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Chapter

Introductory Chapter: Neuroscience *Wants* Behavior

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1. Introduction

What do we mean by "behavioral neuroscience"? This is the branch of neuroscience developed from Wilhelm Wundt's and William James's physiological psychology and addressed to the study of the "the neural and biological bases of behavior, including effects of lesions and electrical stimulation, recording of electrical activity, genetic factors, hormonal influences, neurotransmitter and chemical factors, neuroanatomical substrates, effects of drugs, developmental processes, and environmental factors" [1].

Historically, neuroscience is born with the identification of the *neuron* as an autonomous and functionally independent cellular unit of the nervous system. The studies carried out to define the properties of the neuron have benefited from the progress made in various disciplines, in particular using methods to measure ionic and molecular displacements at the subcellular level and—thanks to the original psychopharmacology, psychophysiological, and neuroimaging approaches—the progress made in the knowledge of integrated systems at the base of the behavioral variations of the individual [2]. In the beginning, neurotransmitters such as acetylcholine, 5-hydroxytryptamine, and GABA have been discovered, and the structural aspects of membrane receptors for different molecules with neurotransmitter functions have been analyzed. Subsequently and of particular interest was the identification of endorphins and their receptors on nerve cells [2]. With the identification and study of endorphins, a new approach to the analysis of substances that perform a modulating function on the genesis and transmission of nerve impulses has been developed. As part of the research on cellular differentiation by chemical substances, molecules have been identified that play a fundamental role on the growth and tropism of the nerve cell [2]. The prototype of these substances is the nerve growth factor isolated in the early 1950s by the Italian neuroscientist Levi-Montalcini [3].

In short, neuroscience initially contributed to defining the functioning of the neuron and the role of neurotransmitters, of neuromodulating molecules, and of those with trophic action.

In parallel, the biomedical approach has allowed the use of various investigation techniques to explore the anatomic-functional structure of the nervous system as an integrated unit, both in normal and pathological conditions. In this sense, the progress made in neuroradiology and neuroimaging must be seen. The neuroscience approach has therefore extended to the description of molecules able to control the genesis of some brain proteins (the so-called genetic engineering) [2]. In particular, molecular biology has allowed us to study amino acid sequences of peptides that seem to play a physiological or pathological role, in relation to the different conditions of isolation and characterization [2].

To date, behavioral neuroscience also includes psychoneuropharmacology studies, which have analyzed the complex interactions between substrates of the central nervous system, the distribution of various molecules, and the state of brain functioning [2]. The result is practical acquisitions, which are extremely important in the synthesis of psychotropic drugs widely used in the therapy of neurotic and psychotic states.

Behavioral neuroscience concerns not only with the biological bases of behavior. It concerns with the more complex phenomena of the mind and brain.

2. From brain activities to mental activities

Not only *bío* but also *psyche*: the great challenge of neuroscience is to understand behavior and thought.

Although humans have wondered about the control of behavior for thousands of years, only fairly recently has a mechanistic view of the brain taken hold [4, 5]. The concept of *localization of function* was an important milestone for behavioral neuroscience. Today we know that the contemporaneous functional modulation of different cerebral areas varies in a predictable way depending on what a subject is doing. Thanks to modern neuroimaging and a more carefully validated understanding of human cognition, a detailed view of the brain organization is now emerging. Modular systems are outdated; the network approach is the current one [2].

One of the main topics of discussion in the twentieth century was whether *mental activities*—such as thought, emotions, self-awareness, and will—are functions different from *brain activities*, such as the movement of a limb, the perception of a color, etc., or if they also represent functional expressions of the brain neurons. Mental and cerebral activities would seem to be the unique and indivisible expression of the activities of the neuronal and glial elements that make up the brain organ. Although the expression is different in quality and in the ways in which it manifests itself, both activities are due to a single mechanism by which neurons communicate with each other and with the rest of the body [2]. The neural circuits and their realization are encoded in the animal genome, while the environmental stimuli play a fundamental role for the definitive realization of the synaptic connections.

Neurons, organized in ganglia, complex structures, and networks, process nerve impulses, memorize them, and emit behavioral responses. It is probable that once we fully understand these first two levels—that of the functions of the individual neurons and that of the activities of the neural networks—we will arrive at the elucidation of the type of circuits (or nervous activities) with which subjects are able to decide a specific motor act or a reminiscent act and the mechanisms by which the brain, at the same time as processing sensory inputs, makes subjects aware of all these operations.

Only today, we begin to have information of fundamental importance on the nature of mental processes such as consciousness, will, social cognition, and enormously complex problems that constitute the core of the third level of brain functions.

3. Brain-behavior relationship

Disorders of the brain and nervous system (such as Alzheimer's disease, Parkinson's disease, stroke, and traumatic brain injuries) highlight the importance of the biological bases of behavior. The *brain-behavior relationship* seems to be the descendant of the Cartesian mind-body dualism, where the brain is the biological component and behavior the psychological one.

Despite the passing of the centuries, the body-mind dualism continues to be an unresolved problem in this day and age. At the beginning of the history of neuroscience, the mind and brain were kept apart as if they were separate and distinct concepts. Nevertheless, the notion that the brain and behavior function separately turns out to be an impediment to scientific progress, since they are related in a more complex way than one might imagine. Indeed, the brain-behavior relationship is modulated by different factors: the environment, sociocultural and historical aspects, phylogeny, genetics, and ontogeny.

Today we still find ourselves having to answer this question: *Are we our brain?*

As recently suggested by Dede and collaborators, "the development of brain-behavior relationship depended thereafter on interdisciplinary collaboration, and scientists' ability to formulate new experimental questions and designs, but mainly on the methods devised for studying both parts of this dipole" ([6], p. 12). Today, behavioral neuroscientists balance three general research perspectives in designing their research [6]:

- Correlation: body and behavioral measures covary.
- Somatic intervention: manipulating the body may affect behavior.
- Behavioral intervention: experience affects the brain.

Indeed, behavioral neuroscience research is now conducted at a level of analysis ranging from molecular events to the functioning of the entire brain and complex social situations.

4. The nature and purpose of the book

Revising the story of brain-behavior relationship research since its beginning, a treasure of information about how the brain works seems to have been discovered. Nevertheless, neuroscientists' research will continue until no more questions can arise [7]. Indeed, the benefits of the correlation-somatic-behavioral research approach [6] are greatly enhanced by the combined use of new technologies: neuroimaging, ICT-IoT assessment methods, and machine learning. It can be assumed that computerized functional localization is now a reality and that the brain-behavior relationship has already moved on to the next stage of its development (what we have just named the third level of brain functions). Considering the above, this volume aims at providing an overview of behavioral neuroscience and deepening neuronal mechanisms and brain circuits that regulate the fundamental aspects of human behavior, such as cognitive and emotional functions. It is intended to give the reader with the most up-to-date vision on how the interaction between biological mechanisms and neuropsychological processes leads to complex and highly organized behaviors. The approach is multidisciplinary, and various levels of investigation are represented.

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References

[1] Thompson RF. In: Smelser N, Baltes P, editors. International Encyclopedia of the Social and Behavioral Sciences. Oxford, UK: Pergamon (Elsevier); 2001. ISBN 9780080430768

[2] Kandel ER, Schwartz JH, Jessell TM, Siegelbaum SA, Hudspeth AJ. Principles of Neural Science. 5th ed. New York: McGraw-Hill; 2012. ISBN 0-07-139011-1

[3] Cohen S, Levi-Montalcini R, Hamburger V. A nerve growth-stimulating factor isolated from sarcom as 37 and 180. Proceedings of the National Academy of Sciences. 1954;**40**(10):1014-1018

[4] Lezak MD. Domains of behavior from a neuropsychological perspective: The whole story. Integrative views of motivation, cognition, and emotion. In: Nebraska Symposium on Motivation. Vol. 41. Lincoln: University of Nebraska Press; 1994. pp. 23-55

[5] Lezak MD. Neuropsychological Assessment. 5th ed. Oxford, UK: Oxford University Press Inc.; 2012. ISBN: 9780195395525

[6] Dede E, Zalonis I, Gatzonis S, et al. From discovering to better understanding the relationship between brain and behavior. Integrative Neuroscience Research. 2017;**1**(1):5-16

[7] Reitan RM. Certain differential effects of left and right cerebral lesions in human adults. Journal of Comparative and Physiological Psychology. 1955;**48**:474-477