Seeing Seizures: From Charcot to Artificial Intelligence in Epilepsy and Functional Disorders

(Neuroperspective)

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Modern epilepsy care is increasingly shaped by algorithms, large datasets, and computational models. Yet its intellectual roots lie in a very different clinical world, the nineteenth-century wards of the Salpêtrière Hospital, where Jean-Martin Charcot (1825–1893) built a discipline founded not on machines, but on observation (*Goetz 1995*).

Charcot's neurology was, above all, a neurology of the eye. In an era without EEG, neuroimaging, or digital recording, the principal instrument of the neurologist was careful attention to clinical detail. Charcot and his pupils documented the phenomenology of neurological disorders through meticulous bedside examination, drawings, and early medical photography. Seizures, paralyses, tremors, and abnormal postures were analyzed as if they were natural phenomena unfolding in real time. From these observations emerged the anatomo-clinical method: the systematic effort to correlate symptoms observed during life with pathological findings discovered after death (*Goetz 1995; Charcot 1881).*

This approach proved particularly influential in the study of epileptic seizures and related paroxysmal disorders, including what we now call functional (dissociative) seizures (*Bourneville and Regnard 1878*).
At the Salpêtrière, Charcot confronted a complex diagnostic landscape in which epilepsy overlapped with what was then called hystero-epilepsy. Rather than dismissing the ambiguity, he attempted to describe it. His lectures carefully distinguished patterns of seizure activity, while his collaborators, including pioneers of medical photography, captured sequential images of attacks that today might be classified as epileptic or functional seizures (*Charcot 1881; Bourneville and Regnard 1878*). In the absence of electrophysiology, semiology became the

primary diagnostic tool, highlighting the critical importance of careful observation in understanding paroxysmal attacks of diverse origins (*Kanner 2020*).

In the twenty-first century, neurology operates within a radically different technological environment. EEG, magnetic resonance imaging (MRI), and genetic testing have transformed the diagnostic landscape in epilepsy (*Berg et al. 2010*). More recently, artificial intelligence (AI) has begun to enter clinical practice: machine-learning systems analyze EEG recordings, detect seizure patterns, and assist in neuroimaging interpretation (*Qamar et al. 2025*) Large computational models can identify subtle correlations within datasets that would be impossible for individual clinicians to recognize, including biomarkers of seizure onset and propagation (*Qamar et al. 2025)*.

Yet the contrast between Charcot's neurology and contemporary AI-driven neurology is not merely technological, it is epistemological. Charcot's method was grounded in narrative clinical reasoning. Each patient represented a unique constellation of symptoms requiring careful interpretation within a broader clinical context. AI, by contrast, excels at pattern recognition across massive datasets, often producing results without explicit explanatory frameworks (*Shoeb 2009; Topol 2019*). Where Charcot sought to understand the meaning of symptoms within the lived experience of a patient, AI frequently operates through statistical inference and pattern discovery.

This tension raises an important question for modern epileptology: does technological sophistication risk distancing clinicians from the observational traditions that originally defined the discipline? Algorithms can detect patterns, but they do not watch patients in the same way Charcot and his students did in the amphitheater of the Salpêtrière. The neurologist of the nineteenth century learned from prolonged clinical observation, sometimes from a single patient studied over years. In contrast, contemporary systems may derive insights from thousands of recordings but remain blind to the subtleties of human expression, behaviour, and context that often guide nuanced clinical diagnosis (*Bourneville and Regnard 1878; Kanner 2020*).

At the same time, the relationship between Charcot's legacy and modern artificial intelligence is not purely oppositional. In some respects, AI can be seen as an extension of the same intellectual project Charcot began: the search for reproducible patterns within complex neurological phenomena. The difference lies in scale. Charcot's patterns emerged from the disciplined eye of the clinician; today they may emerge from computational models trained on vast quantities of data (*Qamar et al. 2025; Topol 2019*). Yet the essence remains the same: understanding the unfolding of seizures and paroxysmal events in all their clinical richness.

The challenge for contemporary epileptology is therefore not to choose between human observation and AI, but to integrate them. Charcot's approach reminds us that clinical meaning cannot be entirely reduced to data. The subtle phenomenology of seizures — the gestures, postures, emotional expressions, and contextual triggers that he documented so carefully — still requires attentive clinical interpretation (*Kanner 2020*).

In this sense, the age of AI may ultimately reaffirm rather than replace the principles that guided Charcot's work. Technology can augment diagnosis, but it cannot fully substitute the clinician's capacity to observe, interpret, and understand the patient as a whole, whether the crisis is epileptic or functional (*Bourneville and Regnard 1878*; *Berg et al. 2010*).

More than a century after his death, Charcot's lesson remains strikingly relevant: epileptology begins with seeing. Even in an era increasingly mediated by algorithms, the careful observation

of seizures, epileptic or functional, remains the foundation upon which all neurological knowledge must rest.

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