Applied Psychophysiology and Biofeedback
https://doi.org/10.1007/s10484-024-09620-x

OBITUARY

In Memoriam: Maurice B. (Barry) Sterman (1935–2023), Pioneer of SMR Neurofeedback 'Show me the Data'

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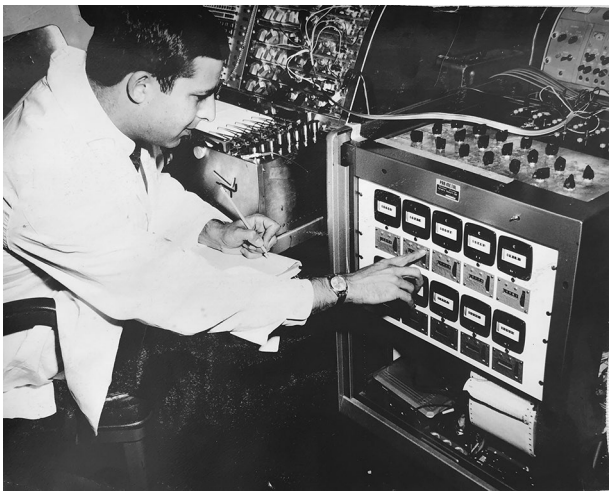
Accepted: 17 January 2024



The scientific community mourns the passing of Dr. Maurice B. Sterman, better known as Barry Sterman, a visionary researcher whose pioneering work in neurofeedback and sleep medicine revolutionized our understanding and treatment of brain disorders such as epilepsy, insomnia and ADHD. Dr. Sterman passed away on December 22nd, 2023, amidst his loving family at the age of 87. He leaves behind an unparalleled legacy that has profoundly shaped the fields of neurofeedback, sleep medicine and clinical neuroscience.

Born December 31st, 1935, in St. Paul, Minnesota, Barry displayed an early fascination for the possibilities of self-regulation. In his childhood and adolescence Barry was very close to his eleven-year older sister Esther, and considered her almost a surrogate parent, or, as he once stated: "*I was her 'little boy'!*". After she lost her boyfriend, who was drafted to WWII and got killed on the beaches of Normandy, she was never the same. Barry observed her going into a profound depression and later struggling with the symptoms of Raynaud syndrome, observing her fingers turning white and blue in response to cold and warm objects, but also occurring when she was upset. On doctor's recommendation, the Sterman family relocated to a warmer climate, and thus ended up in Los Angeles, California. Years later when Barry was a graduate student at UCLA, being aware of the principles of operant and instrumental conditioning, he constructed a device for his sister that allowed her to warm her hands through temperature biofeedback.

Later Barry qualified for the University of California (UCLA), and first decided to major in astrophysics due to his fascination for flight and astronomy (an interest he would later marry with his work at the Brain Research Institute).

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Published online: 20 March 2024

Eventually he decided on psychology. In 1958 he finished his bachelor's degree in psychology, partly chosen due to, as he put it, '*…in order to be together with a young lady I was attracted to…*', but did so *cum laude*, and continued the PhD program at UCLA, which he completed in 1963.

During his PhD work, he conducted psychophysiological research on the cold-pressor test. Here, he observed three patterns of EEG activity (Sterman et al., 1966). One pattern was reminiscent of 'internal inhibition' or 'transmarginal inhibition' as described by Pavlov. This concept of 'internal inhibition' became an important thread in his career, proposing that internal inhibition was an 'internal shutdown' resulting in sleep-like stages. This notion of internal inhibition and sleep as an *active* process was very novel; at that time sleep was mainly seen as a passive resting state following wakefulness. These new concepts implicated not only the existence of 'wakefulness centers' in the brain, such as the already discovered reticular activating system (Moruzzi & Magoun, 1949), but also specific 'sleep centers', that Barry discovered together with his mentor Carmine Clemente, to be the Basal Forebrain; this turned out to be a breakthrough for sleep research (Sterman et al., 1962a; 1962b).

In the lab Barry devised an experimental paradigm to further study this state of 'internal inhibition', in which cats were taught a 'withholding of response'. He described for the first time a rhythm of 12–20 Hz (peak range 12–15 Hz) over the coronal gyrus (the feline equivalent of the sensorymotor cortex). He labeled this EEG pattern the "Sensorimotor Rhythm," or SMR (Roth et al., 1967; Sterman & Wyrwicka, 1967). In further work, Barry applied operant conditioning to this SMR rhythm to study the functional implications and observed that cats exhibited a stereotypical motionless posture but were highly alert during SMR-activity (Sterman & Wyrwicka, 1967). By observing the same EEG channels during sleep, he linked the occurrence of SMR—during wakefulness—to sleep spindles—both by frequency and topography. In his publication in the prestigious scientific journal Science in 1970 he utilized this knowledge with the first demonstration that SMR neurofeedback in cats, conducted during wakefulness, resulted in improved sleep and sustained increased levels of sleep spindles (Sterman et al., 1970). This pioneering and innovative early line of research laid the foundation for the serendipitous discovery of the anticonvulsant effects of SMR neurofeedback for seizures induced by Monomethyl-hydrazine in cats (an assignment from the U.S. Air Force). This effect was further replicated in the first human epileptic patient—Mary Fairbanks, a 23 year old student in Barry's lab (Sterman & Friar, 1972). Later research also confirmed the clinical benefit of SMR neurofeedback in epilepsy (Tan et al., 2009) and insomnia (Cortoos et al., 2009; Hoedlmoser et al., 2008), and resulted in a new view of the pathophysiology of ADHD. The fact that ADHD symptoms are also caused by sleep irregularities explains the clinical benefit of SMR neurofeedback in ADHD (Arns & Kenemans, 2014; Arns et al., 2014). His lingering fascination for flight and astronomy was finally fulfilled in the 1990's when he worked with jet pilots at the Edwards Air Force Base, investigating optimal flight performance using EEG. He devised a brain-computer-interface (BCI) system, long before BCI research became fashionable. He worked directly with pilots and devised an alarm system, signaling an imbalance of hemispheric brain activity differences that gave him (and Niels Birbaumer at that time working with Barry) the opportunity to fly and experience Pavlov's transmarginal inhibition during excessive fear.

In addition to his scientific achievements, Barry was instrumental in establishing the Biofeedback Research Society (currently the Association for Applied Psychophysiology and Biofeedback) together with Joe Kamiya. Barry wanted to call it the Society for Self-regulation, but eventually the term biofeedback was chosen. When Barry ran into Mary Brazier—another famous neuroscientist at UCLA—she remarked: '*… you're not calling this new society Biofeedback right? Bio means live and feedback means returning life. You're not doing that, are you?…*', he reminisced about the name, but he never liked the name biofeedback. Barry spent time as a visiting professor at various institutions including the University of Tokyo, University of Edmonton (Canada), Bergen University (Norway), Mexico University (Mexico) and Tübingen University (Germany). He received numerous awards and honors, such as the Jubilee Founder Award from the Sleep Research Society and became a National Science Foundation Fellow at the Institute for Brain Research (Tokyo University) to name a few. In addition, the ISNR has recognized his accomplishments with the M.B. Sterman Career Achievement Award.

Lastly, Barry was renowned for his kindness, humor, and unwavering dedication to helping patients, friends and colleagues and advancing scientific knowledge. He mentored and inspired countless researchers and clinicians, sharing his expertise and passion for neurofeedback, EEG and leaving an indelible mark on the field. "Show me the data" was the mantra that Barry acquired and was really proud of, as many of his colleagues will remember.

In his passing, the world has lost a visionary pioneer and a true luminary in the field of applied neuroscience. His legacy will endure through the continued application of neurofeedback techniques and learning on disease and its profound impact on the lives of patients and their families.

Barry is survived by his wife Lorraine (Taylor) Sterman, PhD, his two children Lisa Sterman, MD and Paul Bradley Sterman and two grandsons, Bodhi and Skylar. He will be sorely missed by all of us who knew him and many who have been influenced by his works, whether as researchers, clinicians, or patients.

In closing, we honor the life and legacy of Dr. Maurice B. Sterman, whose pioneering spirit and groundbreaking work in neurofeedback and sleep medicine have transformed our understanding and treatment of neurological disorders, leaving an indelible mark on the annals of scientific history.

Author Contributions MA, NB initiated the manuscript, MA, EF, NB contributed to, reviewed and approved the manuscript.

Data Availability No datasets were generated or analysed during the current study.

Declarations

Competing interest The authors declare no competing interests.

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