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Johannes Müller

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Introduction

Johannes Peter Müller, 1801–1858

Johannes Peter Müller was born on July 14, 1801 in Coblenz, Germany, an ancient city in middle Germany. Some well-respected historians spell his surname "Mueller" (Young 1990). Müller died on April 28, 1858 in Berlin. Among numerous outstanding achievements during his career, he published several books including the eight books between 1833 and 1840 that comprised his *Handbuch der Physiologie des Menchen.* The *Handbuch* established Müller as the most renowned physiologist of his time. He made important discoveries in physiology, improved upon the discoveries of others, and mentored some of the most important physiologists/physicists of the nineteenth century. In his later years, he devoted most of his effort to the study of single-celled marine animals.

Born the son of a shoemaker, Müller was initially destined to have a career in leather work, but his success in the gymnasium (high school) resulted in his father being persuaded to allow him to enroll in the University of Bonn in 1819. In 1822, Müller earned a medical degree based on a study of animal movement, especially arthropods. Müller then spent a year and a half at the University of Berlin where his principal mentor was Carl Rudolphi, Germany's most eminent anatomist. Müller returned to Bonn initially as a lecturer but eventually as professor. Rudolphi died in 1832. In 1833 Müller was invited to succeed him at the University of Berlin. Müller remained at the University of Berlin until his death from cause unknown; some suggested suicide. Müller spent much of his adult life suffering from depression largely attributed to overwork and to constant financial problems. His financial problems were usually caused by spending too much of his personal income on equipment, etc., needed in his research.

This introduction is based mainly on Steudel (2008), but bits here and there were gathered from

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Fulton and Wilson (1966) and Wight (2000). Because Müller was so eclectic in his research and information about him is so scattered, most of the entry will be written without citing specific references for each fact or set of facts, but all can be verified among the References at the end of this entry.

Handbuch der Physiologie des Menchen

Among Müller's most memorable achievements was *his Handbook of the Physiology of Men* which was published in eight volumes from 1833 to 1840. Boring (1950) summarized each book's emphases as follows. Book 1 (288 pages) considered the circulation of blood and lymph. Book 2 (308 pages) considered chemical correlates of respiration, nutrition, growth, reproduction, secretion, digestion, excretion, and chylification (formation of chyle, which has complex functions in the intestines). Book 3 (270 pages) considered physiology of the nerves. Book 4 (248 pages) considered general muscular movement with special attention to voice and speech. Book 5 (256 pages) began with the formulation of the "doctrine" (Boring 1950, p. 35) or "law" (Finger 1994, p. 135) of specific nerve energies (more on this below) before considering the five senses. Book 6 (82 pages) was titled "Of the Mind" and considered association, memory, imagination, thought, feeling, passion, the mind-body relationship problem, phantasms, action, temperament, and sleep. Boring did not differentiate books 7 and 8 (179 pages for both) but noted that they considered reproduction and development, embryonic and postnatal. Boring considered books 3–6 most important for psychology.

The Law of Specific Nerve Energies

Reduced to its essence, specific nerve energies (SNE) mean that each sensory nerve can only convey information to the brain that arises from the specific activation of the associated sensory receptors or nerves. There are corollary SNE associated with muscle activity, but the emphasis here is on the senses. To explain what SNE meant, Anonymous (1911) wrote:

> . . . the kind of sensation following stimulation of a sensory nerve does not depend on the mode of stimulation but upon the nature of the sense-organ. Thus light, pressure, or mechanical stimulation acting on the retina and optic nerve invariably produces [only] luminous impressions (p. 962).

Boring gave less credit than most authors do to Müller for "discovering" SNE, but Boring did recognize Müller for its clearer formulation. Boring considered that the prior work by the Scotsman, Charles Bell (1774–1842) and the Frenchman, François Magendie (1783–1855) in differentiating sensory and motor spinal nerves laid the groundwork for Müller's formulation of the concept of SNE (see Boring 1950, pp. 31–33).

Other Accomplishments by Müller

Müller's research was so prolific that only a small sampling of his accomplishments can be mentioned here,

Physiology

As noted earlier, Müller's dissertation dealt with locomotion in animals. He began with arthropods but eventually addressed locomotion in other classes of animals. In 1820, the Bonn Faculty of Medicine offered a prize to whoever could prove that a fetus can breathe in the womb. Müller confirmed that a prenatal lamb did breathe in its mother's womb. Using self-experiments and self-observation, Müller determined that optical perceptions can arise without an adequate stimulus, such as mystical visions including ghosts. It is unclear whether Müller realized that memories acquired via first- or second-hand reports might be the basis for such visions.

Embryology

Many of Müller's contributions to embryology were methodological. He published on the development and structure of glands. He discovered the embryonic duct that formed the fallopian tubes, uterus, and vagina.

Neurophysiology and Neurology

Controversy had arisen involving Charles Bell and François Magendie regarding priority for the discovery of the distinction between spinal sensory and motor nerves, and after Magendie retracted some of this findings as his methods had been questioned, Müller entered the fray. First, he tried to do research using rabbits that yielded ambiguous results. Müller then began to use frogs, which offered the advantage that the spinal cord is easier to remove with its functions well preserved, and the relationships between the nerves were more apparent. Müller's results using frogs were unambiguous and reproducible; thus, was the validity of Bell's and Magendie's findings established. Müller went on to study cranial nerves. He showed that two branches of the trigeminal nerve were sensory and the third branch was predominantly motor but with sensory fibers that provided feedback from the muscles. Any student of neuroanatomy should be familiar with the intricate sensory-motor feedback loops that prevent muscles from over-contracting, thus detaching from the bones, yet sufficient to maintain muscle tonus. Müller also studied the glossopharyngeal, vagus, and hypoglossal nerves.

Müller's Students and the Issue of Vitalism

Brazier (1959, p. 20) described Müller as the "greatest physiologist of his time" and a "gifted teacher." Müller had many more students than the few mentioned here: (a) Emil du Bois-Reymond was a pioneer in electrophysiology of muscle, (b) Theodore Schwann developed cell theory, (c) Rudolf Virchow was well recognized for his research on anatomical pathologies, (d) Ernst Brücke became a distinguished physiologist at the University of Vienna and was described by Sigmund Freud who studied with him for 5 years as his most highly respected teacher, (e) Carl Ludwig was the most distinguished physiologist at the University of Leipzig in his time where he significantly influenced Wilhelm Wundt. Ivan Pavlov studied with both Müller and Ludwig, and (f) Hermann von Helmholtz. Had the Nobel Prize existed in Helmholtz's time, likely he would have qualified for four: one for his research in vision, one for his research in audition, one for his formalization of the Law of Conservation of Energy, and one for being the first to measure the speed of nerve conduction.

"Vitalism: The Best and the Worst"

This heading is the title to chapter 4 in Meulder's (2010) biography of Helmholtz. It followed chapter 3, "Johannes Müller "Man of Iron." Most authorities agree that Müller was a vitalist throughout his career. Muelder raised some doubt about whether Müller was a vitalist at the end, but acknowledged that his students, Helmholtz, du Bois-Reymond, Brücke, and Ludwig successfully branded Müller as a "vitalist."

Vitalism is the belief that living matter is sustained by a vital or "life force" that cannot be reduced to chemistry and physics. Biologists today believe that it was necessary to reject vitalism to enable biological science to progress. Between them, du Bois-Reymond and Ernst Brücke made a pact to compel and establish the truth that "No other forces than common physical chemical ones are active in the organism" (Boring 1950, p. 708). Helmholtz and Ludwig must not have been present for the pact, as they surely would have joined in.

Two of Helmholtz's greatest accomplishments served directly to refute vitalism. First was his determination that the speed of nerve conduction was approximately 150–180 ft/s (Cahan 2018, p. 93). Müller speculated that nerves conduct at the speed of light and that "We shall probably never attain the power of measuring the velocity of nervous action" (Boring 1950, p. 41). Such speculation and belief imply that nerve conduction was in the realm of the supernatural. Second was Helmholtz's formalization of the Law of Conservation of Energy. Cahan (2018, p. 151) summarized the Law as follows:

> Nature as a whole contained a store of force . . . that could be neither Increased nor decreased; its total quantity was "eternal and unchangeable like the quantity of matter."

There is an emerging parallel to vitalism that is plaguing animal cognition research today, namely, an advocacy for emergent properties. Here such advocacy with be termed "emergentism." Duane Rumbaugh and his colleagues have been at the forefront of such advocacy. Anonymous (2009) wrote:

> Throughout his professional life, Rumbaugh has sought ways to test and understand intelligence that does not depend on the human capacity for complex language. In addition, he has sought to go beyond the two traditional methodologies: "respondents," innate, involuntary reactions to stimuli based on conditioning; and "operants," limited, voluntary actions that are designed to gain an award through operating on a particular environment. Rumbaugh has added a new methodology: "emergents," which are unusual problem-solving behaviors that are not based on repetition or associative learning, but instead seem to emerge from a kind of integrative process based on genetics, instinct, and cognitive reasoning.

See also Rumbaugh (2002) Rumbaugh et al. (2003) and Rumbaugh et al. (1996). Belief in emergentism accepts that behavioral scientists may investigate phenomena that are not in principle reducible to physics and chemistry.

Emergentism has its roots in the nineteenth century theory of "mental chemistry" advocated by the philosopher, John Stuart Mill. Interestingly, John Stuart Mill's view was in opposition to his father's advocacy of "mental mechanics." In brief, John Mill believed that "the whole is equal to the sum of its parts" versus John Stuart Mill's belief that "the whole is greater than the sum of it parts." As "proof" of mental chemistry, J. S. Mill used water to argue that water has properties that cannot be predicted from its elemental constituents' oxygen and hydrogen. The "mental mechanist" would counter that when we know all the properties of hydrogen and oxygen, we will be able to account for all the properties of water.

In other words, to be a vitalist or emergentist promotes giving up and avoiding the hard work necessary to establish the physicochemical foundations of biological and psychological phenomena. For a more detailed account of the hazards of and parallels between vitalism and emergentism, please see Thomas's entry, "Morgan's canon" in this *Encyclopedia*.

Cross-References

- ▶ Afferent and Efferent Impulses
- ▶ Arthropod Locomotion
- ▶ Energy
- ▶ Hermann von Helmholtz
- ▶ Laboratory Research
- ▶ Leipzig
- ▶ Respiratory System
- ▶ Sensory Receptors
- ▶ Vertebrate Nervous System

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