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Editorials

The State of the Brain 2025: OHBM leaders and awardees reflect on the science and the community

Peter Bandettini, PhD[1][a], M. Mallar Chakravarty, PhD[2,3]

[1] Laboratory of Brain and Cognition, National Institute of Mental Health, Bethesda, MD, USA, [2] Department of Psychiatry, McGill University, Montreal, QC, Canada, [3] Brain Imaging Centre, Douglas Research Centre, Montreal, QC, Canada

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The "State of the Brain" special issue of *Aperture Neuro* is now in its third year. Each year, we invite the leaders, award winners, and invited speakers of the Organization for Human Brain Mapping (OHBM) Annual Meeting to reflect on the meeting, the community, their own research, the field of brain imaging as a whole, or another topic they feel is of importance to our community. This open-ended call has been a catalyst for a wide range of valuable, unique, and timely insights and perspectives. The nine papers of "State of the Brain: 2025" included calls to look deeper into the physiological and physical origins of the signals we measure, new framings of functional connectivity, consciousness, and generative modeling; and the expansion of cross-species imaging into rodents. Four of the nine 2025 contributions focused on the health of our community itself. Below is a short summary of each of these thought provoking papers from the 2025 issue, and an introduction to our 2026 iteration. Lastly, we offer our own perspective on the journal and how the field has been evolving in the past year.

INTRODUCTION

Following the OHBM 2024 meeting, Aperture Neuro initiated an annual special issue called the "State of the Brain," with the goal of having leaders, awardees, and invited speakers reflect on the Annual Meeting, the society, the field of brain mapping in general, controversies, or their own research. With this third iteration, the exercise is beginning to feel like the tradition it is becoming, and one that we believe reflects our mission as a journal supporting contributions by and for our unique and diverse international community of brain scientists.Our goal is that the papers that we receive create a snapshot of what our community is thinking about, grappling with, worried about, and excited about.

The 2025 snapshot has emerged as slightly different in character from 2024. The inaugural issue leaned toward methods and technology – BOLD contrast mechanisms, TMS robotics, OPM-MEG, and data reproducibility. In 2025, set against the backdrop of the meeting in Brisbane, Australia and a turbulent year for science funding, particularly in the United States, a substantial portion of the contributions turned to the community itself. The scientific contributions, in turn, converged on a shared theme that has been emerging over the years: we have become very good at describing our data, and we now need to understand where those patterns come from, or rather, what mechanisms influence them.

Below, we summarize the nine papers published in "State of the Brain: 2025," introduce "State of the Brain: 2026," and close with our own brief perspectives.

STATE OF THE BRAIN: 2025

Following OHBM 2025 in Brisbane, we received nine outstanding contributions to "The State of the Brain: 2025". They cover a breadth of topics: the biological interpretation of resting-state fMRI, eigenmodes and resonance, the definition of generative models, the relationship between consciousness and cognition, and cross-species imaging in rodents – alongside reflections on inclusivity, hearing accessibility, mentoring, and the harm caused by bullying and harassment in academia. The contributors and associated papers were the following:

Lucina Uddin (Keynote Speaker) contributed: "What the Organization for Human Brain Mapping community is do-

[a] **Corresponding Author:**
Peter Bandettini, PhD (bandettini.peter@gmail.com)
Laboratory of Brain and Cognition, National Insitute of Mental Health
Bethesda, MD, USA

ing right."[1] Drawing on nearly 20 years as an OHBM member, including service as Program Committee Chair, Dr. Uddin argues that OHBM is a model for promoting inclusive excellence in neuroscience. She traces the history of the society's diversity efforts – from NSF-funded student travel, to the Code of Conduct and childcare grants, to the annual Diversity Symposium, which in 2025 focused on the inclusion of First Nations in neuroimaging research. Her central message is that, at a time when diversity initiatives in the United States are under attack, OHBM's commitment has not wavered, and that this solidarity is what makes the community resilient.

J. Jean Chen (Education Chair) contributed: "Reflections on current trends in functional MRI — The State of the Brain 2025."[2] Dr. Chen surveys the techniques highlighted in the 2025 educational courses and keynotes, and then asks what the data they produce actually *mean*. I (Bandettini) resonated with this perspective as I regularly raise this question during talks and lab meetings. She describes the growing lexicon of resting-state dynamics – gradients, modes, quasi-periodic patterns, and large-scale dynamic causal modeling – and asks whether these patterns arise from neuronal activity, hemodynamics, systemic physiology, or cerebrospinal fluid dynamics. She then discusses the expanding role of fMRI in precision brain stimulation, including connectivity-guided TMS targeting, closed-loop systems, and digital twins. Finally, she reminds us that functional connectivity, while well-characterized, is not well understood. Her central argument is that if fMRI is to realize its full potential, the OHBM community needs to invest more in understanding the physiological underpinnings of the signal, beyond what big-data fMRI alone can offer. As another aside, I (Chakravarty) really sees an expanded role for model-systems here, where more traditional measures of physiology or basic neuroscience techniques (like opto-genetics or DREDDs) can be used to probe circuits.

Elvisha Dhamala (Diversity and Inclusivity Award) contributed: "The power of community."[3] Dr. Dhamala describes how OHBM – the Hackathon, the Special Interest Groups, and the Program Committee – shaped her career, and how the community supported her through completing a PhD largely in isolation during the COVID-19 pandemic. She argues that neuroimaging has been dominated by WEIRD (Western, Educated, Industrialized, Rich, Democratic) researchers studying WEIRD populations, which limits the generalizability of our findings. Diversity among researchers and among study populations is therefore not only an ethical goal but a scientific requirement. She proposes expanded mentorship programs, workshops, and public engagement so that geography and resources do not limit participation. Given the international scope of OHBM and the emerging regional chapters may be an excellent place to expand the scope and diversity of mentorship and the training programs that we can offer so that they better consider local resources, cultures, and geographies.

Sharna Jamadar, Julia Kam, Davynn Tan, Nicky Chong-White, and J. Tilak Ratnanather (Keynote Speaker) contributed: "Tous pour un, un pour tous (All for one, one for all): Accessible neuroimaging and research dissemination via speech to text apps."[4] This commentary addresses an under-appreciated aspect of inclusivity: hearing accessibility, both inside the MRI scanner and at scientific conferences. Communication with participants in the scanner is often poor, and is especially difficult for people who cannot use hearing devices in the magnet or who do not speak the local language. The authors demonstrate that a freely available speech-to-text captioning app can be used simply and effectively for a child with hearing loss in a 3T scanner. They also report on the accessibility "experiment" run at the 2025 OHBM roundtable, and offer practical recommendations that apply well beyond OHBM.

Amy Brodtmann (Mentor Award) contributed: "The other pandemic."[5] This is a deeply courageous and important paper. Reflecting on 25 years in imaging research, Dr. Brodtmann writes candidly about bullying and harassment in academia, including her own experiences, and about the colleagues who have changed departments, fields, or countries, or left research altogether, to escape them. When she asked her mentees what they valued in her mentoring, the consistent answer was "tough love": high expectations, combined with encouragement, support, and protection. She argues that we cannot afford to lose talent through a lack of courage to confront issues of bullying and harrassment, and that OHBM should set more clear behavioral expectations for its members and incentivize all to build safe and productive workplaces. In the current landscape of hard-fought funding and, oftentimes, skepticism over the role of science and scientific expertise in society, we cannot forget trainees are the true legacy of the scientific process. Making their academic journey supportive, safe, and attainable, while maintaining high expectations, is both the mark of true mentorship and an investment in the future of science.

Silvia Gini and Alessandro Gozzi (Keynote Speaker) contributed: "Expanding the cross-species lens: Rodents in focus."[6] The authors argue that cross-species functional imaging is moving from a niche pursuit to an essential theme in systems neuroscience, and that 2025 in particular produced compelling demonstrations of its potential in rodents. Historically, cross-species work focused on non-human primates, but rodents – especially the mouse – offer an enormous experimental ecosystem and precise causal tools. This team is a true proponent (and pioneer) in the shift from one-to-one regional correspondence toward network-level homology, as large-scale systems such as the default-mode and salience networks appear to be conserved from rodents to humans. This correspondence provides a common scaffold on which causal manipulations in rodents can help address long-standing questions in human neuroimaging. In particular, Gozzi's keynote address, relying on his rodent model research, spoke directly to Lucina's statements on our lack of understanding of what connectivity measures mean. Further still, the address provided an exciting presentation of how these techniques can be used to better understand neurodevelopmental conditions like autism.

Matthew Greaves, Leonardo Novelli, Michael Breakspear, and Adeel Razi (Keynote Speaker) contributed: "What is a generative model? Definitions, disagreements, and evaluation in human neuroimaging."[7] At OHBM 2025, the term "generative model" was used to describe everything from biophysical neural field models, to general linear models, to black-box AI systems, and SPM which is marking its 30th anniversary. Prompted by this, the authors surveyed the community. They found reasonable agreement on functional criteria, such as the ability to simulate data, but marked disagreement about whether specific, widely used methods qualify. Out-of-sample generalization and interpretability were consistently used. The authors propose a pragmatic working definition and a short set of reporting standards so that generative claims can be more easily interpreted and evaluated. Such action prevents a common problem in science of researchers "talking past" each other, each using terminology for which their definitions differ just enough so as to foster confusion and barriers to progress. This is an example of a community taking stock of its own vocabulary, thus reigning in terminology drift that can inevitably happen.

Melanie Boly (Keynote Speaker) contributed: "Human consciousness and cognition go hand in hand, but require different types of explanations."[8] Dr. Boly describes how consciousness science has moved from descriptive correlations to mechanistic predictions. The Perturbational Complexity Index (PCI), derived from TMS–EEG, is now in multi-center clinical validation for bedside assessment of unresponsive patients. Studies using awareness scales directly validated by subjective reports, together with improved statistical methods, suggest that some degree of awareness is necessary for above-chance performance – that consciousness is a prerequisite for most purposeful behavior rather than an epiphenomenon. Yet consciousness and cognition can also dissociate, and subjective experience is not fully captured by its behavioral expression. She argues that this motivates Integrated Information Theory (IIT) as a framework that makes testable predictions about conscious states independent of behavior.

Joana Cabral and Haeun Sun (Keynote Speaker) contributed: "Beyond networks: Functional connectivity as eigenmode resonance."[9] The 2025 meeting showcased a move beyond discrete networks toward continuous descriptions of brain organization – functional gradients, geometric modes, connectome harmonics, and field theories. This paper struck me (Bandettini) as among the most creative of the papers put forth by these esteemed researchers! The authors point out that brain activity can be decomposed into eigenmodes with varying weights. However, rather than being just a potentially useful construct, the authors suggest that we might consider the brain as actually a resonant system. For many more simple physical systems – a drum, a bridge, a bell – eigenmodes describe the system's intrinsic resonant patterns. If brain eigenmodes are *truly* eigenmodes, the authors argue, we should look to the principles that govern resonance in bounded systems, which are well established in acoustics, structural dynamics, and fluid dynamics, to understand their origin and meaning. We might also ask what benefit - computational, metabolic, or otherwise - could such a resonant system convey. While such bold ideas draw natural skepticism, including that of myself (Bandettini), I absolutely respect the act of putting this creative and thought provoking idea out there to be developed and tested to its limits, as such models ideas are, I believe, what the field needs more of. Hopefully this motivates debate and discussion about how to best model time-varying brain function with fMRI, and what the deeper implications might be.

STATE OF THE BRAIN: 2026

Shortly before OHBM 2026 in Bordeaux, France, we again invited the leaders, award winners, and keynote speakers to share their insights on the field, the Annual Meeting, and/or their own research. At the time of this writing, most of our invitees have agreed to write a perspective. We look forward to seeing which new themes or variations of old themes carry forward from 2025!

CONCLUSION

On reading the 2025 papers, two primary threads appear.. The first is scientific: several authors, approaching from different directions, argue that our descriptions of brain activity have outpaced our understanding of principles or mechanisms that might be derived. We need better models. The second is about our community: what it does well, where it falls short, and what it must protect.

From PAB's perspective: Several of the 2025 papers echo a concern I have had since the earliest days of fMRI. We have become extraordinarily good at extracting patterns of information from the BOLD signal – networks, dynamics, gradients, quasi-periodic patterns, even eigenmodes – but we still struggle to say what these *patterns actually mean or imply.* I have recently given several talks, where I have shown layer-specific activity and dynamic connectivity data from the work of those in my group. However, after describing the primary questions or hypothesis, then showing the data, and providing some interpretation of the results, I find myself feeling at a gut level that most interpretations fall well short of integrating into more mechanistic models of how the brain actually works. It's never comfortable to realize that, even with the best of intentions, one is falling into "hand waving" explanations. Our data acquisition abilities are increasing rapidly in sophistication, but I feel we need better, more precise predictive models which can then generate better questions and subsequently derive more true insight from the data.

Jean Chen explores the question of whether the signals reflect neurons, vessels, systemic physiology, or CSF. Joana Cabral and Haeun Sun ask whether our eigenmodes are truly resonances of a physical system or simply efficient mathematical constructs untethered to the reality of the brain. Matthew Greaves and colleagues show that we do not even agree on what we *mean* by a generative model! These questions suggest strongly that next advances will come from better contextualizing our measurements with phys-

iology, physics, mechanistic models, and causal manipulation – including, as Silvia Gini and Alessandro Gozzi show, in rodents, where we can directly perturb the system and observe the result with direct implications for how deeply we can interpret fMRI signals. I also continue to believe that the BOLD signal contains untapped information about neuronal activity and physiology, waiting for more sophisticated, model-driven approaches to help extract it.

From MMC's perspective: OHBM 2026 may be the farthest distance I've ever travelled to attend a scientific conference (I live in Montreal, Canada). In fact, it's likely one of the farthest distances I *could* travel to anywhere on the globe. But no matter where it is, OHBM feels different than any other meeting I could be attending. The faces are familiar and the innovation is always striking. Joanna Cabral's thought-provoking talk encouraged us to examine our data frame-by-frame and subject-by-subject and actually think deeply about how neural signatures behave in time and space. I find this take-home message refreshing in the age of big data and AI, where many labs use derivatives that are pre-processed for them. Alessandro Gozzi and Sylvia Gini remind us that we can creatively use animals to test hypotheses based on our observations in humans. Along with Jean Chen, they ask the question "what does the signal we observe even represent?" Is it neuronal excitation, neuronal inhibition? Something else? Can we use animal models to better understand the underlying architecture driving our observations related to how brain networks are organized? If we combine these observations with emerging and rapidly changing AI tools described by Adeel Razi we may find that we are well positioned, as a community, to decode and better understand brain structure and function through collaborations that span the multi-disciplinary breadth of our community.

Interestingly, there were three submissions that discussed diversity. Lucina Uddin's piece reminds us that we have made great strides when it comes to considering the cultural climate of OHBM and how we encourage members from diverse backgrounds to participate. It also reminds us that we have to hear them as well. Nonetheless, Elvisha Dhamala's piece reminds us that we have a long way to go before we can successfully claim that we have achieved representation across researchers and the study populations. Finally, Amy Brodtmann's piece reminds us that scientific rigour need not be born out of terror or bullying. It's one of the most powerful submissions I've ever come across as an editor, and I encourage readers of this journal to read through it. It will be worthwhile.

"State of the Brain: 2025" shows a field that is asking more fundamental questions about its own measurements and a community willing to look honestly at itself and continue to grow not only in size and breadth but in how well it helps support the international community of brain mapping scientists. "State of the Brain: 2026" promises to deepen and extend these conversations. The State of the Brain remains healthy, self-critical, and thriving.

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