A quiet innovator: Peter Lakatos (1972–2021)

Peter Lakatos passed away on Sunday, 30 May 2021. He was 49 years old. Peter was a Research Scientist at the Nathan S. Kline Institute for Psychiatric Research in New York State and a Research Assistant Professor in the Department of Psychiatry at NYU Grossman School of Medicine. With Peter's sudden death, neuroscience has lost a gentle giant.

Peter Lakatos was a quiet innovator, a sturdy physiologist, and an enormously hard-working data analyst, with a child-like curiosity that he had retained throughout his many years in the lab and behind the computer. Peter leaves behind his wife and collaborator of many years, Monica-Noelle O'Connell, and their daughters Lili and Nora.

Born in 1972 in Hungary, then part of the Eastern bloc, Peter attended medical school and studied neuroscience at the Semmelweis University in Budapest, Hungary. After a crucial internship at the Nathan S. Kline Institute and early encounters with a system being developed for recording neural activity using linear arrays along the depths of neocortex, Peter decided to move to the United States in 2003, and he joined Charles Schroeder at the Nathan S. Kline Institute as a postdoctoral scientist.

It must have been around this time in the early 2000s that electrophysiologists started to look with renewed interest at the spontaneous activity captured in the local field potential (LFP); such activity was often dismissed as neuronal noise, or even derided jokingly as the 'exhaust fumes' of the firing neurons. Peter Lakatos' keen interest fell exactly on this seeming by-product of neuronal activity, and he embarked on an almost two-decades-long journey into the physiological circuitry and the psychological consequences of slow neural oscillations.

In 2008, a publication in *Science* with the innocuous title "Entrainment of neuronal oscillations as a mechanism of attentional selection"¹ took the field by storm. In this study, which had been cited almost 1,500 times by the time of his so untimely death, Peter and his co-authors demonstrated that slow endogenous neural oscillations in sensory cortex become phase-aligned to the (quasi-)rhythmic structure of attended exogenous sensory input, with a cascade of putative neurophysiological and behavioral consequences. Another opus magnum in 2009 entitled "The leading sense"² demonstrated the phase-reset of slow neural oscillations in one sensory modality through attended events occurring in another, or what Lakatos et al. termed 'supramodal control'.

Credit: Monica-Noelle O'Connell

It can hardly be overstated how influential these (from Peter's vantage point, initial) observations in the years 2007–2009 became in the decade to follow. Peter has left us with some of the singularly clearest demonstrations of the hierarchical organization^{3,4} of slow neocortical and thalamo-cortical neural oscillations; their orchestration across brain areas (such as between V1 and A1 (refs. ^{2,5}), or across thalamic nuclei and sensory cortex^{6,7}); and their functional utility in neurobiologically grounding or even explaining psychological phenomena such as selective attention^{1,8,9}.

A glance at any of his papers from 2005–2020 and the frequency with which they appeared will reveal the breadth and depth of the 'Lakatos method'—this was simply Peter's way of doing research, how he operated. Vanishing into the basement laboratories of the Nathan Kline Institute, churning, analyzing, and innovating away; and every few years surfacing with another Paper, with a capital P, that would go on to change and shape our field.

Peter has not left us with much written prose about himself or his way of thinking. He did put it very aptly, though, when he

noted in 2016, recounting his first 15 or so years in neuroscience: "Data was my muse and I followed wherever it led me." In the same text, Peter proved that he was no foreigner to the dance and rock staples of his youth when he tongue-in-cheek mashed up Grace Jones' biggest hit with his own biggest hit, neural entrainment or the enslaving of brain rhythms: "Sometimes I feel like I am slave to the rhythms of the brain, since they have occupied most of my research time and scientific thoughts"¹⁰.

Peter was a dyed-in-the-wool physiologist. When discussing the origins of certain neural phenomena, his neuroanatomical and neurophysiological knowledge and his ability to connect far-flung threads of research truly shone. He was an outstandingly polite and careful colleague to consult with on scientific problems. At the same time, he also knew when it was upon him to be authoritative and could end or resolve debates with a dry, almost deadpan seriousness.

Incidentally, in arguably the first report of cyclic changes of neural excitability—a paper that Peter often cited and which he helped to bring to contemporary readers' attention¹¹—Bishop (1933) wrote, "[i]n satisfactory [neural-recording] preparations the results are so specific and so clear-cut as to leave no doubt in the minds of the observers that they are valid and fundamental evidences of a definite type of functioning." These words were almost verbatim the reply Peter gave when I expressed a tentative doubt whether slow neural oscillations occur at all in auditory cortex. He said, "but the oscillation is there; you can see it with your bare eye." This exchange shows that in Peter's crafted and detail-rich work, using direct recordings from non-human primate brain structures, there always existed a primacy of direct observation in the neurophysiological probe, on the recording screen, over mere statistical inference.

In the midst all of his amassed implicit and explicit knowledge as a neuroscientist, Peter was one of the humblest academics imaginable. Never did he boast, other than with a childlike joy, about the achievements of his lab or himself, and never would he

have openly called out somebody who was maybe in the process of uttering utmost nonsense (which, as we all know, does happen). “I like when I don’t have to talk; I can listen and think better,” he once wrote to me in an email when we were in the process of planning the roster for a workshop. Incidentally, this reply of his might have well arrived at 0530 hours (in his time zone!), a time of day not untypical for Peter to be up, getting work done before family life resumed.

When Peter did talk and present, though, the awe in the room was palpable. For example, in 2013 at a workshop in Leipzig, Germany, he presented results he had just turned into yet another ‘monster’ of a paper, in the best possible sense: “The spectrotemporal filter mechanism of auditory selective attention”⁹. In this study, Lakatos and his team show that within auditory cortex, a rhythmic stream of tone pips to which an animal was currently attending led to an optimal temporal alignment of cortical excitability, but only in those neuronal populations that were tonotopically selective for this attended tone frequency (‘best frequency’, e.g., 2 kHz). In turn, the same neuronal population showed an essentially 180°-flipped pattern of neural entrainment when a tone stream was at these neurons’ ‘non-best frequency’, such that the least excitable part of their endogenous oscillatory cycle became aligned with the acoustic input.

As the workshop audience recognized with jaws dropping, this observation implied a simultaneous dual-stream setup of neural entrainment: an excitable or optimal neural phase for attended environmental rhythms and an inhibited or non-optimal phase for non-attended ones, even when both were in the same sensory modality. Even though

present or future colleagues will rightfully object to details of Peter’s ingenious proposals, the impact of his theoretical claims for the fields of speech, language, attention and neuropsychiatry research, based on sleek experimentation and meticulous neurophysiological recordings, is uncontested.

As an aside, the interested reader might also want to turn to Figure 3 in that exceptional report when looking for some rare, solid evidence that slow neural oscillations in sensory cortex are truly endogenous, in that they do retain their ‘entrained’ phase for a few cycles after an exogenous rhythm has ended before they subside back to their preferred endogenous phase⁹.

Let us not forget what an utmost patient and caring supervisor and mentor Peter was to his small and long-standing team of trainees and technicians at the Institute. “The people who do the really difficult work in the lab are my lab-mates. They deserve at least as much credit as I do for anything our lab achieves, which will hopefully be a lot in the coming years.”¹⁰

Those ‘coming years’ have come to a painfully early close now. But Peter’s immaculate eye for methodological detail and his unstoppable curiosity have carried his respective teams of co-authors to a series of future classics in sensory neurophysiology—page turners that will remain with us, to be perused time and again. Luckily, in 2019, Peter led a signature effort to produce an elaborate review paper that summed up his views on neuronal entrainment, with the reference list clocking in at no less than 234 papers¹². Last but not least, Peter must have left hard drives full of experimental data recorded from auditory and other sensory cortices

and, often recorded simultaneously, from the brain area that arguably intrigued him most⁷, the thalamus and its nuclei such as the pulvinar.

If you allow me one last reminiscence: when Peter picked me up near the George Washington Bridge on my first day as a guest in his lab in 2014, Tom Petty’s eternal “Wildflowers” began playing on his car radio. He will be dearly missed by so many of us, and we will all miss out on so many more of his intrepid innovations that will never be. But I do like to imagine Peter Lakatos now right there—“among the wildflowers”¹³. Farewell, Peter. □

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Published online: 12 July 2021

<https://doi.org/10.1038/s41593-021-00897-3>

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Competing interests

The author declares no competing interests.