Short communication

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Mirroring the Mind and Brain: Reflections on Hans Berger's EEG and the Scientific Perception of Reality

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Abstract

This year marks the 100th anniversary of the invention of the EEG (electroencephalogram) by Hans Berger (1873–1941), who is widely recognized as the first to record electrical brain waves in humans. While brainwaves recorded on photographic paper served as an effective example of what Berger called Hirnspiegel ("brain-mirror"), his early drawings provide a unique insight into the workings of his mind—and, by extension, those of any researcher.

On July 6, 1924, Berger, a German psychiatrist based in Jena, Germany, successfully recorded electrical oscillations from the exposed cortex of a 17-year-old boy named Zedel, who had undergone palliative trepanation with a trephine opening by neurosurgeon Nikolai Guleke (1878–1958). What he observed would later be identified as the first human EEG recording[1]. Over the years, Berger meticulously refined his techniques, eventually reducing interference from factors such as skin conductance, muscle contractions, vessel pulsations, and eye movements. Since then, the EEG has become one of the most important tools for diagnosing neurological disorders, including consciousness impairment, coma, sleep disorders, and epilepsy, and is widely used in research.

However, Berger's journey toward the invention of the EEG was far from straightforward. His diary entries from 1928, just months before he submitted his first article on the EEG (published in 1929), reveal that he almost abandoned his research due to persistent doubts. In one entry, he wrote: "Plans! I feel the need for creative scientific work.

For many years I have worked in vain on the presumed EEG. What now? Abandon EEG!"[2]. But soon after, on September 28, 1928, he confirmed the validity of his findings, exclaiming in his diary: "Eureka! I've got it, I've found it!, just when I had already given up the matter in despair![3].

Berger began his research on cerebral electrophysiology in 1910, using a string galvanometer, initially the Einthoven model designed for recording electrocardiograms. After 1924, he adopted the more sensitive Edelmann models[2]. The string galvanometer, a sensitive instrument for measuring tiny electric currents, operated by suspending a fine filament of wire, often made of quartz or metal, within a powerful magnetic field.

When an electric current passed through the filament, it moved in response to the magnetic forces. A strong light source, directed at the filament, and an optical system magnified these movements, which were then recorded photographically. This setup allowed for precise measurements of electrical activity.

All the EEG traces published in Berger's 14 articles between 1929 and 1938, which described the EEG and its clinical applications, were recorded using a moving-coil galvanometer. These recordings, captured as black-on-white curves on photographic paper, provided objective evidence. Notably, a recording from October 19, 1925, made with the string galvanometer, has survived[3]. In this case, Berger redrew the cerebral waves in white ink, depicting a regular fluctuation that, in hindsight, appeared too regular to be accurate. Later brainwave recordings on photographic paper revealed a much more irregular pattern. This seemingly minor discrepancy past prompts important reflections on the role of perception and interpretation in scientific observation.

Our perception of reality is not direct or unfiltered; it is shaped by our preconceptions, beliefs, and prior knowledge, which serve as lenses through which we interpret the world. We do not experience reality as a blank slate (tabula rasa), passively receiving knowledge from perception alone.

Even the process of induction - drawing general conclusions from specific observations through experimentation - is not purely objective. Our minds actively organize and interpret the information we gather, consciously and unconsciously.
Berger's redrawing of cerebral waves, projected by light and magnified through the optical system, offers a fascinating example of this cognitive process.
Although he ultimately succeeded in developing a tool that provided objective, measurable neurophysiological correlates of brain function, his initial observation of brainwaves, unrecorded by photographic equipment, reflects the dynamic interplay between subjectivity and objectivity in scientific research.
Berger drew not only what he saw but also what he *believed* he was seeing: a continuous, regular sinusoidal wave pattern. His perception was not comparable to the mechanical capture of an image by a camera; it was an active process of interpretation, an attempt to make sense of phenomena appearing before him for the first time. While brainwaves recorded on photographic paper served as an effective example of what Berger called *Hirnspiegel* ("brain-mirror"), his early drawings provide a unique insight into the workings of his mind—and, by extension, those of any researcher.

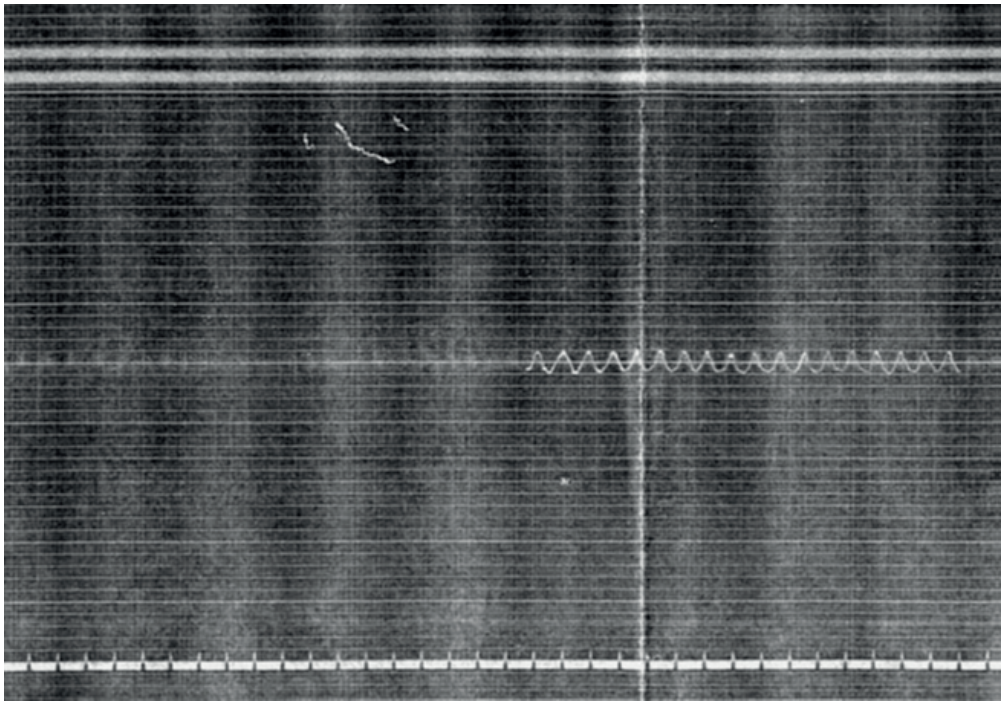

Fig. 1. Brainwave recording from October 19, 1925, generated using a string galvanometer. The bottom of the image shows the time scale, with each vertical bar representing one second. The center displays the brainwaves, as redrawn by Berger in white ink on the right half of the image, depicted as a continuous and regular sinusoidal pattern.

Bibliography and notes

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