NATIONAL ACADEMY OF SCIENCES

CURT P. RICHTER

1894—1988

A Biographical Memoir by

JAY SCHULKIN, PAUL ROZIN AND ELIOT STELLAR

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CURT RICHTER STANDS AS America's foremost psychobiologist in the twentieth century. He was the first empirical scientist in the field, and certainly made his mark in virtually every corner of it.

Richter's father, an engineer, and his mother had emigrated to America from Germany several years before Richter was born. They settled in Colorado where Richter was born in 1894. His father, who died when Curt was a young boy, owned a factory. Young Curt spent a fair amount of time in it learning how to tinker. His father wanted Curt to become an engineer, and this made a lasting impression.

The early life of Richter in Colorado was characterized first by a proclivity for fixing things, for tinkering and invention, and second, by an interest in sports. Both remained passions throughout his life. He was a zealous athlete. When he was young he excelled at baseball, skiing, and basketball. As an adult, and right into his eighties, he was an excellent tennis player, challenging people half his age. He was also known to vault over the high pike fence around the Phipps Clinic when the gates were locked, leaving younger colleagues to climb over slowly and carefully. This was when he was in his seventies. He was a physical man.

He was not a good student, however. He did comply,

nonetheless, with his father's wishes, and went to Germany to study engineering. This was just before the First World War, and he remained there during the beginning of the war. It was at this time that he realized just how American he was, and also how little interested he was in becoming an engineer.

When he returned to America he enrolled at Harvard College. There he was a mediocre student until he took a course in genetics. Next was a course with the comparative psychologist, Robert Yerkes, in which he excelled. As he would later put it "his gene was released." He realized that his interest was in understanding behavior. His emphasis was on innate factors in the organization of behavior.

It was quite an irony that Richter's next move, at the suggestion of Yerkes after a stint in the army, was to go and work with John Watson at the Phipps clinic at Johns Hopkins. Watson, the great champion of behaviorism, heavily emphasized the importance of the environment and learning in the genesis of behavior. He left little room for innate mechanisms in behavior. Richter arrived at Hopkins in 1919.

Hopkins was a place that championed research. The president of Hopkins, Daniel Gilman, tried to bring the best researchers to the university. In Adolf Meyer, the head of the Phipps Clinic and the Psychiatry Department, Richter found a real benefactor in his pursuits of inquiry. Watson did not stay around to really witness Richter's progress, for within a short time he left Hopkins and Richter was able to take over his laboratory. He would spend the next seventy years in that laboratory, later called the Laboratory of Psychobiology. During this period his constant question was: what are the biological roots of behavior?

PSYCHOBIOLOGIST

Richter's Ph.D. thesis was on the biological clocks within

the body, and how they organized behavior. His first paper on this topic was called "A Behavioristic Study of the Activity of the Rat." He devised a way to measure the spontaneous activity of rats. He then described how running behavior varied during the day and night, over weeks and months. He also discovered gender differences in the expression of this behavior. For example, he found that the ovarian cycle influences the female rat's running activity to produce peaks at each ovulation, and that females are generally more active than males. He also found that biological needs affect the cyclicity of behavior.

Most significantly, Richter was ahead of his time in discovering the circadian rhythms (and longer term endogenous clocks that influence behavior) in his classic studies of biological rhythms. He would later point to a part of the brain that is critical for the generation of circadian rhythms. He also demonstrated that the circadian clock was not dependent on learning or upon external stimuli for its expression. Rats deprived of visual or other sensory stimuli still express a circadian rhythm. In fact, rats kept under anesthesia for twenty-four or forty-eight hours maintained circadian cycles in phase on recovery from anesthesia.

Throughout his career, Richter the tinkerer followed his childhood proclivities and found ingenious ways of measuring behavior: the widely used Richter tube for measuring fluid intake, the ubiquitous running wheel for measuring activity rhythms, new ways to measure sweating, salivation, and nest building.

While Richter was certainly no behaviorist or learning theorist—two terms which went together in this country during the early part of his career—he shared the behaviorist's interest in objectivity. On the other hand, he shared the ethologist's interest in the innateness of behavior. Perhaps one should understand Richter as a comparative psychobi-

ologist, who always worked within an evolutionary framework, taking the best from the behaviorists and the ethologists.

Richter's work can be seen in the tradition of Claude Bernard and Walter Cannon. Bernard emphasized the regulation of the internal milieu, and Cannon emphasized homeostasis. While both Bernard and Cannon were concerned with physiological mechanisms in the maintenance of the body, Richter emphasized the role of behavior. Both physiology and behavior, he felt, are called upon to maintain homeostatic regulation. In modern terms, Richter was a whole organism physiologist. For him, behavior was a biological phenomenon, serving to maintain the body in physiological balance.

At Hopkins Richter had an important colleague in E. V. McCollum, the noted nutritionist. He influenced Richter and his studies on the psychobiology of homeostatic regulation. McCollum had shown how changes in the diet can provoke compensatory behavioral responses, a demonstration of Cannon's concept of "the wisdom of the body." Studies had already been conducted by Clara Davis in the 1920s, in human infants, that suggested that nutritional balance could be maintained by self-selection of a diet from a variety of simple basic foods. Richter, more than any one else, went on to show that animals could maintain their homeostatic balance when offered a selection of pure protein, carbohydrates, minerals, and vitamins. For him, self-selection of a diet was based on innate capacities. Most critically, he showed that when deprived of specific nutrients, rats compensated in their food selection in his "cafeteria" situation.

The hunger for sodium is a good example. It was already known that adrenalectomized rats would die without access to sodium, for without access to sodium, and without the sodium retaining hormones secreted by the adrenal gland,

the animals chronically lose sodium. Richter showed that the adrenalectomized rat would maintain its sodium and extracellular fluid balance by ingesting enough sodium to remain alive. He suggested that animals did not have to learn about the consequences of the sodium ingestion. He noted the promptness of the salt appetite, and that it was manifested with a variety of salts. He hypothesized that an increase in sodium taste sensitivity was a mediator of increased sodium hunger. He performed a number of studies to show how gustatory sensibility and the underlying neural mechanisms play a role in the selection of nutrients and minerals.

Richter did not stop with sodium; he held the same view for calcium-hungry animals, that is, that they also expressed an innate taste-mediated appetite when calcium-deficient. He showed that when parathyroidectomized, the animal chronically excretes calcium. With access to calcium, rats selected the calcium salts. Richter thought that calcium hunger and many other specific hungers were innate. As it turns out, Richter was right about sodium, a prototypical example of an innate behavior, but not right in extending his concept to all other specific hungers.

Richter was particularly interested in the hormonal regulation of behavior. Having discovered mineralocorticoid-induced sodium hunger, he made it clear that the adrenal hormones could serve for both the physiological and the behavioral regulation of sodium. That is, the hormone acted to conserve and redistribute sodium in the body, but also to generate the behavior of salt ingestion. Many subsequent investigators pursued this line of reasoning and used sodium hunger as a paradigmatic case of innate motivated behavior and as a basis for an analysis of the neural control of behavior.

Richter saw sodium hunger as adaptive behavior. Another

example he studied was the increased ingestion of minerals during pregnancy and lactation. He charted out the mineral intake during the reproductive cycle and found that a variety of minerals essential in pregnancy and lactation (sodium and calcium) were ingested in large amounts, serving both the mother and the offspring.

Another adaptive behavior that Richter investigated was bait shyness: the reluctance of rats to try unfamiliar foods (neophobia). He was one of the first to describe learned-poison-avoidance during his World War II effort to control rat populations in the city of Baltimore. Later, learned-poison-avoidance (conditioned taste aversions) became of central importance in the psychology of learning.

Richter discovered many other behavioral adaptations and brought them into the laboratory for study. One is coprophagia (feces ingestion) in nutritionally deprived rats, a practice that procures required nutrients. A second one is the building of warm nests by hypophysectomized rats to compensate for the loss of the capacity for physiological thermal regulation.

As a psychobiologist, Richter was interested in the effects of domestication on the physiology and the behavior of the animal. He found that a number of body organs were changed by domestication. Many did not grow as large. This held for the kidney and the adrenal gland, in addition to the pituitary and the liver. There were also differences in behavior. The domesticated rat would survive adrenalectomy by ingesting sodium, the wild rat would not; the wild rat was much more neophobic than the domestic rat.

Richter's tie to biology led him to the comparative analyses of different species. He used his data on salt hunger in rats to understand the abnormal salt appetite of a little boy. His success in studying biological clocks in rats led him to

extensive studies in how alterations of biological rhythms can result in psychiatric disorders.

Richter's perspective was functional as well as comparative and he showed that decerebration causes a functional activation of the muscles of support, regardless of whether they are extensors or flexors. Thus, while decerebration led to extensor rigidity in most animals, he showed that for the tree-dwelling sloth, which supports itself with flexor muscle activity, decerebration led to flexor rigidity. He also demonstrated the release of the grasping reflex following damage to the frontal lobe in the monkey, shedding light on the strong grasp reflex of both human and monkey infants whose frontal lobe was not yet fully developed.

Richter was also always on the alert to see clinical analogues for his experimental work on behavioral adaptations. For example, as mentioned above, a young boy had been admitted to Hopkins because of marked development of secondary sex organs. In the hospital they made a fatal mistake. They placed the boy on a regular hospital diet, low in sodium chloride. The boy subsequently died. At autopsy it was discovered that he suffered from adrenal cortical pathology. Therefore, he could not produce aldosterone, the principle mineralocorticoid, and was unable to retain sodium. It turned out, in interviews with the parents, that the boy loved salt, ate pure salty foods; salt was one of his first words. The excessive salt ingestion of the boy was a behavioral adaptation to insure the regulation of the internal mileu, just as it was in the adrenalectomized rat.

Richter also often related his experiments to psychopathology. Thus he inquired whether various forms of pathology such as manic depressive illness were due to the disruption of the endogenous biological clocks. Richter also produced a laboratory phenomenon which he called hopelessness. Others later called a similar phenomenon help-

lessness. He thought that "vodoo death" (being frightened to death) was a state of hopelessness characterized by acute parasympathetic blockade that stops the heart.

CURT RICHTER, AN AMERICAN INQUIRER

Curt Richter is not as well known in psychology as his pioneering research would suggest. There are several reasons for this. First, he was way ahead of his times, and his thoughts were off the mainstream of psychology, psychiatry, and medicine. Second, he worked alone in a medical setting and had no regular graduate students. Many of his young collaborators went into physiology and medicine and excelled there. Yet with extraordinary prescience, Morgan dedicated his 1943 edition of *Physiological Psychology* to Richter as well as to Lashley. Finally, Richter pioneered research into many different areas of behavior involved in nutrition, emotion, biological rhythms, and temperature regulation, and it was only gradually that psychology realized that he was talking about adaptative behavior and motivation in all individual cases.

Curt Richter published over 200 papers and the range of journals that Richter published in was extremely broad. Yet whether he published in *Endocrinology, Neurology, The American Journal of Physiology* or the *Journal of Comparative and Physiological Psychology*, he always had the same style. His experiments were simple, his ideas were interesting, and his results convincing. He studied real phenomena and reported them clearly and simply.

In his later years, Richter worried about the overemphasis on experimental design in experimentation and in grant proposals. He pointed out that one had to have already solved a problem before one could get a grant to study it. He thought that this would amount to only discovering what one already knew, therefore ruling out the importance of

discovery and forgetting its value. In such a context there was little room for exploration, of simply being an inquirer. He argued for free inquiry in research, basically what American inquiry has stood for since the time of Benjamin Franklin.

It was the tradition of Franklin through his influence on Charles Saunders Peirce that emphasized method and invention, common sense, experimentation, and strong ties to the biological sciences in the study of behavior. From within this tradition Richter enjoyed the pleasures of inquiry. The spirit of Richter is therefore closely coupled to the sense of inquiry within America. From Benjamin Franklin, who founded the first intellectual society in America, to Charles Peirce, the inventor of pragmatism, the sense of inquiry within America is non-ideological, and always supportive of new inventions. With a background in engineering, it is perhaps a significant fact that Richter was always inventing new methods and techniques which figured prominently in the advances in knowledge that he made.

Curt Richter was also a good man, and a gracious host. On many occasions in recent years, many of us had the great pleasure of visiting him in his laboratory. He was always eager to listen and learn. Even in his nineties, he wanted to know the latest findings in the field. He always took the opportunity to inquire. And in doing so, he kindled in all of us the joy and excitement of inquiry.

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