Symphony of Matter and Mind

Part six

Harmonies of the Mind
Physics and Physiology of Self

Chapter synopsis:

1. Physical Approach to the Binding Problem.

The model of reality created by our brain is like a jigsaw puzzle consisting of many pieces connected into a unified picture. How do they combine together while keeping individual characteristics? This is one of the major questions in neuroscience called the binding problem. It also concerns our sense of ourselves as an integral Self which is born from a vast number of signals coming from external and internal sensors at the current moment and events stored in memory.

Traditionally, models in neuroscience look for neural correlates of consciousness trying to explain the physiology behind the mental phenomena. The same approach persists in solving the binding problem. Many neuroscientists perceive the question "What is it physically?" as the question "What is the physiology?" But physiology is the embodiment of physical processes that employ a physical mechanism. We need to show what the Mind is physically and how its various aspects, including the binding problem solution, are implemented in physiology. The explanatory gap between physiology and psychology should be covered with a physical bridge. But if we want to find an answer in physical terms, we need to posit the question in physical terms too. The chapter offers a physical formulation of the binding problem and paves the way to solving it in the following chapters.

2. Brain Polyphony and Polyrhythm.

The brain is a dynamic oscillatory system with a complex frequency and phase structure. In this sense, it is an ensemble that plays polyphonic and polyrhythmic music of the mind. The Teleological Transduction Theory (TTT) uses musical terminology not as a metaphor, but as an analogy based on the general physical mechanism of frequency and phase coupling that underlies both the music of sounds and neural activity. The musical code (notation) reflects the main physical parameters of the harmonic sound production that we call music. This code is information-rich and effective at the same time. The basic elements are relatively simple but can accommodate a large set of parameters. Such code allows a potentially massive number of

unique parts to be played simultaneously without losing identity. The requirements are the same for the neural code. Perhaps the principles of its formation are similar. This chapter develops the Symphonic Neural Code hypothesis proposed in the previous parts of the study.

3. The Emergence of Order from Complex Dynamics.

Any living organism is a system of interacting and energy-exchanging self-sustained oscillators with various amplitude-frequency characteristics and phase portraits. The internal interaction of the elements, generating different frequency modes and phase trajectories, is based on frequency-phase tuning and bringing the entire ensemble to harmony. The chapter proceeds from the hypothesis that the brain does not differ in this sense from the rest of biosystems. The orchestra of the brain plays a unified symphony composed of many different parts, and the mechanism for creating order from these complex dynamics is universal. The chapter explains how this mechanism works in the brain.

4. Personality as a Physical Process.

The chapter is devoted to the details of physical processes in the brain that form the higher cognitive functions that we combine in one word — personality. It offers a new look at the cortico-thalamic system that plays a vital role in these functions and shows how the general algorithm of the mind is implemented at this level. The hypotheses about the physics and technology of the process explain the observed physiology.

5. The Secret of the Unified Self.

How does the brain create a coherent model of reality while maintaining the representations' identity and at the same time preventing the overall picture from falling apart into separate pieces? This 'binding problem' is still considered to be an open issue in neuroscience. The chapter describes the physical binding mechanism and its technological implementation in the brain. It offers an elegant solution to the issue of differentiation and cross-modal unity.

6. Looking for Harmony in the Brain.

Based on the previous hypotheses of TTT, this chapter offers a new look at brain frequencies. It explains the functions of different frequency levels and their combinations in the overall signal processing performed by the neural system. It also contains a hypothesis about the frequency structure of the brain, which by no accident is very similar to the musical structure with its various intervals reflecting frequency ratios, as the physical mechanism is universal. Moreover, this structure coincides with experimentally derived frequency levels of

the brain. Thus, the proposed model moves current theoretical neuroscience further by providing explanatory power.

7. Musical Notes of the Mind.

The chapter considers the ‘building blocks’ of the neural code as the notes of the mind with varying amplitude-frequency and phase structure. It rejects the standard models of neuroscience that consider action potentials as identical spikes. This reduction does not correspond to the reality of the neural activity and contradicts the observed speed and efficiency of information transfer in the brain. Each action potential has a complex waveform. Thus, the information density of each note is very high, and the system as a whole has tremendous computing power.

8. Brain Music Notation.

The hypotheses offered in this and previous volumes of the series lead to nontrivial conceptual and technical consequences for the brain research process. We have no choice but to study the internal characteristics of each note, and its place in the general melodic, harmonic and rhythmic structure. The chapter shows possible ways of analysis that will combine all the parameters that have to be reflected if we want to write a full-fledged musical notation necessary for reading and reproducing the neural code. To understand the music of the mind, a radical paradigm shift in neuroscience is needed. The research technology will follow.