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## What Does the Nervous System Do?

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### I. Introduction

. . . We think of ourselves and others as engaged from moment to moment in doing this or that. That is a convenience of speech. Each of us at any moment of the waking day is a whole bundle of acts simultaneously proceeding. . . . In no case does any other of all the doings of the moment disturb the one focal doing. We are each therefore at any moment a pattern of active doing; a single pattern of pieces all subordinate to one keystone. No other part of the pattern is allowed to disturb the keystone of the pattern. Should it do so then the pattern changes and the disturbing piece becomes usually the keystone of a new pattern which supplants the previous. The keystone is the crown of the unified doing of the moment (Sherrington, 1946, pp. 172-173).

Our responses are the products of the nervous system acting through the body. We walk, talk, touch, look, listen, even laugh, in so many ways that our total responses can only be summed up as behavior—behavior designed for the moment. Our nervous system provides an immense repertoire of specific behavior, together with built-in contingency plans. It is at one and the same time reporter, editor, producer, file clerk and delivery boy for our moment by moment events. It collects critical newsworthy information, analyzes it, modifies it in relation to our interests, keeps a record of all transactions and delivers a report to our muscles and glands so we may act. In our behavior we see reliability, precision and versatility—programs of living designed specifically for us. Yet our reactions to many things are identical, universals of response shared so commonly among all men and women that we are able to analyze the biological basis of behavior from them.

In this text we shall concern ourselves with the biological bases of behavior, the “hows,” “whys,” and “so whats.” How does the nervous system administer that miraculous performance called behavior? What is the role of the subcomponents of behavior in relationship to its overall plan? These questions are challenging ones, and at present we really do not have all the answers. But in behavioral neuroscience we are attaining more and more exciting findings. The prospects for the future are very bright indeed. Neurobiology is still a very young field, and much is happening every day. In this text we shall take you into the nervous system and from within try to show how it pilots our behaviors. However, prior to embarking on this journey and seeking out the ways the nervous system controls behavior, we would do well to put our mission into perspective. Just what does the nervous system do?

## **II. Functions of the Nervous System**

### **A. The Nervous System Organizes and Directs Motor Responses**

We can start at the end—ourselves moving. Much behavior is purposeful movement, and the nervous system is the executor of this movement. As Lord Adrian (1955), a revered neurophysiologist and one of the founding fathers of the study of the brain, once wrote, “The chief function of the nervous system is to send messages to the muscles which will make the body move effectively as a whole.” Such effective, unitary movement has extraordinarily diverse components. Embodied in it are some of the simplest and some of the most complex behavioral

responses. The simplest of these is a reflex. A tap to the knee elicits a kick of the leg, the prick of a pin on a finger brings its withdrawal. Patterns of movement, whether those of a Mozart playing a concerto or of you and me simply talking, are the integrated result of many influences.

But even holding still is a tremendous motor task. We might not normally think about it, but one of the jobs of the nervous system is simply to maintain posture. The nervous system is constantly at work maintaining our body's posture to keep us upright. It issues a continuing program of signals so that the appropriate muscles maintain the appropriate tensions. No robot yet invented even approximates the skill of our nervous system in moving a body or keeping it erect.

Motion is totally unified: the body moves as a whole in a highly coordinated manner.

The individual cannot be the seat of two focal acts at once. In the pattern of doing of the moment the focal act has commonly a number of satellite acts contributory to it, the keystone of the pattern. A score of contributory acts of posture, and of sensory adjustment, secondarily contribute to give speed or steadiness or precision to the focal act, and of these each one can be and probably has been at other moments a centre of awareness. . . . Elsewhere focal mind is exemplified by perception or cognition, but here we see it wedded to motricity, "doing" a motor act (Sherrington, 1946, p. 173).

We can see then that the answer to "so what" and "why" is that motion gives us behavior.

How? Behind the scenes, under our skin so to speak, driving our muscles are teams of nerve cells playing out their patterns of activity from the spinal cord and instructing the muscles, through long nerve fibers, to contract and relax. Those teams prompt muscles to action, pulling on our bones in different ways so smoothly we scarcely realize the underlying structure is bone and muscle. This neuronal activity and the teams of neurons playing it out give us purposeful motion.

## B. The Nervous System Monitors Its Outside World

The nervous system is concerned and inquisitive about what goes on around it. It monitors light, sound, smell and "the feel" of things. In brief, it monitors every physical stimulus known. Where pertinent, it even looks at magnetic fields; birds use such information to migrate.

Such monitoring is carried out by specialized receptors. Eyes capture light and convert it into brain language; ears hear sounds; the nose collects smells; hands, legs, and, in fact, our whole body surface is sensitive to touch, pressure

and vibration. The receptors of these body parts report to the brain, and the impressions they bring result in behavior: a simple reflex, an association or perhaps simply a mental note of what has transpired. The job of the nervous system is to make sense of the stimuli which it receives. “Why?” To monitor the environment. “How?” With receptors. “So what?” To adjust behavior in a meaningful way to the world about.

Much of what exists in the external world, even in our immediate surroundings, we never perceive, at least at a conscious level. How do we select certain things for our attention over others? If we become deeply interested in one particular thing, chances are good that we will miss others. Yet at the same time the important things never go unnoticed—they are just too impressive. Try sitting on a tack and not noticing it. Pain, as we are all too aware, emblazons itself upon our brains and calls us to action. The job of the nervous system, then, is to put stimuli in the appropriate perspective. Mind is focal in collecting and integrating stimuli and in producing responses.

### C. Learning and Remembering

Learning is the most important thing we do. What we perceive becomes, in many cases, part of us so that our present is a cumulative function of the past. We must learn or we cannot become even the feeblest masters of our destinies. Creatures, such as an amoeba, for example, unblessed with anything like our powerful memories, meander about looking for morsels of food. Merely eating consumes nearly full time for simple creatures, but occupies only a fraction of our day because of our superior nervous system and physiology. Learning, not eating, is our dominant mechanism of survival, giving self-assurance and economy, as well as sustenance, to daily living. It is what we learn individually and are finally able to put into practice that makes us each so different. It is also our combined efforts that make our society and give us a rich culture. So perhaps we can see why we can say that learning is the most important thing we do.

How do we learn? In many ways, only a few of which are really known, the nervous system builds into its structure relics of its past. In order to study learning and memory, we need to understand the basic cellular operations of the memory system. For now, we can say that somehow neural circuitry encodes the realities it has experienced and the logic and associations that have served us so well.

Despite all we know, everything stamped into the files of our brain, and all we can do from what we have learned, the mind's product is still focal, unitary action, as Sherrington saw. We still strive to make one decision, generate one thought, do one thing; no other part of the pattern is allowed to disturb the focus.

## D. Thinking and Personality

We use our brain to generate and relate thoughts. Thinking takes individual events and generates concepts—ideas. Ideas then become their own reality as they are put into practice. Ideas are one of the most important products of our brain. Some people make a living solely on their ideas. The nervous system is working ceaselessly on all it has in its possession and all it takes in, even when we are not conscious of its goings on, in order that individuals may achieve their goals.

Everyone has a unique personality. It, along with our abilities, makes us individuals. We may all respond in the same way to simple stimuli, but we feel and behave in many different ways toward complex situations and to other individuals. Our nervous system is us, making us what we are.

## E. Much of the Nervous System Is Devoted to the Care and Upkeep of the Body

The body and nervous system are partners, and each depends on the other. The role of the nervous system in relationship to the external world is obvious. It is at the forefront of our conscious experience. Less well known is the key role the nervous system plays in body function, much of which is outside one's normal conscious experience. The nervous system acts through the body, and it maintains and cares for its home, its avenue of access to the external world. The nervous system not only ties together and unifies the world about but it does so for the internal world as well. As Carrel said, "The body is a unity which has become multiplicity while keeping its unity" (Carrel, 1938). The nervous system draws the organs together to function as a unit, coordinates internal body states, and maintains the body's constancy. The nervous system is, in a sense, the keeper of the greenhouse—the moist healthy environment inside us. It keeps us warm or cool, by directing and promoting heat loss or heat preservation. How does it do this? There are divisions of the nervous system subcontracted specifically for these purposes. As we shall see in Chapter 2, the nervous system is, in fact, composed of many subsystems.

Our bodies have to be renewed, and we require sources of energy and building materials in order to maintain existence. Food and water are needed by all. "To your good health" is the toast, and a well put one it is at that. Our nervous system directs our behavior toward the goals of fulfilling its needs and locating food. It tells us when we are thirsty and when we must eat, and it directs the ensuing course of action. All the more to our delight, it makes this course a rewarding experience. What great pleasure there is in fine food and fine drink!

Our nervous system protects itself and its inseparable partner, the body, from injury. It causes us to scream out in pain when we are hurt. Pain tells us to cease whatever we are doing and change our behavior to relieve that distress. Some responses are high priority reflexes bypassing the brain altogether, other reactions are complex deliberations drawing upon past history and future plans held in the mind's stores. Upon injury, the nervous system also directs reparative responses to aid in the rebuilding of the body.

Furthermore, the nervous system directs adaptive body responses, the reaction to stress, for example. In this way we gain extra psychic and physical energy which we can bring to bear on a particular response. Athletes most frequently break records under the stress of competition, and similarly students often perform miracles in learning before examinations. Recall the last time you were scared! Beyond adaptation to emergencies, however, the nervous system is involved in mating behavior, reproduction and care of the young. It ensures its own future, so to speak, by promoting social behavior and, in particular, by seeing that males and females are attracted to one another.

All of our living is under control of the nervous system. It is a careful and wise planner that knows what it needs to do, and it does it extraordinarily well. Perhaps all the activity, all the daily tasks, are very wearisome for the body and the brain. But rest comes. We fall asleep. Sleep restores our mental and physical states. Yet even in sleep, we see the unitary and focal action of the nervous system. Our stream of waking consciousness leaves, and we find new states. Muscles relax, active movement is depressed, active posture is relaxed, the eyelids fall and the mind drifts off to the unknown to wander in dreams and to return when we awaken. Sleep is indeed a puzzle. As Sherrington commented, "This reaction of falling asleep seems at first sight the pursuance of a vicious circle. Fatigue, tending to incapacitate realizes a mechanism which incapacitates altogether" (Sherrington, 1946, p. 259). At any rate, the nervous system directs sleep: it is commander-in-chief of waking and unwaking states, mind awake-mind asleep, a daily rhythm which paces our life: 16 hours awake-8 hours asleep, 16-8, 16-8, 16-8.

## F. Development and Maturation

It is obvious, of course, that the job of the nervous system does not start with the mature person or mature animal. It starts before we are born, when in fact, the nervous system itself is incomplete. The central nervous system (CNS) grows and develops along with other parts of the body. Together with the brain, sexual characteristics develop; attributes and abilities mature.

It is also obvious that the means to function perfectly, reliably, flexibly is

stringent at all times. A mistake is a mistake no matter when it happens. The nervous system must deliver the correct responses even when it is immature.

The nervous system is adjusting behavior throughout life and delivering that behavior according to an ever-changing plan. Initially it is learning to move, to eat, to communicate. But it continues in the development and constant refinement of behavior in light of our experiences, capacities and goals. We acquire skills and learn to behave in more and more sophisticated ways. And there again, many of the same changes in nervous system functions continue to unfold, and in the end the twilight years come, with all the nuances of insight that old age brings. Behavior develops against genetic and experiential backdrops, combined in a manner which is seemingly inseparable.

## G. Behavioral Abnormalities

Sometimes, though, the workings go astray, and behavior becomes abnormal. These malfunctions tell us about the normal operation of the brain. We can learn from the variations which occur naturally, as well as those we experimentally create. When the nervous system malfunctions, its product, behavior, does likewise. Behavioral abnormalities may take the form of perceptual or motor deficits, or they may be displayed in personality or thought disorders such as schizophrenia. Here the unity can disappear; the constant workings, the reliability, the precision give way. The nervous system can often be controlled by drugs or, on the other hand, it can be engineered into strange and often unfortunate states through drug abuse. Some drugs have lasting consequences on the activity of the nervous system that far outlive the functional lifetime of the drug.

### **III. What the Nervous System Does**

We see it does everything, and it does it with precision, unity and versatility. How are all these feats possible? Ironically, although the mind—brain—does it, it does not tell us how. It does not report on how we stand or move, nor is it particularly informative about how we think. Its main assertions are that it is I standing, it is I performing, it is I thinking about this and that. It gives us a startlingly real revelation of the unity of focal mind.

We must rely on discerning observation and detailed measurement to discover how the nervous system operates. Fundamentally the nervous system delivers the same fantastic performance all through life. Through it all, it maintains unity of focal mind. Of course, there is always change, there is ever a new

individual; man knows he is forever changing. The nervous system directs and oversees the never-ending changes.

In Chapter 2, we shall begin our exploration of the biological bases of behavior by describing the organizing principles of the nervous system. How is the system put together? What are the main principles underlying its plan? As the story unfolds in Chapter 2 and in subsequent chapters we shall describe our current state of knowledge on how the nervous system monitors the outside world, how it directs motion, learns and stores experiences and maintains and adapts the internal state of the body. We shall describe the various ways in which external and internal influences come together to produce behavior. Near the end of the book we shall describe the way the nervous system develops, and how certain behaviors come about. Finally, in the last chapter we shall explore some of the capacities and properties of our nervous system which distinguish us from animals.

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