist Max Planck and the conductor/composer Wilhelm Furtwängler (who had, incidentally, been trained by the same counterpoint teacher as the gifted musician Planck).[2]

Köhler was convinced that with a proper understanding of the brain, the laws of mental life could be used to enrich physics itself, and, reciprocally, an enlarged physics could lead to a more profound understanding of the mind. He wrote in his 1938 book *The Place of Value in a World of Facts*:

> It will be obvious that from this point of view the physicists' sentiment against man appears as a dislike of problems that belong to their own field. As a matter of fact, the physicists should welcome the decisive test of their concepts and principles to which the interpretation of mental functions and structures must gradually lead...They can no longer regard man as an entity from another world that unfortunately plays a role in the development of physics, but whose participation should be reduced to a minimum. The very being that observes physical facts in the narrower sense of the word, that thinks about these facts, and that thus build up the science of physics, constitutes at the same time the most challenging subject-matter of that discipline. It does so whether or not its mental operations happen to refer to the study of inanimate systems; because

[1] Wolfgang Köhler, 1919, *Physical Gestalten.*

[2] Matt Ogden, paper presented at April 1-5 LYM Dynamics Conference, *The Furtwängler Principle in Art and Science.*

> any trait of its mental life that is functional and functionally effective will have to be derived from facts and principles with which the science of general dynamics is concerned."

The Potential of the Brain

By the end of the first decades of the 20th century, it had been established that brain functions, rather than being localized in isolated areas, are organized into complex *functional systems*, incorporating many different, and often distant, parts of the brain at any given time.

In respect of its organization, the brain is a highly differentiated structure, divided into two hemispheres and various interconnected systems: the reticular system governing the overall waking and sleeping state; the occipital, parietal, and temporal lobes comprising the region generally involved in the analysis, coding, and storing of information; and the frontal lobes, associated with planning and judgment. Most important, however, is the brain's capability to systematically change its functional organization, sometimes radically, in response to damage or other disturbances.

In the blind, the main brain region used in handling vision, the visual cortex, becomes appropriated for other uses; similarly in the deaf, the auditory cortex is recruited by other systems. Amputees commonly develop "phantom limbs" (advantageous in learning to use prosthetics by "manipulating" the missing limb) because the brain retains the cortical representation of the missing limbs even though they are obviously no longer able to send signals to the brain. In children, damage to the primary speech centers may cause only temporary aphasia, as other areas are gradually incorporated to fulfill the same function. Then, there are cases of Savantism, where seemingly hidden powers of the mind emerge in people with otherwise severe neurological damage, seemingly compensated by heightened visual or musical powers, encyclopedic memory, or prodigious calculating abilities. Through a kind of inversion, latent—but lawful—powers of the mind are revealed by pathological disturbances of the brain's "normal" functioning.[3]

The remarkable adaptability of the brain, including under the influence of conscious thought, is generally termed neuroplasticity, a phenomenon which defies mechanistic explanation. What it does express, at a higher level of complexity, is a gestalt phenomenon which is more than the sum of its parts, or, in this case, the individual connections between the brain's nerve cells. It is also uniquely dependent on the *social dimension* of human development. A.R. Luria, one of the founders of neuropsychology, believed that individual brain development could not be understood outside of the dynamics of culture and language. In his 1973 book *The Working Brain*, he wrote:

> Whereas higher forms of conscious activity are always based on certain external mechanisms (good examples are the knot which we tie

[3]The neurologist Oliver Sacks has written a number of books which contain insightful case studies documenting the effects of neurological disorders on individuals, and their common struggle, often unconsciously, to retain a coherent sense of social identity in the midst of debilitating conditions.

> in our handkerchief so as to remember something essential, a combination of letters which we write so as not to forget an idea, or a multiplication table which we use for arithmetical operations)—it becomes perfectly clear that these external aids or historically formed devices are essential elements in the establishment of functional connections between individual parts of the brain, and that by their aid, areas of the brain which previously were independent become the components of a single functional system. This can be expressed more vividly by saying that historically formed measures for the organization of human behavior tie new knots in the activity of man's brain, and it is the presence of these functional knots, or, as some people call them, 'new functional organs' (Leontiev, 1959), that is one of the most important features distinguishing the functional organization of the human brain from an animal's brain.

At present count, the human brain is thought to contain roughly 100 billion nerve cells, or neurons, mostly located in the several-millimeters-thick surface matter of the cortex (the "grey matter", as opposed to the "white matter", which is composed of the nerve fibers, or axons, covered with a protein insulator called myelin). Nerve cells transmit electrical impulses to each other through tiny gaps between neighboring axons, called synapses. It is estimated that each neuron is capable of forming, through the growth of its axons, between 1,000-10,000 such connections with other neurons. It is the brain's ability to continually form new connections, which is the cellular and molecular correlate of neuroplasticity.

Current brain imaging technology still lacks the spatial and temporal precision needed to record the subtle neural traces involved in the rapid and intricate activity that, especially for higher mental functions, must implicitly involve the entire brain (or at least significant regions of it). It is doubtful whether processes at microscopic levels smaller than these extended neural networks, such as individual neurons, or individual neurotransmitters (the chemicals signals which pass between synapses), can tell us anything about the *contours* of mental action, the structural characteristics of complex thought. While there is much to learn about the sub-cellular microscopic conditions in the brain, the psychophysical correlates of actual thinking are primarily *macroscopic* processes. That is, gestalts are continua which are organized as "macroscopic self-distributions"—what Köhler identified as the study of potential theory, which he believed held the key to many unsolved problems in psychology and physics. Microscopic processes, rather than being held as causal, ought to be regarded as subsumed features of the higher level of organization achieved by the macroscopic organization of the brain.

Of course, this flies in the face of machine theory. In a machine, ordered actions are directed through the imposition of well-defined constraints on the given physical system. These constraints are accomplished through relatively rigid component parts. For example, the various devices of a pin-ball machine to control the path of the ball; the walls of an engine block which direct the expansion of gas onto the underside of the piston; or the resistors, capacitors, and transistors controlling the flow of electric current in a computer chip. The modern machine theory of the organism originated with Rene Descartes, who claimed that the body is nothing more than an aggregation of anatomical constraints, of pumps, tubes, and ventricles regulating metabolism.

Contrary to this mechanistic view, however, living organisms, even down to their constituent "parts", are not static entities, but instead are involved in a continual exchange and transformation of material (Vernadsky's "biogenic migration of atoms") both with the environment and within themselves. For that matter, there is no reason to assume that there is not an inherent organization in living matter itself that functions on the basis of its own unique "free dynamics" of forces. This organization is present even at the very beginning of the development of an embryo, during morphogenesis. Current science is still at a loss to explain how a single, undifferentiated egg cell proceeds, as if purposefully driven, to its final state as a fully formed organism. Can we claim to have advanced beyond Descartes' machine theory, just because biological constraints are now conceived of on the genetic or molecular (or even quantum) level?

Potential theory today is still largely restricted to a formal mathematical scheme, applied to inorganic physics. Riemann's work on potential, which permeates his work on electricity, gravitation, and magnetism, was directly shaped by his reflections on the underlying nature of "ponderable matter", in which the paradox of continuity and discreteness—the so-called wave-particle paradox—seems most vividly, and ironically, expressed in the act of cognition. "Thinking itself, however, I can only consider as a process which occurs within the interior of ponderable matter," wrote Riemann. Yet, "As is evident to anyone who tries to analyze inner perception impartially, it is impossible to explain thinking on the basis of the motion of matter in space..."

The work of Riemann and his mentors Carl Gauss, Wilhelm Weber, and Lejeune Dirichlet, forms the foundation of what later became known as electromagnetic field theory, which Albert Einstein attempted to generalize into the notion of a unified field. Vernadsky, who proposed that Riemann's work in this direction be applied to the comprehension of living phenomena, also recognized the significance of Köhler's application of field physics to psychology as leading to "a new scientific expression of physical space,"[4] an insight which points to the *inclusion of psychophysics within the scope of a unified field theory.* In other words, the action of "ponderable matter" must be considered from the standpoint of what it is capable of doing not only in the abiotic domain, but the biotic and cognitive as well. Such an approach is entirely out of line with today's customary treatment of the brain as an evolutionary oddity, subject to the statistical laws of information theory and the psychological perversions of behaviorism.

Isomorphism is Another Word for Harmony

But just what are the neural traces of complex mental activity? To what "structural properties" do we refer when we speak of isomorphism?

[4] Vladimir Vernadsky, 1931 speech, The Problem of Time in Contemporary Science, as referenced in Sky Shields' paper, *Human Creative Reason as a Fundamental Principle in Physics.*

A certain kind of *geometric isomorphism* seems given by experience. Vision, for example. The objects arrayed on a table in front of me are arranged a certain way, corresponding more or less exactly to my visual perception of them, and, presumably, corresponding to the configuration of stimuli in the visual centers of my brain. We know that visual stimulation proceeds initially from the retina, through the optic nerve, and terminates in the primary area of the visual cortex at the back of the brain. From there, there is a further transmission involving several other layers of tissue, including the so-called associative cortex, where multiple inputs are processed (for example, damage to the secondary or tertiary visual centers or other cortical areas with which they communicate could lead to loss of color vision, the loss of the ability to recognize discrete objects, or even the loss of the ability to recognize faces). There is also a level of differentiation even among individual neurons. In both the retina and the cortex, different groups of neurons respond to different stimuli, helping to organize raw sense impressions at the very source of stimulation.

As far as the initial projection from retina to cortex, the so-called retinotopic mapping, adjacent areas of retinal stimulation do correspond to adjacent areas on the brain, although not in a simple geometric pattern. There is evidence that, at least for the central field of vision, the mapping is similar to a complex logarithmic transformation, in which radial lines and concentric circles (the map of the circular retinal surface) become orthogonal grids when mapped onto the primary visual cortex. This helps to explain some features of the stability of the visual field, such as the fact that when objects change size or orientation they remain recognizable as the same object. However, it is not at all certain how this stimulus pattern is further transformed during projection to successive cortical areas, or even whether these projective transformations are always carried out in the same way, since conscious and unconscious processes are already known to change certain functional pathways in the brain.

The same questions arise for each of the five senses, though the individual senses themselves are not isolated faculties. For example, just thinking about music can stimulate areas of the motor cortex that are normally activated when playing an instrument. Or, in the more extreme cases of synesthesia, people experience various faculties evoked simultaneously, such as seeing colors when hearing music, or seeing numbers as abstract shapes. Sense impressions alone are nothing more than "instrument readings", the meaning of which is expressed in the combination and contradiction among the various senses. At present, the only such type of reading that is susceptible of measure in the brain is the electrical activation of its neurons. At a basic level, then, a *functional isomorphism* corresponds to such *sequences* of instrument readings, the relations of which refer to a physical process, which is analogous in its form of determination to the psychophysical process occurring in the brain.

At this point, we are near the limit of what can be said about isomorphism in its most general sense, given current experimental data, which, in its present form, can probably tell us less about the actual structure of human mental activity, than a rigorous phenomenological account of mental activity can tell us about the nature of the underlying brain process. In other words, our question can be posed as follows: "What do the manifest effects of cognition reveal about the necessary laws of cognition, and therefore, the laws of psychophysics?"

A competent analysis of the historical development of the human species demonstrates that every successive increase in population, life expectancy, and general social reproductive power, is mediated by advances in technology and socio-cultural modes of organization that can only be attributed to the phenomenon we call "creative thought". Therefore, poetry, art, and scientific discovery properly represent the irreducible states of human mentation—those unique mental states that distinguish our species characteristic from the fixed ecological characteristic of animals.

In an individual mind, a new discovery of principle reorders all existing knowledge, and implicitly every belief that previously constituted one's world-view. The history of science shows that the process of discovery proceeds non-linearly, where new hypotheses contend with established axioms, where only in the contradiction of experimental facts with previously held beliefs does a fundamentally new insight emerge, concerning the ordering principle behind an array of possible phenomena. Such a creative act involves the transformation of an entire mental/emotional state—including its neuro-physical correlate, or the total physical state of the brain—into a wholly new state. A singular idea, therefore, exists not as an isolated thought-object (we might be tempted to say "neural trace"), but in the *change* of existing axiomatic (or neurological) boundary conditions. As in science, poetic irony draws on exactly this contradiction of two successive mental states to derive metaphorical meaning "in between the notes", as any good joke demonstrates.

Knowledge refers thus, not to a formal state of organized mental facts, but to a process of mental change coherent with ordered changes of physical processes-processes known to us not as fixed "laws" of nature, but as lawful changes we can impart to nature. Broadly speaking, the changing patterns of electrical stimulation of neurons in the brain reflect the "projected" effects of such ordered, cognitive transformations.

With this resort to the phenomenology of creativity per se, we have landed squarely in the terrain of Leibniz's *Monadology.* That human creative reason produces an *unmediated* convergence of the internal processes of the individual mind, and the external processes of nature, seems to be the only justifiable conclusion given by the principle of psychophysical isomorphism. There is probably no better elaboration of this standpoint, than LaRouche's updated treatment of the *Monadology*, in his essay *Project A*:

> Now, let us look at the thing as to form. Let us assume hypothetically, that we are examining now the proposition, that whatever the form in which physical reality is ordered, external to our perception of it, we can only understand that form when it is translated into the form in which our thoughts must proceed, or *by virtue of*, or *in coherence with*, this notion of the unmediated relationship between the particular creative reason of the individual and the universality. That is the proposition to be examined.

> That is where the fallacy lies in most thinking: to say that we have deductive, that we have geometric, that we have other forms, and so forth, and that in this way we may choose different forms of representation to represent the common reality or to distinguish, as in a more general way, between an objective realm, which is not directly known to our senses in its own form, and the perceived or subjective form in which that realm and its efficient relations are reflected upon the form in which we are capable of thinking. That is the obvious issue. Can we make that distinction?
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> We have to reject that distinction. In the process, by the nature of creative reason, we are not trying merely to represent or mirror what is happening in the universe; we are acting upon the universe, to such effect that creative reason itself is the cause of those changes which are effected. At least, those which are *significant* changes.
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> Therefore, creative reason itself, in the form in which we represent it, is a cause of existence in the universe: It is a characteristic of substance, of substantiality. Thus, there is no difference between the form, in the proper *form of reason of knowledge*, and the *subject of knowledge*, the *object of knowledge*. No difference in form whatsoever, except to the degree we have failed to perfect the quality of creative reason to know this latter.

A general isomorphism has long been recognized among thinkers going at least as far back as Plato, but is probably best expressed in experimental science by Kepler's *Harmonies of the World*. In one of the first demonstrations of a physical gestalt, Kepler shows the solar system to be a single, functional system, organized by the same harmonies inherent in the human mind, principles lawfully revealed in the paradoxical perceived motion of the planets. In addition to its obvious relevance in validating, in a thoroughly explicated form, the coherence of the laws of science (and beauty) with the laws of human reason, it also confirms the wisdom of including "tuning" and "resonance" among the verbs of our inherently limited technical vocabulary of "fields", "forces", and "stimuli" to describe brain processes.[5]

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[5]Lyndon LaRouche, writes in his paper *The Meaning of Physical Time*:

> It is this latter distinction of mankind, to which we allude, when we speak of mankind as having a power, that of a soul, a power which is not a by-product of biological creatures as we know them otherwise, but which equips human beings and their societies with a genuinely creative potential, if we choose to accept that gift to us.
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> This potential is therefore associated with something specific to the manifestations of the human brain-function in some way, as a power which is clearly associated with the human brain's expressed function, but a power which does not exist in the brain of any other living species. The evidence is, that something in the nature of the human species has developed the ability to "tune into", as if by a mode of coupling, some higher power in the universe, as no other known species has done. It can be restated: that the specific distinction of the manifest creative powers of the human mind, is that it is susceptible of being tuned into

Of course, the development of a new science of dynamics is ultimately needed to give new meaning to these words. The advantage of this new science will be the ability to subject all three domains of the non-living, living, and cognitive to precise experiment, within the purview of a proper unified field conception. What we learn, will tell us as much about ourselves as the world around us.

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the principle of the Creator of the universe. In other words, that power can not be a by-product of biology as customarily defined by science so far, but is, as I shall address this in the forthcoming, concluding part of this series of reports, rather, "tuned into", dynamically, a power which is of a specifically higher quality than the evolutionary potential of living processes otherwise.